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## Shadow Economy and a New Quality of De-shadowing Policy Through the Use of Artificial Intelligence Tools

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**Abstract.** *The article identifies the actual socio-economic effects of legalization and the threat of shadowing from the use of AI in business and entrepreneurship; to indicate indicators that demonstrate the integration of digital technologies in business for the purpose of transparent business conduct. The state of the shadow economy in the country and the state policy of de-shadowing using AI tools. To achieve the specified goal, the work used methods of analysis and synthesis, grouping, and generalization, which allowed for a comprehensive study of existing scientific achievements on the issues of digital transformation of business using AI, to solve the tasks set for scientists, and to outline the prospects for future research in the area of forming an effective mechanism for the policy of de-shadowing domestic business based on AI tools. The socio-economic benefits of using AI in partial de-shadowing of economic relations are substantiated and indicated, including personalized assistants that reduce the burden on the employee and eliminate the human factor; the ability of AI to protect itself from cyberattacks, that's, to build a new quality of cyber protection in working with business partners and state institutions. The authors found that with the advent of AI, new challenges arise, such as new tax evasion schemes, i.e., the threat of shadowing economic relations. Scientists argue that the level of shadowing in a country is influenced by institutional capacity. Research has shown that the more software is used, the more likely a company is to eventually use artificial intelligence technologies and use fewer employees. The authors express the opinion that the shadow economy has grown in the last decade due to the emergence of new methods and ways of shadowing economic activity, which were formed on the basis of innovative financial instruments and new generation digital technologies. Prospects for further research include studying the specifics of using AI for the transparency of business process algorithms of digital enterprises, the protection of buyers' personal data, and the ethics of online trading.*

**Keywords:** legalization; digital de-shadowing tools; AI technologies; digital development; cloud computing; Big Data.

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## Тіньова економіка та нова якість політики детінізації за рахунок використання інструментів штучного інтелекту

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### Анотація.

У статті визначено фактичні соціально-економічні ефекти легалізації та загрози тінізації від використання ШІ в бізнесі й підприємстві; надано показники, що засвідчують інтеграцію цифрових технологій у бізнесі для прозорого ведення бізнесу. Для досягнення визначеної мети в роботі використано методи аналізу й синтезу, групування й узагальнення, що дали змогу комплексно опрацювати наукові здобутки з питань цифрової трансформації бізнесу і підприємства з допомогою використання ШІ. Обґрунтовано соціально-економічні корисності використання ШІ в частині детінізації економічних відносин, зокрема персоналізовані асистенти, що зменшують навантаження на працівника та усувають людський чинник; здатність ШІ убезпечитись від кібератак, тобто вибудувати нову якість кіберзахисту в роботі з бізнес-партнерами і держінституціями. З'ясовано, що ШІ зумовлює нові виклики, зокрема з'являються нові схеми ухилення від сплати податків. Науковці стверджують, що на рівень тінізації в країні впливає інституційна спроможність. Аргументовано, що зі зростанням рівня використання програмного забезпечення підвищується ймовірність упровадження підприємствами технологій ШІ, що з часом може призвести до скорочення потреби в найманій праці. Висловлено думку, що протягом останнього десятиліття тіньова економіка зростає внаслідок появи нових методів і механізмів тінізації економічної діяльності, сформованих на основі інноваційних фінансових інструментів та цифрових технологій нового покоління. Перспективи подальших досліджень полягають у вивченні особливостей використання ШІ з метою забезпечення прозорості алгоритмів бізнес-процесів цифрових підприємств, захисту персональних даних споживачів та дотримання етичних принципів інтернет-торгівлі.

**Ключові слова:** легалізація; цифрові інструменти детінізації; технології ШІ; цифровий розвиток; хмарні обчислення; великі дані.

**Statement of the problem.** The development of the shadow economy (SE) in the 21st century is gaining more and more scale. We are witnessing such types of corruption as institutional, intergovernmental, interpersonal. Nepotism is a component of the SE. It has become quite widespread in the former socialist republics, in particular in Ukraine. The SE has been systematically strengthened, in part due to its scaling in the last decade, due to new methods and ways of shadowing economic activity, which are formed on the basis of innovative financial instruments and new generation digital technologies. We are talking about AI, the IoT, blockchain technology, Big Data, and generative pre-trained transformer (chat-GPT).

The presence of a SE in the country is evidence of the imperfection of state institutions in terms of quality management. Weak official institutions, i.e., non-working laws, create the basis for the formation and development of strong informal institutions, which only contribute to the flourishing of the SE. In general, it's worth emphasizing the fact that high-tech production is not characteristic of the SE. Shadow business is aimed at obtaining quick economic benefits without involving high-tech production and digital technologies. But, if we talk about "the activities of the digital SE, then it is carried out exclusively in electronic space without official business registration and tax evasion" [1, p. 502]. A characteristic feature of the SE is "any undocumented action. It's this type of action that can be massively carried out in the spaces of the digital world, without any evidence or fixation, neither in real nor in virtual space" [2, p. 129].

**Literature review.** The focus of scientific attention of M. Navickas, V. Juscius and V. Navickas is focused on identifying the relationship between the increase in the tax burden on labor and the growth of the SE [3, pp. 1–2, 11]. The researchers concluded that income inequality, business freedom,

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corruption levels, and the impact of GDP per capita are variable determinants of the SE in Eastern European countries.

The study of AI and the use of its methods (for example, machine learning, deep learning, neural networks, expert systems, knowledge-based systems) in economic activity, using a scientometric approach, was once carried out by scientists S. Bickley, H. Chan and B. Torgler [4]. Investigated AI methods as alternative modeling methods, compared the effectiveness of AI methods with mechanistic models solely to create datasets for validation/testing AI methods, scientists Y. Ye, A. Pandey and C. Bawden [5, p. 9].

We consider the research of K. Cufar [6] to be valuable in a scientific sense, because she considered the concept of AI as hardware/software, in order to expand the range of ethical and legal issues that should be resolved by regulating AI. According to K. Cufar, a holistic and systematic interpretation of the AI phenomenon deprives it of its imaginary uniqueness. She emphasizes that if “we seriously consider the issue of global extraction of materials, labor and data necessary for the creation of artificial intelligence machines, then artificial intelligence becomes another example of colonial capitalism” [6, p. 307].

Researchers Y. Qin, Z. Xu and X. Wang dedicated their publication to studying the impact of AI on the country’s economic development through the prism of intelligent decision-making, social governance, innovation, and Industry 4.0, conducting a content analysis [7]. M. Amanova devoted his research to studying the impact of digitalization and the application of various digital tools to reduce the SE [2].

A group of foreign scholars, T. Chin, Q. Li, F. Mirone and A. Papa, have creatively approached the disclosure of the contradictory effects of the use of shadow AI on knowledge leakage in metaverse-based business models. They formulated and revealed the meaning of the Yin and Yang paradox through the prism of the SE. The scholars emphasize that the Yin and Yang dialectic has a deep philosophical origin, which is aptly suited to explaining socially constructed norms and ethical issues. They concluded that “the accelerated evolution of artificial intelligence technology allows firms to create metaverse-based business models where the use of shadow AI is widespread” [8].

L. Gasparenienea, R. Remeikienea and V. Navickas [1] devoted their scientific research to the study of the SE of the country. Scientists point to the fact of voluntary consent to participate in shadow schemes between the seller and the buyer, where, moreover, each of them inflates benefits and advantages for himself. On the other hand, the researchers established the fact that consumers recognize digital shadow activities as illegal and point to the need for effective work of the legislative branch of government and legal institutions. Consumers see the need to bring to administrative and criminal liability all, without exception, who are participants in digital shadow transactions. Among a number of measures aimed at de-shadowing e-commerce, scientists L. Gasparenienea, R. Remeikienea and V. Navickas indicate the need to create an e-police institute, publish information about identified unscrupulous e-sellers in the e-space, constantly monitor the effectiveness of the work of regulatory authorities, and develop AI-based software for instant detection of shadow business owners [1, pp. 502, 506–507].

We managed to reveal the content of the digital transformation of Industry 4.0 towards the formation of Industry 5.0 of a national type by using the capabilities of AI, Big Data and the IoT [9]. We also managed to present the regional development of Industry 5.0 and the search for opportunities for digitizing infrastructure based on the application of AI in the author’s scientific vision [10].

**Purpose.** The purpose of the article is to consider the socio-economic effects of legalization and outline the threats of shadowization from the use of AI in business and entrepreneurship, analyze the actual size of the SE in some countries of the world, and Ukraine in particular; indicate the instruments of de-shadowing policy that may occur as a result of the application of AI; identify the factors of the

development of the SE of Ukraine; reveal the reasons for the change in the Digital Transformation Index of Ukraine by region according to the sub-indices Internet Development, Institutional Capacity and analyze these changes in connection with the shadow activities of e-business.

**Results.** Innovative and technical and technological changes in the field of information technology and computer engineering are radically transforming traditional production, market, business and management, digitizing it [2, p. 127]. In the 21st century, we are witnessing how “economic crises and changes in fiscal policy dictate the volume of informal economic activity” [11, p. 2525].

The SE includes any type of economic activity that’s hidden from government authorities in order to avoid paying taxes and non-compliance with regulations. The SE “undermines” government revenues, contributes to the inconsistency of the regulatory framework for competition, destabilizes economic activity [13, p. 2526] and causes businesses to either close down or keep double-entry bookkeeping.

In the last 10 years, there has been an increase in transactions in e-space, which’s accompanied by an increase in the number of illegal digital operators and contributes to the involvement of consumers in digital shadow trade [1, p. 502]. The digital SE indicates the development of illegal, unregistered or unconfirmed official activity on the Internet, but which is aimed at making a profit, which’s characterized by tax evasion or circumvention of legal norms regarding trade and/or business reporting [1, p. 507].

With the emergence of new generations of digital technologies, there’s a paradoxical interaction between unethical employee behavior in the use of AI and its consequences. This points to unconventional but crucial challenges that digital entrepreneurship face in achieving the UN Sustainable Development Goals, as “the use of shadow AI by employees in business not only provides benefits, but also creates risks of organizational knowledge leakage” [8]. We share the opinion of K. Cufar, who emphasizes the fact that “AI as software/hardware prompts us to consider that the threats to fundamental rights posed by AI software are hopelessly intertwined with the threats posed by AI hardware. Transparent and fair AI can’t be the product of colonial displacement and dispossession. Instead of endless proliferation, a sustainable AI industry that is mindful of human rights inevitably involves fewer and more expensive, maintainable, and durable technological products. Technological interventions should be guided not by corporate greed and the desires of privileged users, but by the real needs of humanity as a whole” [6, pp. 326–327].

The 2023 indicators of the SE sector are of some concern, since the share of the SE in the GDP structure of most countries is too large. Thus, the leader in SE is Sierra Leone (64.5%). Tanzania (44.7%) and Mozambique (39.8%) are also characterized by high indicators of shadow economic activity in the country. The former republics of the Soviet Union, such as Uzbekistan (24.4%), Georgia (22.1%), Armenia (18.9%), Azerbaijan (17.7%), Kazakhstan (11.2%), have a significant level of shadow economic activity, which requires the governments of these countries to have a high-quality and effective policy of legalizing economic activity. As for Lithuania (7.4%) and Latvia (9.3%), in these countries after their accession to the EU the level of the shadow sector gradually decreased, and in the last 10 years it’s less than 10%, which testifies to the effectiveness of a high-quality policy of interaction between business and government institutions as a result of digitalization (Fig. 1).

Automation and robotization of production and industrial processes, on the one hand, allow minimizing the costs of workers in production, although on the other hand, it requires large investments at the beginning of the application of robotics/automation and specialists capable of working with advanced technologies and applications [2, p. 127]. In addition, open trade leads to higher specialization of the economy, which also requires more complex activities, including more specific needs related to patents and licenses for technologies, in particular AI, which cannot be provided for shadow economic agents. At the same time, international trade activity limits the ability

of domestic firms to hide their income through the legal and ethical standards of their trading partners. Therefore, higher trade openness can reduce shadow economic activity [13, p. 3].

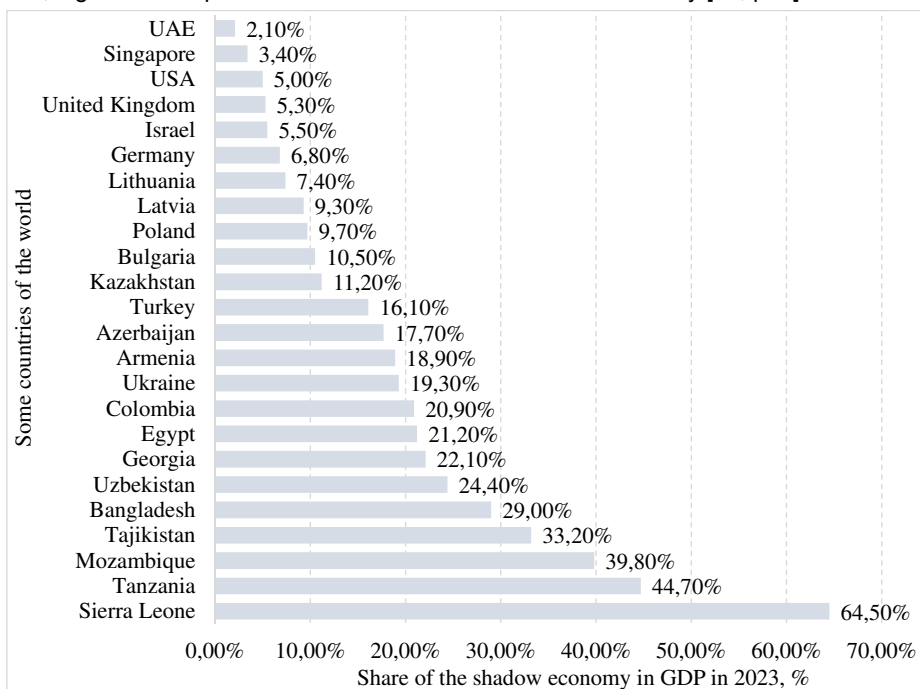


Fig. 1. The size of the SE in some countries of the world in 2023.

Source: compiled based on the source [12].

In Ukraine, the share of the SE in GDP in 2023 was 19.3%. This's less than in the 90s of the 20th century and in the first decade of the 2000s of the 21st century, but for a country where all governments and 6 presidents, without exception, constantly talk about reforms and make attempts to implement them, a share of about 20% is too high. In Ukraine, the high level of the SE is due to institutional corruption. In pursuit of the goal of reducing corruption, it's worth using "the most productive way, which's to increase the probability of being caught in illegal activities, as well as increase fines" [3, p. 12].

It's worth paying attention to the indicator of Israel, which is 5.5% despite the fact that the country is constantly exposed to military shelling and since the 50s of the 20th century has been defending its independence, while remaining highly technological and innovatively developed in all sectors of the economy. Singapore, having chosen an innovative and technological path of its development at the end of the 20th century, was already in the 21st century able to declare itself as a highly technical and technological country with a low level of corruption, strong government institutions and a share of the SE in GDP in 2023 at the level of 3.4% (Fig. 1). But in the world, there's an indicative example of a country with the lowest level of the shadow sector, and this's the United Arab Emirates (2.1%).

Deputy Prime Minister for Innovation, Development of Education, Science and Technology, Minister of Digital Transformation M. Fedorov emphasizes that "the future of Ukraine is in the development of the digital economy and innovations. Artificial intelligence is an important part of this path. Today, AI in Ukraine is already used in various areas – from military technologies to govtech" [14, slide 4]. The level of innovative and digital development in Ukraine and the ability to apply AI in business and everyday life are affected by the quality, speed and price of the Internet as a service.

It should be noted that despite the rather rapid pace of digital transformation in Ukraine as a whole, there are still regions and areas in which the development of the Internet still requires the implementation of a number of support programs from both the state and public organizations. Thus, from the data in Fig. 2 we see that the worst situation is in the frontline regions, namely: Donetsk, Kherson, Kharkiv, Kirovohrad, Zaporizhia. An average level of development was observed in 2024 in Chernihiv, Cherkasy, Mykolaiv and Ivano-Frankivsk regions. The Internet developed most progressively in 2024 in Chernivtsi (0.982) and Poltava (0.964) regions. This is due to the fact that these regions have a large number of relocated businesses, which have a demand and great motivation for innovative digital development and the application of digital technologies such as AI, the IoT, and Big Data.

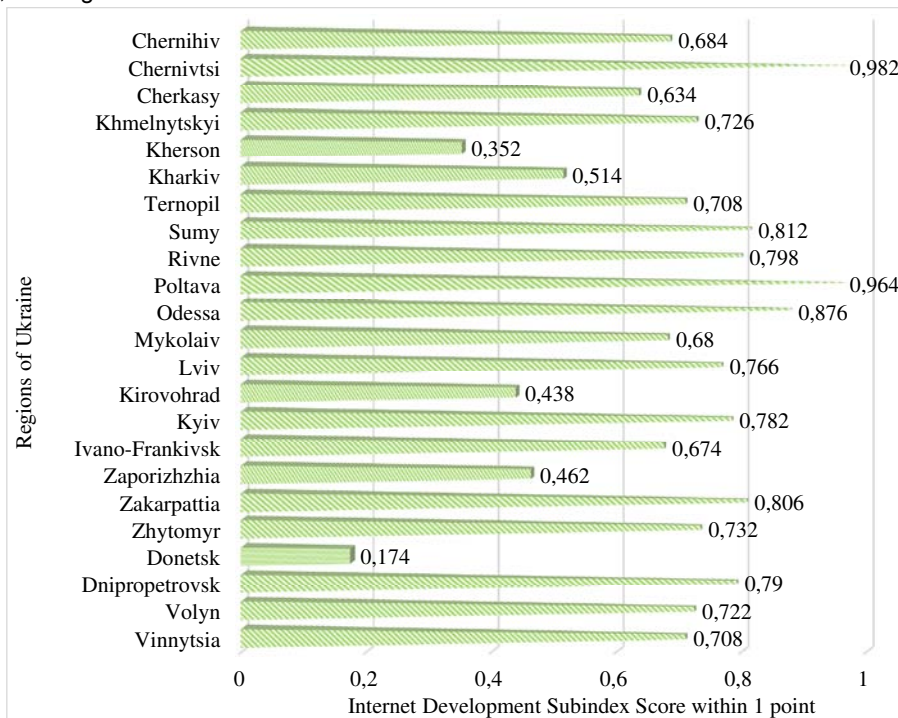


Fig. 2. Digital Transformation Index of Ukraine by Regions by Sub-Index “Internet Development” in 2024.

Source: built on the basis of the source [15, p. 20].

As of the end of 2024, Ukrainians used the following top AI products: chatbot services (57%), facial recognition technologies (34%), personal assistants (26%), chat-GPT (33%), robot vacuum cleaners (17%), smart home technologies (11%), AI-based image creation (13%) [14, slide 6].

Digitalization is a process that’s perceived as appropriate for innovative, progressive development of the economy. The boundaries between digital and traditional are increasingly blurred, as technical and technological changes permeate every business process. There’s now a need for a deep understanding of the nature of these changes in order to respond at all levels: social, state and personal [2, p. 129].

Fig. 3 and 4 present a comparison of indicators characterizing the digital development of the economy and society in Ukraine in 2022 and 2024. It’s interesting that the share of enterprises using social media in the total number of enterprises in 2024 was 30%, which’s almost 1% more than in

2022. To reduce the level of shadowing in business, it's worth completely digitizing document flow at the enterprise and switching completely to online payments and settlements, both with regulatory authorities and with business partners. To do this, of course, it's necessary to use more and more software in business. Over the past two years, the situation has improved, because the share of enterprises using software in the total number of enterprises has increased by 9.3%.

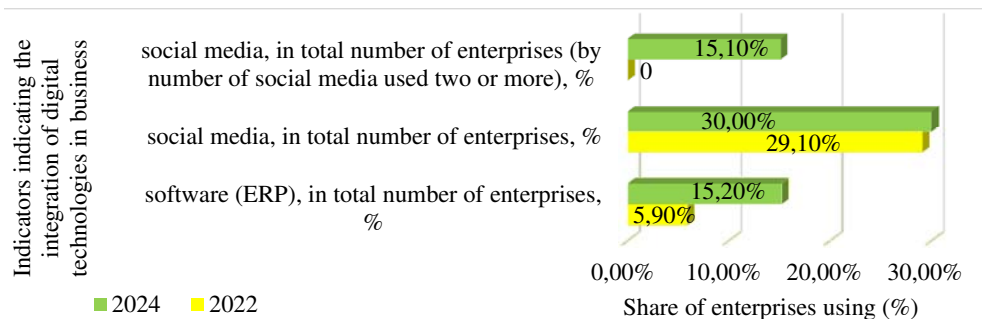


Fig. 3. Individual indicators characterizing the digital development of the Ukrainian economy and society in 2022 and 2024.

Source: built on the basis of the source [16].

It's becoming obvious that the more software is used, the more likely the enterprise will eventually use AI technologies and use fewer employees. Accordingly, for the enterprise this may have a positive impact on reducing wage costs, but the country may experience an increase in official unemployment rates and the emergence of a shadow labor market with shadow employment. Analyzing changes in the share of enterprises using AI technologies in the total number of enterprises in 2022 and 2024, we see +0.2% (Fig. 4). However, over the studied period, the trend is negative in the share of enterprises conducting "big data" analysis in the total number of enterprises (-7%) and in the share of enterprises purchasing cloud computing services in the total number of enterprises (-3.9%).

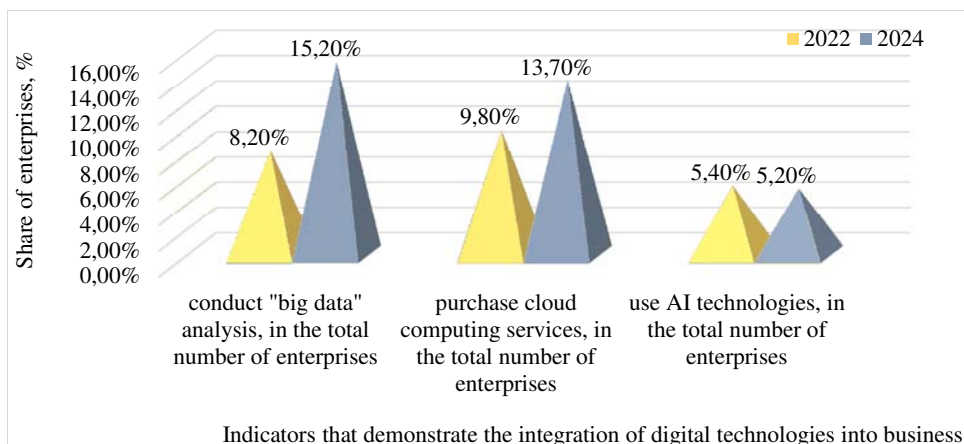


Fig. 4. Indicators characterizing the digital development of Ukraine's economy and society, including AI technology, cloud computing, and Big Data in 2022 and 2024.

Source: built on the basis of the source [16].

The level of SE in a country is influenced by institutional capacity. If development institutions are strong and functioning, then there will be no weakening of the shadow economic activity sector.

However, if laws do not apply in a country, and the institution of government does not enjoy a high level of trust, then development institutions weaken and informal, unofficial rules, shadow laws, and traditions begin to operate. For these reasons, in order to reduce the level of the SE in the country and accelerate the digital transformation, it's necessary to form a strong institutional capacity. Fig. 5 presents indicators for the "Institutional Capacity" subindex by region through the prism of the digital transformation of Ukraine in 2024. Thus, the greatest progress in this issue was made by Poltava, Zakarpattia, Dnipropetrovsk, Rivne, Ternopil, Odessa and Lviv regions. The least progress in institutional capacity in 2024 was made by Zhytomyr (0.183), Donetsk (0.341), Mykolaiv (0.327), Cherkasy (0.483) and Kharkiv regions (0.491).

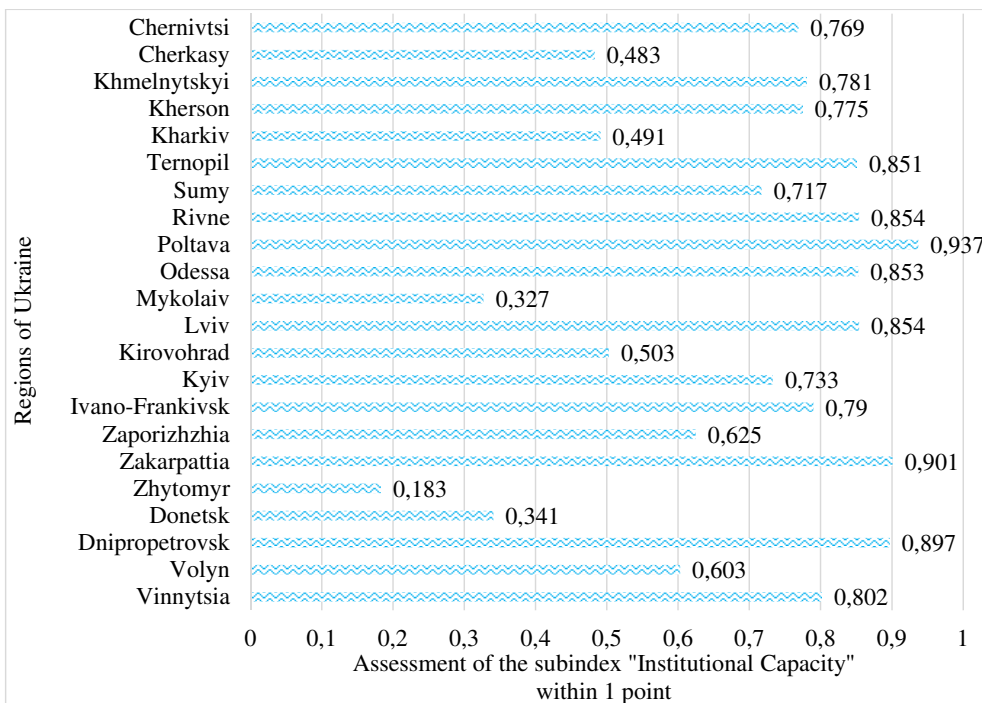


Fig. 5. Digital Transformation Index of Ukraine by Regions by Sub-Index "Institutional Capacity" in 2024.

Source: built on the basis of the source [15, p. 20].

The use of digital tools in business processes has a positive effect to a greater extent. The only exception is the ever-growing lack of need for human resources, i.e. the replacement of a person by a machine, technology, the rapid convergence of a machine and a person, deep automation and digitalization of business processes. However, with the advent of AI, new challenges arise such as new tax evasion schemes, i.e. the threat of shadowing of economic relations. In Table 1, we have attempted to present the socio-economic effects of legalization and threats of shadowing from the use of AI in entrepreneurship.

Table 1

Socio-economic effects of legalization and the threat of shadowing from the use  
of AI in business and entrepreneurship

Socio-economic benefits of using AI in partial de-shadowing of economic relations	Obvious threats to the application of AI in business, leading to an increase in the share of the SE
1	2
Personalized assistants reduce the workload on the employee and eliminate the human factor. Enhanced interactive search capabilities.	The difficulty of controlling shadow e-business activities, because the metaverse, a highly immersive, computer-generated 3D environment based on technological evolution, is a rapidly growing business platform in which AI is the key to transforming the virtuality of business into reality and, thus, creating business models based on the metaverse is "inconvenient" for controlling shadow activities.
Arguing for transparency in business activities, i.e. with a thorough explanation of the content and structure of the work.	Information security breaches through free, unauthorized or hidden AI tools cause unforeseen risks of commercial information leakage, which negatively affects the functioning and sustainable development of digital entrepreneurship.
Allows you to optimize the operation of the software during the preparation of financial and economic reports and makes it impossible to ignore a number of factors.	Imperfect protection of personal data and information leakage, which is also difficult to control, because the activity is shadowy. If AI is used by a shadow company, then legal regulation will not work.
AI allows you to quickly and reliably protect yourself from cyberattacks, that's, a new quality of cyber protection is being built in working with business partners and state institutions. It forms the protection of algorithms in business, blocks deepfakes, and prevents the threat of phishing attacks.	Conflicts in the distribution of intellectual property rights for a product or service created by AI, as the activity is shadowy and carried out outside the law. Further development of AI-based digital infrastructure may negatively affect the ethical behavior of digital entrepreneurs if they actively use shadow AI.

Source: compiled by the authors based on sources [8; 14] and own observations.

In the 21st century, we are witnessing how AI acquires, in the course of working with it in business, the features of a "digital partner", but at the same time, the institution of trust is in the first place. Enterprises and businesses that use AI must take care of maximum data protection and in every way profess unquestioning adherence to ethical standards. Digitalization and innovation of business processes in business without responsibility to consumers and regulatory authorities will not lead to the desired profits and expansion of production.

**Conclusions and prospects for further research.** The implementation of the government's planned tasks in the partial de-shadowing of business activity in Ukraine and the reduction of corruption at the institutional level is expected to play an important role in strengthening and restoring the level of trust of international partners in Ukraine and forming transparent and "soft rules of the game" for digital businesses operating in the official sector of the economy. The tools that can accelerate the processes of legalization of capital and de-shadowing of the Ukrainian economy are AI, Big Data, cloud computing and further digital development of e-government and e-democracy in the country.

The introduction of high-tech latest generation in the business processes of enterprises and organizations allows to digitize their activities, to make them transparent during inspections by inspectors of the State Tax Service of Ukraine. In the conditions of martial law, which caused a difficult economic situation, inflation, devaluation, the government of the country is faced with the lack of desire and readiness of Ukrainian large and small businessmen, individual entrepreneurs to pay taxes in full and be "tax moral". In the last 3 years we have been reading more and more in the

media about large-scale tax evasion, the fact that businesses operate under shadow schemes, and they keep double accounting.

In the near future, we see a need to explore new possibilities for using AI technology to identify unscrupulous taxpayers. There's a need to develop mechanisms for using AI to quickly, impartially and transparently verify the operation of business process algorithms in e-commerce. For the Ukrainian economy, there is a need to develop measures for ethical online trading that doesn't lead to the loss of personal data of domestic buyers.

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