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Research article

APPLICATION OF THE INTERNET OF THINGS AND 6G CELLULAR COMMUNICATION TO OPTIMIZE ACCOUNTING AND INTERNATIONAL MARKETING

Zenovii-Mykhaylo Zadorozhnyi, Volodymyr Muravskyi, Nataliya Pochynok, and Uliana Ivasechko

Abstract. Digitalization of marketing forms preconditions for personalization and individualization of advertising promotion of goods (works, services). Databases about consumer preferences and market situation are at the disposal of major international corporations, which makes it difficult for advertisers and admen. It is envisaged that the development of technologies of the Internet of Things (IoT) and 6G cellular communication should change the situation in the field of processing and using information for accounting, management and marketing purposes. The purpose of the scientific research lies in optimization of accounting and international marketing in terms of determining income, expenses and, accordingly, profits from the lease of commercial and advertising space in all international participants of lease relations on the basis of information generated by innovative technologies of the Internet of Things and cellular communication of the sixth communication generation. In particular, the method of using technologies of the Internet of Things and 6G cellular networks was developed for obtaining information about the movement of visitors of commercial establishments and their consumer preferences. The procedure for recognition and accounting of all market participants' income, expenses and, accordingly, financial results from the lease of commercial and advertising space has been developed, including operators of commercial establishments, advertisers, admen, and leasers. The organization of accounting the lease of commercial and advertising areas as part of international economic activity of enterprises has been optimized by providing international access to information and software and technical resources of the Internet of Things and cellular communication. Management decisions have been made as a reaction to information from a database about visiting commercial establishments. Based on the authors' proposals, the order of circulation of accounting and management information and funds from buyers to operators of trade networks, trade establishments, advertising agencies and, finally, producers of goods (works, services) are proposed through the systems of international information relations that form a closed cycle of economic activity at the global level and require further scientific research.

Keywords: accounting; international marketing; lease profit; commercial and advertising areas; the Internet of Things; 6G cellular communication; international economic activity.

Authors:

Zenovii-Mykhaylo Zadorozhnyi
West Ukrainian National University, Ukraine
E-mail: zadoroznuy.zenoviy@gmail.com
https://orcid.org/0000-0002-2857-8504

Volodymyr Muravskyi
West Ukrainian National University, Ukraine
E-mail: vavanm2@gmail.com
https://orcid.org/0000-0002-6423-9059

Nataliya Pochynok
West Ukrainian National University, Ukraine
E-mail: natapochynok@gmail.com
https://orcid.org/0000-0003-4416-3680

Uliana Ivasechko
West Ukrainian National University, Ukraine
E-mail: u.ivasechko@wunu.edu.ua
https://orcid.org/0000-0002-3317-2306

Correspondence author: Volodymyr Muravskyi, vavanm2@gmail.com

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1. Introduction

Further development of marketing is connected with personalization of the means of advertising promotion of goods (works, services). If the current practice of contextual advertising is focused on taking into account the information behavior of the Internet users, then the future of marketing is connected with monitoring the daily management of users in various life situations. Behavioral marketing is focused on the study of consumer decision-making in searching, selecting and purchasing goods (works, services). Information and communication technologies play an active role in the personalization of marketing research. Monitoring of the Internet search by users of cellular services in combination with tracking the movement of persons forms a significant information resource for marketing promotion of goods (works, services).

This accumulated database about consumers' behavioral actions and habits is available mainly to large international corporations. Advertisers are forced to seek the services of global players on the market of marketing services. Particularly the problem of a limited choice of marketing platforms and intermediaries in advertising is being sharpened by conducting international economic activity by an enterprise. International marketing services are offered by large transnational marketing corporations. Therefore, in the orientation of manufacturers and sellers of goods (works, services) to international markets one has to agree to a price supply without proper competitive methods of limiting monopolistic influence on marketing services. The issues of personalized and behavioral marketing at micro-level are becoming considerably urgent, but these problems are devoted very little attention to in the scientific domain and practical R&D activity.

Therefore, the article is focused on solving the problems of overall accessibility of innovative digital marketing for small companies through implementing technologies of the Internet of Things and cellular communication of the sixth generation into information processes of operators of commercial space and advertisers. The purpose of the research is to identify the facts of visitors' movement in commercial establishments using IoT and 6G technology to digitize the accounting of financial results from the rental of commercial and advertising spaces as part of the international marketing activity of businesses. On the basis of the use of innovative information and communication technologies capable of carrying out identification of persons and their behavior in public space (premises), it is possible to form local information bases that are useful for marketing purposes. Such technologies as the Internet of Things and cellular networks of the sixth generation provide decentralization of information processing. Local databases collected by the latest technologies directly in their places of occurrence may be owned by small local companies.

An access to such information resources can be given to arbitrary stakeholders on the principles of distance and payment, which creates favorable conditions for marketing promotion of goods (works, services) within the framework of international activity of businesses. Enterprises that trade products (works, services) in international commercial sites have the opportunity to control commodity flows and marketing activities. Business management receives a multifaceted information resource for management decisions related to sales and advertising. The ability to use personalized and behavioral information of consumers of goods (works, services) for accounting and marketing purposes at the international economic level determines the relevance and demand of the research topic.

This paper, together with the previous article by the authors Muravskyi et al [1], for the first time in the scientific space, determines the prospects of the combined use of IoT and 6G technologies for the digitization of accounting. It forms a scientific field for other researchers who are interested in the prospects of economic use of IoT and the future (not yet fully formed) 6G technologies. To disclose the topic of the research, the article has the following structural elements: the literature review of scientific research on the prospects of using the Internet of Things technologies and 6G cellular communication in economic processes; forming the purpose of the article, defining objects and hypotheses of research; selecting methods and methodological approaches in the process of scientific research; achieving the results of the research (justifying expediency and efficiency of using IoT and 6G technologies to determine the number and preferences of commercial establishments' consumers; improving the methodology of automated accounting of income, expenses and, accordingly, profits of all market participants of the lease of commercial and advertising space (operators of commercial premises, advertisers, admen, leasers of commercial and advertising space); organization of accounting of lease profits as part of international activity of enterprises); conclusions and prospects of further scientific research.

2. Literature Review

Among the few scientists in this field, it is advisable to distinguish Lu [2], who explored the historical stages of the cellular network development from 1G to 5G, which made it possible to identify future trends of economic use of prospective 6G technology. Popovski et al [3] conducted systematic research in the field of developing 6G cellular networking and connected concepts of "simultaneity", "presence" and "causality", which are basic categories in using new generation cellular communication in economic processes. Zhang et al [4] developed a methodology of decentralized processing and exchange of information using 6G cellular communication for implementing crowdsourcing (transmission of production and information functions of an indefinite circle of people). The problematic aspects of using the promising 6G technology of cellular networks were distinguished by Bourbah et al [5], who drew attention to the complexity of cyber defense of information, high cost of technology implementation, significant organizational restrictions and the need for infrastructure transformations in the transition to a new level of cellular development.

Scientists are actively discussing the branches of economic activities in which 6G technologies are the promising ones. Due to the integration of blockchain and cellular networks of the sixth generation, according to Khan et al [6], prerequisites for solid use of cellular communication in transport, construction, logistics are formed, and also as it has been proven by De Alwis et al [7], in the production industry. Supplementing the research on the branch use of the technology was carried out by Samanta et al [8], who identified the prospects for the provision of administrative services and the development of urban entities based on the principles of a smart city with sixth generation cellular communication. The place of the technology in the development of renewable energy systems was explained by Yap Kah et al [9]. Significant transformations, as it is proved by Singh et al [10], also undergoes the health care system with using cellular networks of new generations in telemedicine and access to medical databases.

There is also research conducted on the combined integration of various information and communication technologies with using 6G cellular communication. For example, Borah et

al [11] substantiated the expediency of building multi-stage artificial intelligence systems with direct communications through 6G cellular networks. As an example of machine learning based on 6G technology in industrial engineering, there can be cited the research on autonomous manufacturing of industrial equipment by Sumaiya & Alsekait [12]. The interconnection of digital doubles and 6G in ensuring autonomy and generative intelligence in economic systems was explained by Shu et al [13]. The 6G cellular connection, according to Wu [14], is the main construction of the 5.0 industry, which is based on the maximum level of autonomy of economic activity in combination with the increase in the enterprise personnel's professionalism. Al-Mohammed et al [15] continued the research and substantiated the prospects for the implementation of the Internet of Things technology on the basis of the Internet communication of cellular communication of the sixth generation in various spheres of economic activity.

It is also expedient to consider the study by Honar et al [16], in which the concept of uniting all the latest information and communication technologies around new generation cellular communication in integration with the Internet of Things devices was developed, which brings the digitalization of financial and economic processes to a new level. Most scientists support a joint conclusion about the prospect of developing of technology of The Internet of Things on the basis of communication exchange of information through 6G cellular communication. However, the ability to collect and process information on the use of 6G cellular networks, which constitutes an invaluable informational resource for marketing remains beyond the attention of scientists who are specialists in the practical use of cellular communication technologies. There are almost no scientific works in the field of methodology and organization of accounting for management and international marketing purposes using 5G and 6G technologies, which made it possible to formulate the purpose of the article.

The purpose of the scientific research lies in optimization of accounting and international marketing in terms of determining income, expenses and, accordingly, profits from the lease of commercial and advertising space in all international participants of lease relations on the basis of information generated by innovative technologies of the Internet of Things and cellular communication of the sixth communication generation. To implement the research, the tasks were formulated, which consist in: substantiation of expediency and efficiency of use of IoT and 6G technologies to determine the number of visitors of commercial premises and their consumer preferences; improvement of the methodology of automated accounting of income, expenses and, accordingly, the financial results of all international participants of the market of lease of commercial and advertising space; organization of information exchange in accounting of lease profits as a part of international activity of enterprises. The object of the research in the article is the economic processes and financial results from the lease of commercial and advertising space from the standpoint of accounting and international marketing.

3. Methods

The specific methods of scientific and empirical research were used in article. In particular, the systematic approach to scientific research has provided substantiation of systematic subordination of accounting to international marketing and management systems. The accounting system is an information generator of data on commercial and marketing processes for the purposes of managing international economic processes at an enterprise. Based on a systematic approach to scientific research, the article uses a list of scientific methods (Table 1).

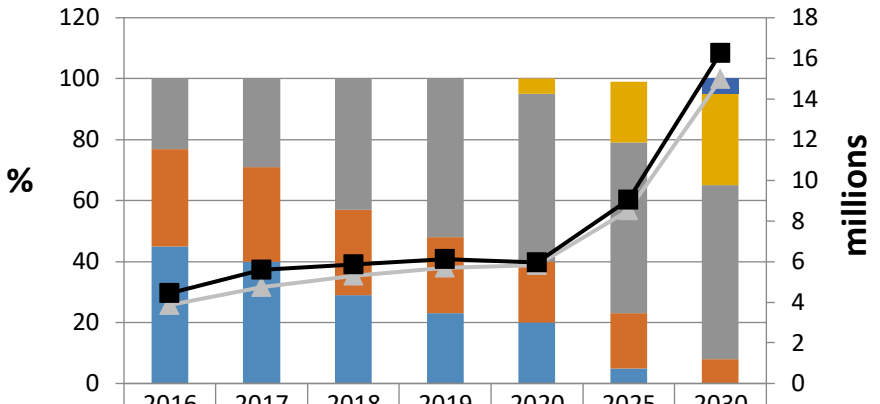
Table 1. Research methods

Section	Research method	Result
Introduction	Deductive method	The subject importance of the research topic has been substantiated. The topicality and perspective of the research in the field of renting commercial and international marketing spaces has been determined.
Literature Review	Economic and mathematical modeling	With the use of polynomial trending based on approximated and smoothed data using Excel, a forecast of the development of 6G cellular networks until 2030 has been provided.
	Graphical method	The use of Excel based on statistical and forecast data made it possible to build graphs on the development of 6G cellular communication.
	Bibliographic and comparative analysis	Empirical research was conducted with the use of a bibliographic approach known as "common word analysis" using the keywords "accounting" and "6G" on the "ResearchGate" information resource. The comparative analysis revealed promising directions for using 6G cellular network technology, which made it possible to determine the purpose and objects of the research.
Results	Functional method	The functional possibilities of IoT and 6G technologies in optimizing the accounting of the lease of commercial and international marketing spaces have been identified.
	Information and entropy method	The method of accounting of income, expenses and, accordingly, financial results from the lease of commercial and advertising spaces among all market participants has been improved, with the use of information about consumer preferences and the movement of visitors through commercial premises.
	Innovative method	Innovations in the organization of accounting and international marketing in the part of external communications between participants of the rental market of commercial and advertising space have been proposed
Conclusions	Generalization of data and research synthesis	Summarizing proposals and developments for explanation of their importance and feasibility. The contribution of the authors to the optimization of the accounting of financial results from the international lease of commercial and advertising space using IoT and 6G technologies and the directions of further research in this area have been determined.

The use of the above research methods made it possible to obtain the results of the scientific research.

4. Results and Discussion

The number of devices connected to cellular communication is increasing every year (from 3,863 million in 2016 to 5,826 million in 2020) [17]. Despite the permanent increase in cellular networks, the pace of introduction of new generations of cellular communication is decreasing (Fig. 1).



	2016	2017	2018	2019	2020	2025	2030
6G	0	0	0	0	0	0	5
5G	0	0	0	0	5	20	30
4G	23	29	43	52	55	56	57
3G	32	31	28	25	20	18	8
2G	45	40	29	23	20	5	0
Year-over-year growth	0.581	0.861	0.563	0.415	0.124	0.537	1.290
Mobile broadband subscriptions	3.863	4.724	5.287	5.702	5.826	8.513	14.965

Figure 1. The pace of cellular devices distribution by generation (2G-6G)
Source: Determined on the basis of ([17]; [18]; [19]); the 2030 indicator is calculated on the basis of data forecasting using Excel.

In particular, on the background of 4G cellular communication growth by 32 % in the previous 5 years, the estimated use of 5G technology in 2020-2025 will comprise only 15 percent (from 5,826 billion units to 8,513 billion units). Similar unsatisfactory indicators are expected for 6G technology, despite popularization of the Internet of Things, which is based on using the fast cellular Internet. Global spending on the development and implementation of IoT technology will grow from USD 646 billion in 2018 to USD 1,100 billion in 2023 [20]. However, the rate of spread of cellular communication devices is much lower than the development of technologies that function with the use of the Internet communication through cellular networks.

An obstacle to the rapid implementation of new generations of cellular communication technologies is the significant payback period of investment projects of cellular operators. In particular, based on the universal concept of the 5G technology development (Table 2), it is possible to estimate potential costs and revenues, as well as the payback period of investments in the implementation of new generations of cellular communication for any cellular operators in the countries of Northern Europe and Eurasia [1].

Under the basic scenario of global socio-economic development, the payback period for projects implementing 5G technology is pessimistically estimated to be 11.3 years. This indicator under a conservative version of socio-economic development is 12.6 years, if the global military-pandemic threats to the functioning of the enterprise continue. Even according to the most optimistic estimates, the investment can pay off in only 4.5 years. Such a trend is

most likely relevant for 6G technology as well, given the same development period as 6th generation cellular communication (Fig. 2).

Table 2. The payback period of 5G implementation projects per cellular operator (million USD)

Indicator	Pessimistic scenario	Optimistic scenario
Basic version of socio-economic development		
The operator's capital costs for implementing the technology	493	341
The increase in operating costs after the introduction of the technology	923	650
Net discounted income of the operator	597	976
Internal rate of return, %	21	23
Payback period, years	11.3	4.4
Conservative version of socio-economic development		
The operator's capital costs for implementing the technology	505	354
The increase in operating costs after the introduction of the technology	935	658
Net discounted income of the operator	571	960
Internal rate of return, %	20	25
Payback period, years	12.6	4.5

Source: Muravskyi et al [1]

The term of development of cellular communication of the fifth and sixth generations is 8 years, which is positively different from 3G (15 years) and 4G (12 years) technologies. Given the shorter term for research and development of new technologies in cellular communication, the pace of their practical implementation is unsatisfactory despite significant advantages over previous technologies.

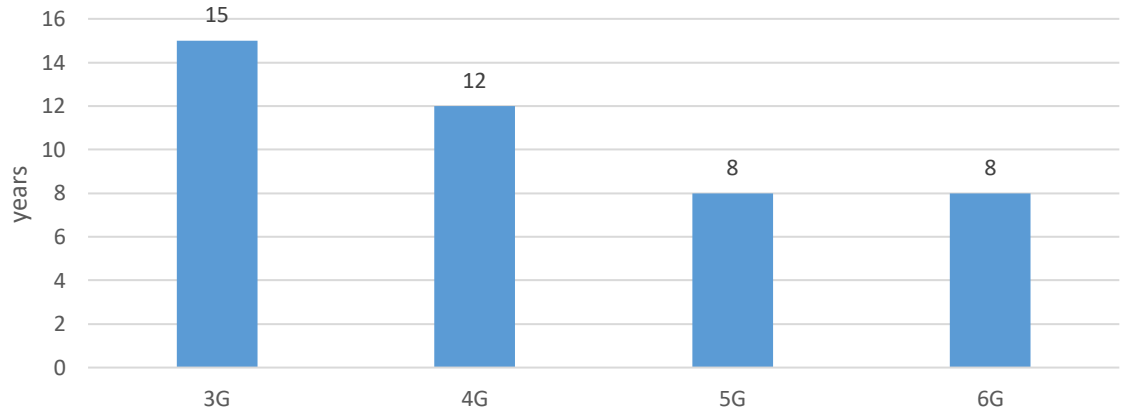


Figure 2. Development periods of 3G, 4G, 5G, and 6G mobile broadband technologies
Source: [21]

For example, the determining functional characteristic of 6G technology is the reliable and accurate identification of the location of the cellular subscriber. The sixth-generation networks are similar to the technology of global positioning (GPS-navigation) are able to determine the

spatial placement of a radio transmitter and a person respectively who is its owner. Unlike the two-dimensional determination (longitude and latitude) of the location of the GPS device, the cellular networks also monitor the height in the process of moving of the controlled object. 6G technology is capable of forming information about the three-wave positioning of the cellular device in the open and closed space. For the management system, an important information resource is the identification data on the movement of persons inside buildings by different floors, functional zones and individual premises. To achieve this goal, compared to cellular communication of previous generations, 6G technology is able to provide a significant bandwidth of the Internet communication (1000 gigabits per second) and at the same time provide information service to a large number of connected cellular devices (10 million devices per kilometer²) (Fig. 3).

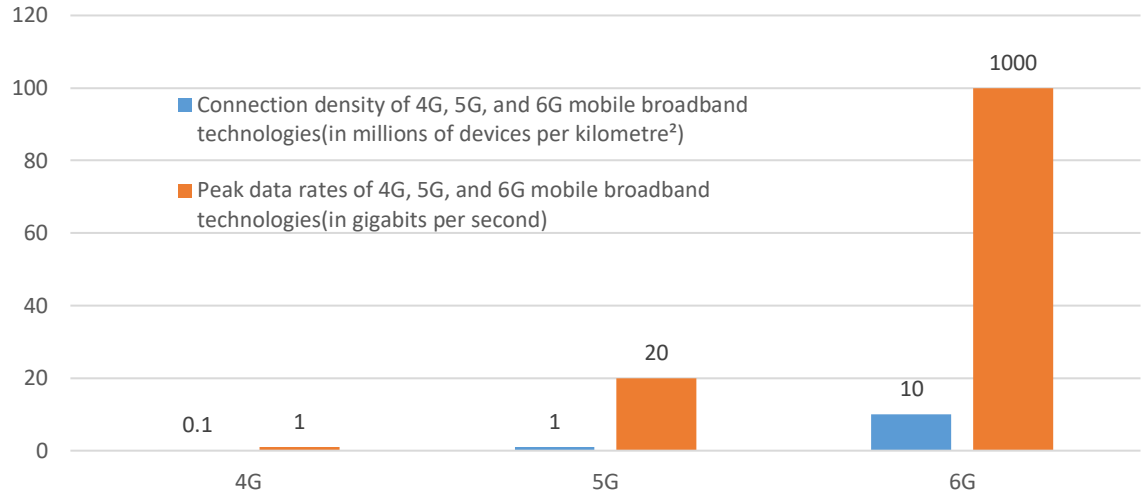


Figure 3. Connection density and peak data rates of 4G, 5G, and 6G mobile broadband technologies
Source: [22]; [23]

Another important possibility of cellular networks of the sixth generation is direct information synchronization with other technical devices at the micro-level. Cellular devices can exchange data without the involvement of operators' base stations. Through the Internet technology, information from 6G telecommunications devices can be accumulated in local databases. Information processes occur in the information environment of an enterprise even before data get to operators of cellular networks. There is already an increase in the number of local databases based on the use of IoT devices connected to the Internet via cellular communication (Fig. 4). In particular, in 2023, the number of access bases for IoT devices through cellular networks will reach 19,087 million units in transport, 15,762 million units in CCTV cameras, and 5,863 million units in home appliances and gadgets.

The Internet of Things technology with data transmission through local cellular communication provides collection of multilateral data and their operative transmission to the management and accounting personnel of an enterprise. As a result, enterprise management receives complete and reliable data on the movement of persons in buildings and adjoining territories. In addition, the use of IoT, implemented in household appliances and clothing items with a connection to

cellular communication, is gaining popularity (630.4 million devices in 2023). In particular, the Internet of Things technology is embodied in household devices, clothing elements, smart gadgets, technological sensors, which permanently transmit information through the cellular network, and is able to monitor household habits, individual characteristics of the body, a schedule of working and weekend days, communication links and, the main thing for international marketing, consumer preferences of individuals [26]. The functionality of IoT and 6G technologies in improving accounting and management are shown in Fig. 5.

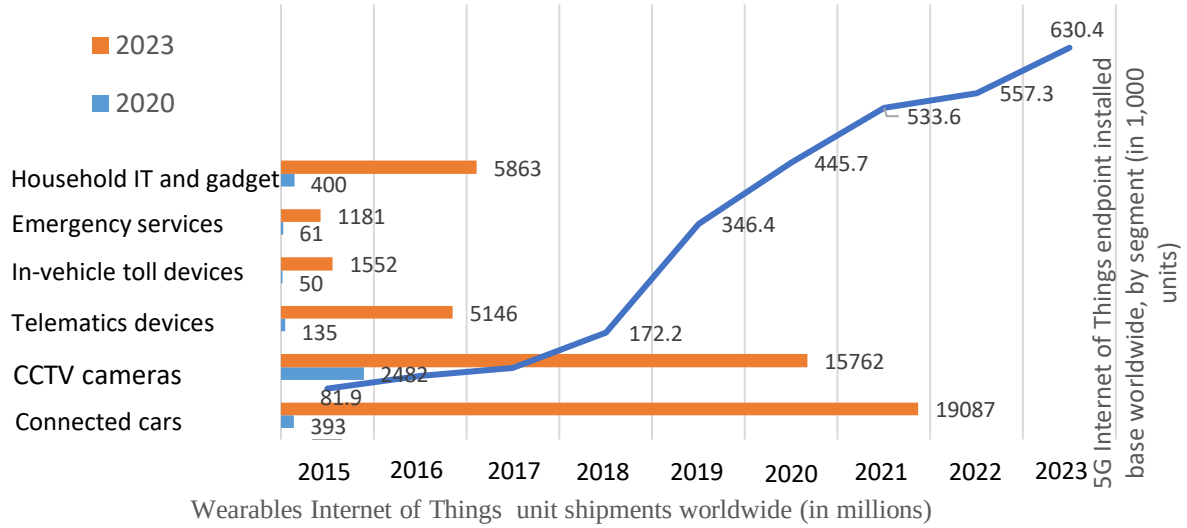


Figure 4. Global distribution of IoT technologies with connection to cellular communications of new generations by 2023.
Source: [24]; [25]

On the basis of information on the number of visitors of the commercial space and its leased area, it is possible to calculate the amount of rent. Determination of the number of visitors ensures the identification of the popularity of a particular commercial space. In most cases, popularity is the result of more profitable from the standpoint of the spatial organization of the location of the entrance and showcases of the commercial space. It is expedient to take into account optimal location of commercial spaces when determining the rent and, accordingly, the income of operators of commercial establishments.

Rental payments can be variable over different periods of time due to seasonal attendance of certain commercial establishments. Since during the New Year holidays traditionally turnover in commercial establishments increases as a result of increase of the number of buyers, the amount of rent may be larger. And vice versa, in the summer holiday season, the number of buyers is significantly reduced, which is the basis for adjusting the rent. It is advisable to form the amount of rent taking into account two factors: the area leased; the number of visitors of commercial premises. The optimal option is an equal ratio of the above factors. The best option is the equivalent ratio of the above factors. Establishing compliance between the rent and the leased area with taking into account the number of visitors, provides fair pricing in the commercial lease market. In addition, the costs of servicing public use areas and areas of general purpose (heating, air conditioning, cleaning, ongoing repairs, etc.) are mainly related to

direct operating (production) costs, which violates fundamental accounting principles. Premises that are not related to the main activity of commercial establishments include corridors, terraces, public toilets, stairs, escalators, adjoining and lounge zones and more.

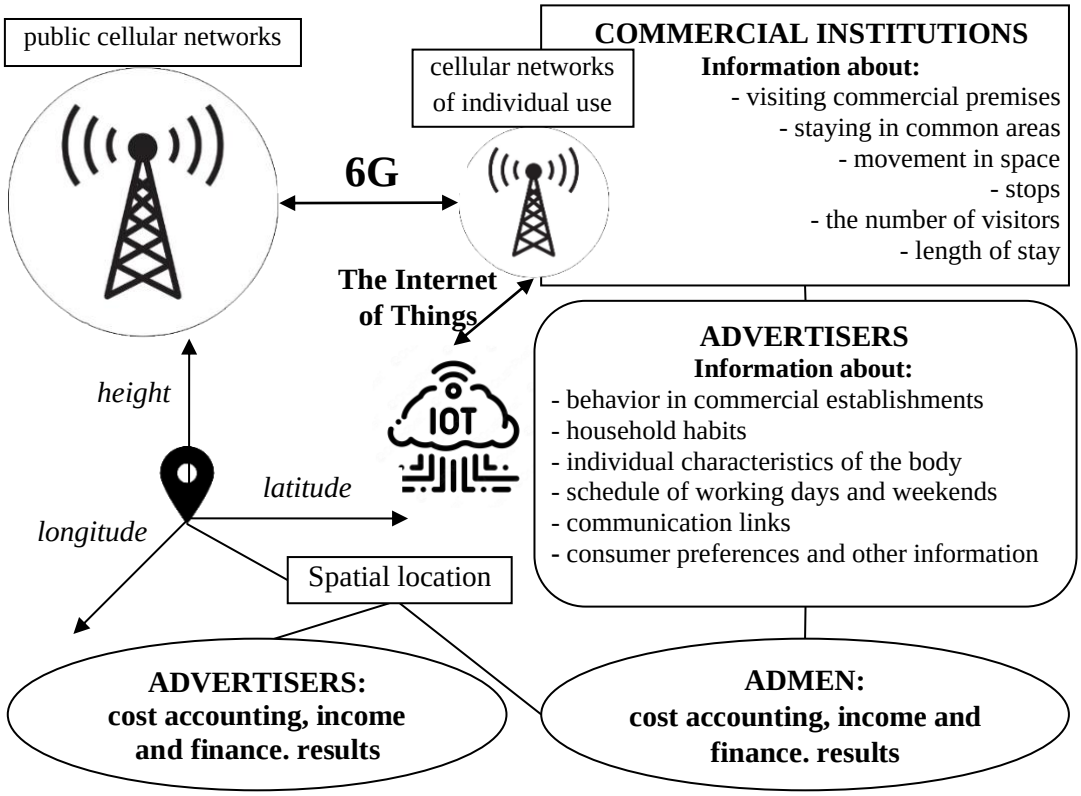


Figure 5. Using the Internet of Things and 6G cell networks for accounting purposes
Source: devised by the authors.

Instead, the identification of such costs, taking into account the number of visitors and their place of stay, provides reliable accounting and distribution. On the basis of accounting information on the total operational costs for the maintenance of all buildings and adjoining areas at the disposal of operators of lease areas, it is possible to organize effective analytical accounting. It is advisable to distribute the total volume of operating costs for the maintenance of the interior space in terms of leasers in proportion to the number of visitors of each room. Such costs are, in their economic essence, general production distributed and at the end of the reporting period are included in the cost of rental services. It is advisable to recognize the costs of maintaining the adjoining territories and at the end of the reporting period, to write off at the end of the reporting period.

It is also advisable to take into account the administrative costs of commercial establishments for the purposes of full and reliable calculation of the cost of lease services in management accounting. It is recommended to distribute administrative expenses in proportion to general production costs at the end of the reporting period. In order to reduce labor intensity of simultaneous financial accounting and management accounting of administrative expenses with their corresponding parallel attribution to financial results and the cost of lease services,

automation of accounting functions is important. Automated comparison of the given income and expenses also ensures prompt determination of financial results of operators of commercial areas. The methodology of digitalized accounting of income, expenses and, accordingly, financial results in the field of lease of commercial and advertising space is presented in Table 3.

Table 3. The methods for accounting of income, expenses and financial results from the lease of commercial and advertising space using IoT and 6G technologies

No.	Primary data	Object of accounting	Methodology of accounting
OPERATOR OF COMMERCIAL ESTABLISHMENTS			
1	The number of visitors, the area of commercial premises	Rent → operating income → financial results	The amount of rent depends on the number of visitors and the area of the commercial premises leased
2.	The number of visitors, the area of commercial premises and common use areas	Costs for the operation of the internal space of commercial establishments → distributed general production costs → financial results	Recognition of operational costs related to the internal space of commercial establishments, general production allocated to the maintenance of each premises in proportion to the number of visitors and the area leased
3	Number of visitors	Costs for maintenance of house territories → general production undistributed costs → financial results	Recognition of operating expenses connected with the internal space of commercial establishments, general production allocated to the maintenance of each premise in proportion to the number of visitors and the area leased
ADVERTISERS – ADMAN			
4	Place and length of stay of persons, number of visitors	Advertising payment → operating income → financial results	Display in accounting of the receipt of advertising payment after confirmation of the fact of demonstration of advertising
5	Location and length of stay of unique visitors	Advertising payment → operating income → financial results	Display in accounting of the receipt of advertising payment after confirmation of the individual user's reaction to advertising
6	Number of advertising displays and reactions to it	Marketing expenses → costs of main operating activities → financial results	Write-off the share of the costs of the main operating activity on the cost of the provided international marketing services in proportion to the number of advertising displays and the reaction to it
LESSEE OF COMMERCIAL AND ADVERTISING SPACE			
7	The number of visitors, the area of the commercial premises	Rent → operating expenses → financial results	Determining the costs of renting of commercial premises depending on their popularity among visitors and the area leased
8	The number of advertising views, the reaction to the advertising	Advertising expenses → sales expenses → financial results	Advertising payment in favor of the advertiser is determined in proportion to the number of views of the advertisement and the reaction to it at fixed (one-time) or dynamic rates (at the end of the period).
9	Number of people attracted by advertising, turnover	Income from the sale of goods (works, services), stimulated by advertising → operating income → financial results	Accounting of the growth of income from the sale of goods (works, services), attracted by advertising and an increase in the number of visitors to commercial establishments

Source: developed by the authors.

With the purpose of avoiding manipulations with the number of visitors for overestimating or reducing economic indicators, it is necessary to ensure the personalization of calculations. For this purpose, it is advisable to identify the unique persons who first visited the commercial establishment. Of the total number of visitors, it is recommended to exclude persons who have visited the commercial establishment. The return of visitors to the same premises cannot be recognized as the fact of their involvement through the use of marketing measures. Therefore, by determining the unique identification number of the cellular device, it is possible to calculate the number of people who first physically arrived into certain places of commercial space.

By comparing the indicators of the visitors' presence in the commercial establishment and reaction and the marketing measure, it is possible to calculate the effectiveness of international marketing. Therefore, unique visits to certain spatial areas of the premises automatically increase not only rent income but also marketing income. Operators of the commercial space have an active and effective zoning mechanism of all premises from the standpoint of the popularity among visitors, which determines the marketing value and the location of outdoor advertising objects. 6G technology provides a function of identifying the exact spatial location of people by attitude towards outdoor advertising objects. Additionally, surveillance cameras which are capable of operating on the principles of the Internet technology are able to track eye focus on spatial objects. As a consequence, it is recommended to identify the facts of visual perception of advertising signs, placards, banners, posters and other advertising objects.

The number and duration of visitors' stops near an advertising sign or commercial window is a criterion for determining the popularity and effectiveness of marketing measures in a commercial space. With increasing popularity of certain places for placing outdoor advertisement or products (goods), it is possible to calculate an integrated lease of advertising and commercial space. The cost of the lease is determined by taking into account the international marketing and spatial components with the attachment to the potential number of people who can be consumers of goods (services) of the leaser. In other words, the amount of rent should take into account visitors' access to the commercial space and the popularity of outdoor advertising objects. On the basis of accumulated information collected by the Internet of Things and 6G technologies, ways of people's movement can adaptively adjust the content of advertising. In particular, depending on the type of attending commercial establishments or a part of commercial premises with a certain type of goods, it is advisable to change the context of advertising and the method of marketing promotion. The content of advertisements is recommended to adapt to consumer needs and interests, which appear depending on the people's physical presence in certain commercial premises or zones. It is advisable to broadcast appropriate advertisements on smartphones and tablets, as well as on devices operating on the principles of the Internet technology. Such devices include smart TVs, smart watches, home appliances with the Internet access etc. Each of the gadgets is able to display advertisements that are most adapted to users' needs.

For advertisers and marketing companies, the ability of monitoring reaction to advertising facilities creates preconditions for automation of accounting and control of marketing profits. Similarly for the method of calculating advertising payments on the Internet, it is advisable to ensure accounting of costs and income from placing objects of outdoor advertising. Automatic identification of short-term facts of stay and contemplation on advertising objects initiates calculation and charging extra of advertising payments. After confirming the facts of

advertising contemplation, it is advisable to write off certain advertising payments that are its costs from the advertiser. Payment from the advertiser in favor of the advertising company is advisable to be recognized as the main operating income. Receipt of payment from the advertiser in favor of the advertising company should be recognized as its main operating income. The amount of advertising payment in proportion to the number of views can be fixed or dynamic over time. At a fixed rate, the advertising payment is accrued and recognized in the accounting of the advertiser's expenses and the advertiser's income immediately after the automatic confirmation of viewing the ad. At a dynamic rate, these costs and income are recognized in accordance with the approved advertising budget and the expected number of views. That is, the advertiser, based on retrospective information, predicts the number of advertising views for certain periods of time and forms a planned budget for international marketing. Accordingly, the advertising payment is accrued at the end of the reporting period at a predetermined rate.

If the number of views is significantly different from the planned figure, progressive and regressive coefficients of adjusting the advertisement budget may be applied. The advertiser will have to increase or reduce marketing costs from predetermined value. Instead, the advertising company also adjusts the appropriate income from marketing services. The formation of a complex advertising budget foresees accumulation of information on advertising views from different objects of international marketing promotion of goods. The amount of the advertiser’s expenses and operating income of the advertising distributor is determined by summarizing the corresponding indicators by all advertising platforms at which appropriate advertising is shown.

In commercial establishments, it is advisable to monitor the popularity of a particular type or kind of goods according to a similar method. Visiting of local commercial zones and shelves in commercial establishments with goods by persons should be positioned as an interest in buying. The more visitors are in local areas, the more interest have the goods which are placed in them. Information generated by the Internet of Things and 6G technologies is of interest to merchandisers for marketing promotion of goods. In particular, identification requires increased attention to low-sales products. That is, visitors are interested in goods, but for some reason they do not buy them. Such goods require the use of more active methods of stimulating demand, including: cost adjustment, active advertising, introduction of shares or sales, etc. Also, an important way to increase the sale of certain goods is to move them to other commercial areas. Additional actions lead to new marketing costs among advertising distributor. After intensifying marketing activities, it is necessary to re-monitor the effectiveness of advertising due to the ratio of marketing costs to advertisers’ income.

The customer of advertising has an effective mechanism for quantitative evaluation of advertising efficiency. It is advisable to compare the increase in the number of visitors for each type of commercial space and goods with the number of people who have been shown advertising. If there is a significant increase in the flow of visitors in a commercial establishment, then personalized advertising was effective. Also, the growth of operating income of commercial establishments from the sale of each type of goods (works, services) can be directly related to the cost of its international marketing promotion, which is an element of economic assessment of the results of advertising activities.

On a similar principle, it is recommended to account the expenses of the advertiser for conducting advertising events. All costs for the organization and conducting of advertising measures are accumulated during the reporting period in the cost account of the main operating activity during the reporting period. At the time of receipt of an advertising payment, which is the income of the advertiser, it is advisable to automatically write off the corresponding share of the main operating (production) costs associated with obtaining this income to the cost of providing advertising services. In order to ensure the efficiency of accounting with an advertiser, one can use the planned values of expenses with subsequent adjustment to the actual indicators at the end of the reporting period. Since under conditions of using the Internet of Things and 6G technologies, income can be determined by each targeted advertising show, it is advisable to automatically reflect the share of adequate costs incurred for the implementation of the advertising event in accounting. By comparing operating income and expenses from marketing services, it is possible to automatically determine the financial result of an advertising company. Accordingly, the overall financial result of an advertiser for the reporting period will equal to the amount of single financial results from personal advertising, which is demonstrated by each individual potential consumer of goods (works, services).

Information from the system of automated accounting and management of shopping establishments using the Internet of Things and 6G technologies can be removed remotely to all stakeholders. Large commercial networks rent commercial and advertising areas at the same time in many countries. International aspect of business is focused on the global distribution of goods and services, which causes activation of the international exchange of accounting information. In most cases, customers and advertising services are in different countries. The organization of accounting for the lease of commercial and marketing space for the purposes of effective international management and marketing is shown in Fig. 6.

In order to digitize the accounting of income and expenses (respectively, financial results), it is advisable to ensure automation of the primary processing of accounting information in the places where it occurs. That is, in international commercial establishments, automated collection with the use of the Internet of Things and 6G data on visitors to commercial premises is necessary. In the future, primary data must be transferred to advertisers and admen in turn. Information collected by the Internet of Things and 6G technologies is accumulated in international databases. Ownership of various software, technical and informational resources can be distributed among all participants of the market for renting commercial and advertising space.

Technical devices for collecting data about visitors to commercial establishments may belong to the operators of commercial networks. Databases about the popularity of shopping and advertising spaces among visitors are the property of advertising companies, which may provide limited access to advertisers based on the principles of international availability and payment. Part of advertising payments received is redistributed by advertisers in favor of commercial establishments, cellular network operators and other participants of the rental market, which provide maintenance of technical devices of the Internet of Things and 6G technologies.

Admen use this data to manage advertising placement and accounting of financial results of advertising companies. Accounting and management employees of advertising companies carry

out remote selection of advertising media, advertising content in accordance with the audience and interests of visitors to commercial establishments, search for optimal places for placing advertising, determine its popularity and effectiveness, quickly adapt marketing measures to the needs of consumers of goods (works, services). Representatives of advertisers, on the basis of remotely collected information, make decisions about international popularity of: leased commercial premises, advertising means for supermarket visitors, individual groups or types of goods for end consumers. In the future requests for the following there may arise: a lease of space in other premises of commercial establishments, a change of vendors and operators of commercial networks, a review of contracts with advertising companies, replacement of advertisers, diversification of advertising activities, revision of product and price policies, etc.

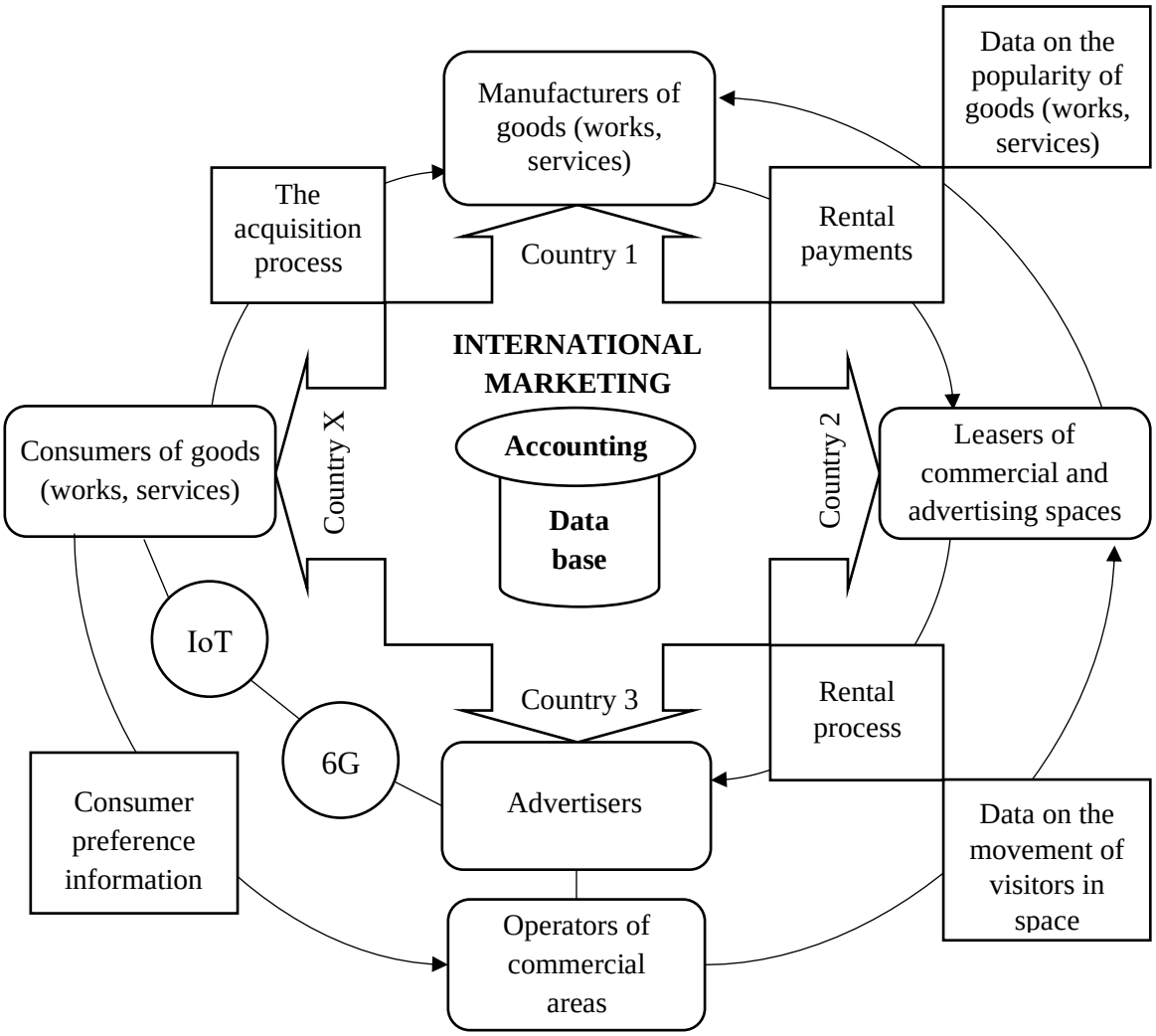


Figure 6. Organization of cash flows accounting in international marketing
Source: developed by the authors.

Through the system of international economic relations, the circulation of accounting and marketing information is ensured between the participants of the market for renting commercial and advertising space, as well as funds from end buyers to operators of commercial networks, commercial establishments, advertising companies and, in the end, producers of goods (works,

services). Information and money circulation forms a closed cycle of international economic activity at the global level, which requires further scientific research and development in the management of accounting and production and international marketing processes.

5. Conclusions

The implementation of information and communication technologies in business activities has led to the digitalization of economic (primarily international marketing and accounting and management) processes. Large international corporations form global electronic databases on consumers of goods (works, services) and provide paid marketing services to advertisers on their basis. Local operators of commercial and advertising spaces are capable of breaking the monopoly of international e-business corporations, who are able to form local databases thanks to the use of sixth generation cellular communication technologies and the Internet of Things.

The database collected by innovative the Internet of Things and 6G technologies accumulates information about visits to commercial premises, stays in general areas of stores, movement in space, people stopping, number of visitors, duration of their stay, etc., and consumer preferences of visitors of commercial establishments. On the basis of this database, it is possible to digitize accounting: for operators of commercial networks – the rent depending on the number of visitors (operating income), costs for maintaining separate commercial premises and areas of general use (operating costs); for advertisers – advertising payments after confirming the facts of advertising display and response to it (operating income), costs for rendering marketing services (operating costs); for leasers – fees for renting premises (operating expenses), advertising expenses (sales expenses), income from the sale of goods (works, services) stimulated by advertising (operating income). Digitization of accounting of the given income and expenses provides automated determination of financial results of all participants in the rental market of commercial and advertising space.

Stakeholder access to the database of accounting and management and marketing data can be provided based on distance and payment. Remoteness foresees the implementation of international economic activities of enterprises in the field of renting commercial and advertising spaces. Producers and consumers of goods (works, services), advertisers and admen, operators and leasers of commercial premises in most cases can be located in different countries. The accounting system is entrusted with the function of international electronic communications between all participants of the market for renting commercial and advertising spaces for the exchange of accounting, management and marketing information. The principle of payment is implemented through the provision of paid services for the global distribution of this information. Part of the received payments are redistributed to the benefit of commercial establishments, cellular network operators and other participants of the rental market, who carry out servicing of technical devices of the Internet of Things and 6G technologies.

Through systems of international economic relations, the circulation of accounting and management, marketing information and funds is ensured from end buyers to operators of commercial networks, commercial establishments, advertising companies and, in the end, producers of goods (works, services), which forms a closed cycle of international economic activity at the global level.

The need for optimization of accounting and international management as well as production and marketing processes in the global circulation of information and money flows with the use of innovative information and communication technologies is the subject of further scientific research. However, a significant limitation of further research in this area is the lack of final technological parameters and organizational conditions for the use of 6G technology, the implementation of which is planned after 2030.

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References

1. Muravskyi, V., Zadorozhnyi, Z.-M., Lytvynenko, V., Yurchenko, O. & Koshchynets, M. (2022). Comprehensive use of 6G cellular technology accounting activity costs and cyber security. *Independent Journal of Management & Production* (Special Edition ISE, S&P), vol. 13, 3, 107-122. https://doi.org/10.14807/ijmp.v13i3.1902.
2. Lu, Yang. (2020). Security in 6G: The Prospects and the Relevant Technologies. *Journal of Industrial Integration and Management*, 5, 271-289. https://doi.org/10.1142/S2424862220500165.
3. Popovski, P., Chiariotti, F., Huang, K., Kalør, A., Kountouris, M., Pappas, N. & Soret, B. (2021). A Perspective on Time towards Wireless 6G. *22nd IEEE International Conference on Industrial Technology (ICIT)*, vol. 110, 8, 1116-1146. https://doi.org/10.1109/JPROC.2022.3190205.
4. Zhang, J., Wang, Z., Wang, D., Zhang, X., Gupta, B B., Liu, X. & Ma, J. (2021). A Secure Decentralized Spatial Crowdsourcing Scheme for 6G-Enabled Network in Box. *IEEE Transactions on Industrial Informatics*. 1-11. https://doi.org/10.1109/TII.2021.3081416.
5. Bourbah, A., Meliani, B., Zhour, M. & Zouine, Y. (2023). The Next-Generation 6G: Trends, Applications, Technologies, Challenges, and Use Cases. *Proceedings of Seventh International Congress on Information and Communication Technology*, 761-770. https://doi.org/10.1007/978-981-19-2394-4_68.
6. Khan, A., UL Hassan, Naveed, Y., Zhao, J., Niyato, D., Zhang, Y. & Poor, H. V. (2021). Blockchain and 6G: The Future of Secure and Ubiquitous Communication. *IEEE Wireless Communications*, vol. 29, 1, 194-201. https://doi.org/10.1109/MWC.001.2100255.
7. De Alwis, C., Pham, Quoc-Viet & Liyanage, M. (2022). Key 6G Technologies. *6G Frontiers*, 35-53. https://doi.org/10.1002/9781119862321.ch4.
8. Samanta, S., Sarkar, A. & Bulo, Y. (2022). Secure 6G Communication in Smart City Using Blockchain. Emerging Technologies in Data Mining and Information Security, *Proceedings of IEMIS 2022*, 1, 487-496. https://doi.org/10.1007/978-981-19-4193-1_48.
9. Yap Kah, Y., Chin, H. & Klemeš J. (2022). Future outlook on 6G technology for renewable energy sources (RES). *Renewable and Sustainable Energy Reviews*, 167, 112722. https://doi.org/10.1016/j.rser.2022.112722.
10. Singh, C., Vijayaragavan, M., Sureshbabu, J. & Alsekait, D. (2022). IoT based secured healthcare using 6g technology and deep learning techniques. *Journal of Pharmaceutical Negative Results*, vol. 13, 9, 462–472. https://doi.org/10.47750/pnr.2022.13.S09.053.
11. Borah, M., Wright, S., Deka, G. & Singh, P. (2022). Role of 6G Wireless Networks in AI and Blockchain-Based Applications. *Prospects of Blockchain Technology for Accelerating Scientific Advancement in*

Healthcare. https://www.researchgate.net/project/Prospects-of-Blockchain-Technology-for-Accelerating-Scientific-Advancement-in-Healthcare.
12. Sumaiya, N. & Alsekait, D. (2022). Machine Learning Based Industrial Engineering With 6G Technology. *Journal of Pharmaceutical Negative Results*, vol. 13, 9, 372–385. https://doi.org/10.47750/pnr.2022.13.S09.46.
13. Shu, M., Sun, W., Zhang, J., Duan, X. & Ai, M. (2022). Digital-twin-enabled 6G network autonomy and generative intelligence: *Architecture, technologies and applications. Digital Twin*, 2, 16. https://doi.org/10.1007/978-981-19-4193-1_48.
14. Wu, Yulei. (2022). Ethically Responsible and Trustworthy Autonomous Systems for 6G. *IEEE Network*, 36, 126-133. https://doi.org/10.1109/MNET.005.2100711.
15. Al-Mohammed, H. & Yaacoub, E. (2021). On The Use of Quantum Communications for Securing IoT Devices in the 6G Era, 1-6. https://doi.org/10.1109/ICCWorkshops50388.2021.9473793.
16. Honar, P. H., Demidenko S.N., Aslam S. & Harris M. (2022). Blockchain and 6G-Enabled IoT. *Inventions*, 7, 109. https://doi.org/10.3390/inventions7040109.
17. Mobile broadband subscriptions worldwide (2023). Statista. https://www.statista.com/statistics/273016/number-of-mobile-broadband-subscriptions-worldwide-since-2007/
18. Mobile technology share by generation (2023). Statista. https://www.statista.com/statistics/740442/worldwide-share-of-mobile-telecommunication-technology/
19. Global 5G subscription forecast (2023). https://www.statista.com/statistics/760275/5g-mobile-subscriptions-worldwide/
20. Prognosis of worldwide spending on the Internet of Things (IoT) (2023). Statista. https://www.statista.com/statistics/668996/worldwide-expenditures-for-the-internet-of-things.
21. Development periods of 3G, 4G, 5G, and 6G mobile broadband technologies (2023). Statista. https://www.statista.com/statistics/1184400/mobile-broadband-development.
22. Connection density of 4G, 5G, and 6G mobile broadband technologies (2023). Statista. https://www.statista.com/statistics/1183690/mobile-broadband-connection-density.
23. Peak data rates of 4G, 5G, and 6G mobile broadband technologies (2023). Statista. https://www.statista.com/statistics/1183654/mobile-broadband-peak-data-rates.
24. Wearables unit shipments worldwide (2023). Statista. https://www.statista.com/statistics/437871/wearables-worldwide-shipments.
25. 5G Internet of Things (IoT) endpoint installed base forecast worldwide (2023). Statista. https://www.statista.com/statistics/1061195/5g-iot-endpoint-installed-base-by-segment-worldwide.
26. Zadorozhnyi, Z.-M., Muravskyi, V., & Muravskyi, V. (2021). Combined Outsourcing of Accounting and Cybersecurity Authorities, *11th International Conference on Advanced Computer Information Technologies (ACIT).* 544-547. https://doi.org/10.1109/ACIT52158.2021.9548649.