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тел/факс: (03131) 2-11-09, (03131) 2-11-09
E-mail: info@economics-msu.com.ua
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ЗМІСТ

М. А. Гнатишин

Економіка ґрунтового карбону та її специфіка в Україні9

В. М. Кміть

Податкові перевірки у період воєнного стану в Україні 16

А. А. Кулик

Документування, облік та оцінка матеріальних збитків, завданих збройною агресією
необоротним активам підприємства.....24

Т. В. Небога

Перспективи участі наукових установ і закладів вищої освіти у цільових регіональних
програмах Одеської області в умовах економічного відновлення35

З. І. Тенюх, У. В. Пелех, Н. В. Хоча

Застосування цифрових технологій в бухгалтерському обліку й аудиті
на підприємствах України.....46

CONTENTS

M. Hnatyshyn

Economics of Soil Carbon and its Specifics in Ukraine9

V. Kmit

Tax Audits During the Period of Martial Law in Ukraine 16

A. Kulyk

Documenting, Accounting, and Valuing Material Damages Caused by Armed Aggression
to the Non-Current Assets of the Company 24

T. Neboha

Prospects of Participation of Scientific Institutions and Higher Education Institutions
in Targeted Regional Programmes of Odesa Region in the Context of Economic Recover35

Z. Tenyukh, U. Pelekh, N. Khocha

Application of Digital Technologies in Accounting and Auditing at Enterprises of Ukraine46

Economics of Soil Carbon and its Specifics in Ukraine

Maria Hnatyshyn*

*PhD in Economics, Associate Professor, Department of Analytical Economy and International
Economics, ORCID: <https://orcid.org/0000-0002-0854-0568>*

Ivan Franko National University of Lviv, 79000, 1 Universytetska Str., Lviv, Ukraine

Abstract. Anthropogenic emissions are one of the main causes of global warming. Carbon dioxide is the most commonly produced greenhouse gas. Sequestration is one of the options to decrease the amount of atmospheric carbon dioxide. One of the main types of carbon sequestration is the biological carbon sequestration method of soil carbon sequestration. There are various estimates of the SCS potential of soils since the knowledge of soil carbon conservation processes is still limited. However, it is evident that degraded soils have more potential to sequester carbon. The aim of the paper is to analyze the social cost of soil organic carbon in soils of Ukraine, discuss different ways used to estimate the price of soil organic carbon and the carbon sequestration potential of different soils. The social cost of carbon was used to estimate the value of soil organic carbon stocks in Ukraine because it shows the avoided social cost of carbon emissions. The social cost of carbon represents the net present value of the climate change impact of additional carbon released into the atmosphere (marginal global damage costs). Estimation of the social cost of SOC stock in different types of soils in Ukraine makes it possible to compare alternative land use options and to make right policy choices. The results depict the high importance of Ukrainian soils in preventing global climate changes through carbon storage. Czornoziem soils are especially rich in SOC, and therefore more valuable in terms of the ecosystem services they provide. The sequestration potential of most types of Ukrainian soils exceeds the sequestration potential of forests. The article proposes measures and practices for soil carbon sequestration and SOC protection. The implementation of the measures to preserve and accumulate SOC will contribute to the increase in biological productivity of agricultural soils and, consequently, boost the yield of cultivated crops, which will have a positive effect on food security

Keywords: climate change, soil organic carbon, carbon sequestration, carbon price, social cost of carbon

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*Corresponding author

Introduction

Global climate change is one of the main threats for the humanity. It is 95% possible that anthropogenic emissions since the 1950s are the main cause of global warming [1]. The process can be slowed down or even stopped if humanity manages to mitigate emissions sufficiently. CO₂ is the most commonly produced greenhouse gas so researches often focus on it. The amount of CO₂ in the atmosphere increased from approximately 280 ppm in 1850 to 411.44 ppm in 2019 according to the Intergovernmental Panel on Climate Change data [2]. Except mitigation, there is one more option to decrease the amount of atmospheric carbon dioxide – to sequester it, which means capture and store it. There are two main types of carbon sequestration: geological and biological. The focus of the research is on the biological carbon sequestration method of soil carbon sequestration (SCS). Estimates of SCS potential differ. In general, the best solution is to increase carbon stocks in degraded soils to recover the historical losses.

A number of international organizations explore the possibilities of sustainable land use as a means of adapting to and mitigating climate change. The main of them are the International Initiative “4 per 1000”, the International Federation of Organic Agricultural Movements (IFOAM), the Intergovernmental Panel on Climate Change (IPCC), the non-profit environmental law organization Earthjustice, etc. National Scientific Center “O.N. Sokolovsky Institute for Soil Science and Agrochemistry Research”, The Institute of Bioenergy Crops and Sugar Beet (IBC&SB) NAAS, Institute of Agroecology and Environmental Management of NAAS and others study the problem in Ukraine.

Restoration of the level of organic matter in the soil requires an understanding of environmental processes important for its preservation. Soil organic matter is composed of soil microbes including bacteria and fungi, decaying material from plants, animals and other organisms and products of their decomposition. Highly decomposed material is called humus. Those organic compounds of soil contain carbon, which is called soil organic carbon (SOC). The higher the amount of organic matter in soil is, the higher is the SOC. SOC is stored in soil through photosynthesis – transformation of atmospheric CO₂ into plant biomass. Only small part of the original carbon from biomass is retained in the soil through the formation of humus, larger share of it is lost as CO₂ due to microbial respiration during the process of decomposition. Compared to biomass, humus is highly resistant to decomposition and can be stored in soil for a long time. Biomass has a much shorter residence time in soil. Carbon can be also lost from soil through soil erosion and leaching of dissolved carbon into groundwater. When the inputs and outputs of carbon are equal, the SOC level remains stable. In other cases, the SOC level may decrease if carbon loss exceeds its inputs, or increase, when carbon inputs from photosynthesis exceed its losses [3]. SOC is highly important for agriculture. It improves soil quality through increased retention of water and nutrients, which makes the soil more productive, improves

soil structure and reduces erosion, which improves water quality. Therefore, it increases food security and decreased negative impacts to ecosystems.

The purpose of the study is to analyze the social cost of SOC in soils of Ukraine, to discuss the sequestration potential of Ukrainian soils and to propose measures and practices for SOC protection.

Problems of climate change, greenhouse gas emissions, soil productivity and carbon sequestration have been studied by R. Lal [4]; T. Ontl & L. Schulte [3]; T. Lighthart & L. van Harmelen [5]; J. Berazneva et al. [6]; M. Sperow [7]; E.A. Mikhailova et al. [8] and others. T. Ontl & L. Schulte analyze the process of soil carbon storage as a vital ecosystem service [3]. T. Lighthart & L. van Harmelen [5] estimate abatement-based and damage-based shadow prices for SOC depletion. E.A. Mikhailova et al. [8] use the avoided social cost of CO₂ to assess the value of SOC stocks. R. Lal [4] discusses strategies to increase the soil carbon pool and possibilities of enhancing food security through carbon sequestration. J. Berazneva et al. [6] also analyze soil carbon management practices and investigate their efficiency. M. Sperow [7] estimates biophysical potential for SOC accumulation and narrows his attention to no-till method and finds it cost-effective. Problems of greenhouse gas reduction and SCS in the soils of Ukraine are presented in the works of S. Balyuk & A. Kucher [9]; A. Kucher [10]; S. Balyuk, B. Nosko & L. Vorotintseva [11]; V. Medvedev [12]; O. Tarariko et al. [13]; S. Pozniak [14] and others. S. Balyuk, B. Nosko & L. Vorotintseva [11] pay much attention to the assessment of SOC stocks in Ukrainian soils and sustainable soil management in Ukraine. They show the leading role of Ukraine in global food security provision and stress the importance of soils of Ukraine in dealing with the global problem of carbon sequestration. A. Kucher [10] assesses the economic value of soil carbon sequestration and the necessary financial support for low-carbon land use implementation in Ukraine. O. Tarariko et al. [13] promote balanced land use and soil protection from erosive degradation in their study, give recommendations on the national agricultural land resources management improvement. S. Pozniak & M. Hnatyshyn [14] pay more attention to international aspects of soil carbon sequestration and analyze the prospects of implementation of the international initiative “4 per 1000” in Ukraine. The need to ensure sustainable development brings together scientists from various fields.

Materials and Methods

The study is based on interdisciplinary approach. The screening and content analysis of scientific journals and publications in environmental economics, agricultural economics and soil studies has been conducted. A number of websites of international organizations were used concerning the possibilities of sustainable land use and how those sustainable practices can help to mitigate climate change and to adapt to it. The following methods were used in the study: calculation-constructive, statistical and graphic

methods, analysis and synthesis, comparative analysis, economic analysis. Abstract-logical method was used for conclusions and recommendations formulation.

To estimate the value of soil organic carbon stocks in Ukraine the social cost of carbon was used. The data used in the study was obtained from international agencies and scientific papers. The study is based on the calculated humus reserves in the main Ukrainian soils conducted by Baliuk et al. [15]. The main sources of data used by them for the calculation of SOC were the data of soil surveys of the National Scientific Center "O.N. Sokolovsky Institute for Soil Science and Agrochemistry Research", scientific institutions of the National Academy of Agrarian Sciences of Ukraine, higher educational institutions and the laboratory of forest soil science of the G.M. Vysotsky Research Institute of Forestry and Forest Melioration. The economic assessment of SOC reserves in Ukrainian soils was conducted through social cost of SOC in Ukrainian soils estimation. Social cost represents the net present value of the climate change impact of additional carbon released into the atmosphere (marginal global damage costs). For the estimation of social cost of SOC the social cost of CO₂ was used as provided by the U.S. Environmental Protection Agency (EPA) [16]. The social cost of CO₂ is measured by the EPA in USD. It represents the money value of damage caused by 1 ton of CO₂ emissions. It includes changes in net agricultural productivity, human health, damages from different climate change risks, changes in energy system costs etc. Therefore, it is designed to include all negative and, if there are such, positive consequences of CO₂ emissions. However, it is not always possible to cover all consequences that might occur because of the lack of precise information. The value of emissions depends on the time span taken into account (the last year included in the forecast), and on the year in which CO₂ is emitted. The larger the time span is and the more years are left to emit the higher will be the damage. So, the value is different for each year. Besides, discount rate should be taken into account. The EPA proposes calculations for 5%, 3% and 2.5% discount rates from which the 3% discount rate was chosen for this study. The social cost of CO₂ evaluated by the EPA was transformed into the cost of SOC based on the amount of carbon. It enabled the estimation of social cost of SOC in soils of Ukraine.

Results and Discussion

According to the overview performed by Ontl and Schulte, approximately 3170 GT of C (organic and inorganic) are stored in total in terrestrial ecosystems. 2500 GT of carbon is found in soil, 1550 GT of which is organic C. For comparison, the amount of carbon found in living plants and animals is only 560 GT and the amount of carbon found in atmosphere is 800 GT [3].

Approximately twenty-four billion tons of fertile topsoil is lost every year. It is 10 to 40 times faster than the rate of soil formation. Therefore, approximately 50-70% of soil carbon stocks have been lost in cultivated soil and it is called soil degradation. 25% of the earth's surface has already become degraded [17]. Plowed land ratio in Ukraine

reaches 53.8%, which is high compared to European countries, plowed land of which make up 30-32% of the total area [9]. Besides, Ukraine is currently experiencing soil degradation caused by the war. According to preliminary estimates of the Ministry of Ecology and Natural Resources of Ukraine, published on the website of the "EcoTreat" project, the estimated amount of damages caused to the environment of Ukraine as of Aug 1st, 2022 is 204 billion UAH. The number includes soil pollution – the spillage of 5.589 tons of petroleum products. The estimated cost of the damage is 3.385 million UAH [18].

It is not an easy task to estimate the price of SOC. It is necessary to distinguish different evaluation methods of carbon price in agriculture. The first one is based on the cost of pollution removal. In this case, it is the value of SCS for the farmer. How much do farmers have to invest to sequester certain value of carbon, how much will they need to invest in future to preserve the carbon in soil, and opportunity cost – the profit that could be earned using carbon-intensive technologies. In certain cases, carbon sequestering and carbon preserving technologies may be even more productive than carbon emitting ones. The second carbon price that can be touched upon is the market price of carbon. It is formed under the emission trading schemes (like EU Emissions Trading Scheme). The cost of emission permits on the EU market in May 2021 for the first time crossed the limit of 50 USD/t CO₂e [19]. The third one is the social cost of SOC, which is based on damage, caused by CO₂ emissions. It is a marginal cost of the damage caused by emission of additional ton of CO₂ into the atmosphere.

There are different estimations of the shadow price of SOC. According to Lighthart and Harmelen, the shadow price of SOC based on the cost of pollution removal is 100 EUR/t SOC and the shadow price based on the damage is 28.6 EUR/t SOC [5]. Another study estimates the shadow price of the steady state of the soil carbon in the range from 95 USD/t to 168 USD/t [6]. According to the findings of the High-Level Commission on CO₂ Emissions, the price to achieve the goals of the Paris Agreement which will ensure an increase in temperature by no more than 2 °C by 2030 is 50-100 USD/t CO₂ [20].

Based on the calculated humus reserves in the main Ukrainian soils of 100-720 t/ha, and, accordingly, SOC – 58-418 t/ha, A.V. Kucher [10] made an economic assessment of SOC reserves in Ukrainian soils, which is 14.4-103.7 thousand USD/ha. That means the price of SOC he considers is approximately 248 USD/t SOC.

Sperrow [7] has calculated the cost of no-till method on U.S. cropland and found out that almost 95% of the biophysical potential of SCS on U.S. cropland could be captured for less than \$100 per ton of CO₂. And he states that this method is cheaper than geologic storage.

In contrast to emissions mitigation technologies sequestration methods usually involve annual spending on keeping C sequestered, i.e., if CO₂ was sequestered due to no-till method the tillage will eliminate all the efforts. Therefore, SCS is not a one-time action. The market carbon price should be modified to get the actual price of carbon

sequestration in agriculture to cover the risks of reemissions. As agriculture is also a large emitter of greenhouse gases, it can be talked of the carbon tax which will stimulate farmers to sequester carbon or the carbon subsidy for farmers sequestering carbon. That is, policy options and the cost of SCS for the state. Some scientist proposes to value soil organic carbon stocks based on the avoided social cost of carbon emissions [8]. It is also possible to use this evaluation for newly sequestered carbon which adds to overall SOC.

Using the assessment of SOC stock in profile of Baliuk et al. [15] the social cost of SOC in Ukrainian soils was estimated. For that purpose, the estimation of CO₂ social cost of the EPA was used. It has calculated the social cost of carbon as \$46 per metric ton of CO₂ emissions in the year 2025 (2007 USD) at 3% discount rate [16]. NSC ISSAR experts estimate total SOC stocks in soils in Ukraine as 7 Gt [15]. Based on that data and estimations the cost of SOC in soils of Ukraine was calculated using the following equation:

$$\text{Cost of SOC stock} = \text{SOC stock} \times \frac{11}{3} \times \text{cost of CO}_2 \times \text{inflation} \quad (1)$$

To count the overall value of SOC in Ukrainian soils total SOC stocks in soils in Ukraine were multiplied by the social cost of carbon. The price of CO₂ was converted into the price of SOC. The proportion is 11/3 [8]. The social cost of SOC was obtained in 2007 USD. To get

the result in 2020 USD amendments for inflation had to be made. Inflation since 2007 was 31.67% according to the World Bank data. Therefore, the cost of SOC stock in Ukrainian soils was counted according to the equation 1 as follows:

$$\text{Cost of SOC stock} = 7 \times 10^9 (\text{SOC}) \times \frac{11}{3} \left(\frac{\text{CO}_2}{\text{SOC}} \right) \times 46 \left(\frac{\text{USD}}{\text{CO}_2} \right) \times 1.3167 \quad (2)$$

The cost of SOC stock equals 1.554.5838 bln USD. The social cost of SOC per hectare of Ukrainian soil is 1.554.5838 bln USD / 60 362 800 ha = 257.540 USD/ha.

However, this indicator is much aggregated, as soils differ considerably by their SOC content. Further,

the SOC social cost for different kinds of soil was calculated. The social cost of SOC is 84.2688 USD/t. So, the average price per ha of the main types of soils in Ukraine and the social cost of those soils in 2020 USD was calculated (Table 1, Fig. 1).

Table 1. Social cost of SOC in Ukrainian soils

Soil type	Average SOC stocks in profile, t/ha	Total stocks of SOC (average values), Mt	Social cost per hectare, USD/ha	Social cost by type of soil, million USD
Chernozems ordinary	217.5	2 283.75	24133.09	253397.43
Chernozems typical	261.0	1 513.80	28959.71	167966.30
Chernozems southern	130.5	469.80	14479.85	52127.47
Chernozems podzolized	165.5	562.70	18363.34	62435.35
Chernozem-meadow soils	313.5	627.00	34784.93	69569.87
Gray forest soils	95.5	410.65	10596.37	45564.38
Sod-podzolic soils	124.5	485.55	13814.11	53875.04

Source: [14-16], own calculations

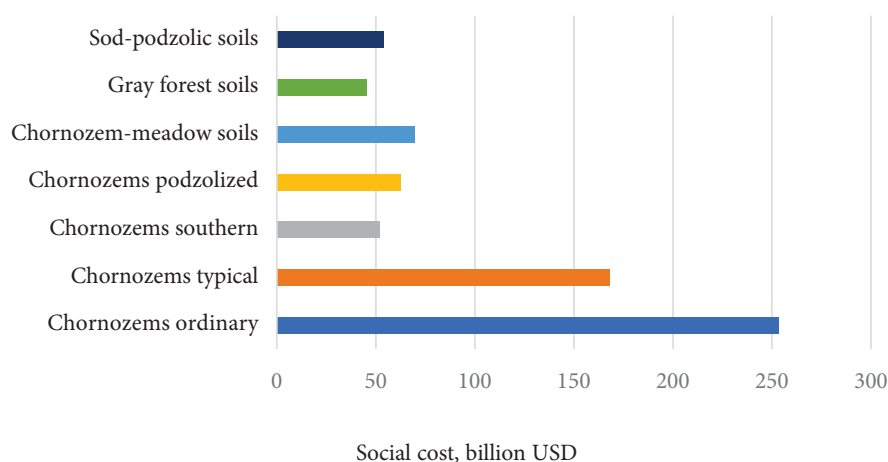


Figure 1. Social cost of the main types of soils in Ukraine

Source: [14-16], own calculations

This means the ecosystem services which soil provides through C storage is very valuable. The sequestration potential of most types of Ukrainian soils exceeds the sequestration potential of forests. For example, the amount of C in forest biomass in Malaysia is 153.14 t/ha [21]. SOC depletion diminishes the amount of C sequestered in soil and therefore decreases its value, while SCS can increase the value of soils.

There are various estimates of soil carbon sequestration potential since carbon removal practices differ significantly and the knowledge of soil carbon conservation processes is still limited. UNEP Foresight Brief cites theoretical estimates of carbon sequestration potential of 0.8 up to 8 Gt C annually (some studies include afforestation or re-forestation practices) and the agricultural land potential up to 10 Gt C annually [17]. Practically achievable sequestration is in the range of 1.5 to 2.5 Gt C annually [17]. The problem is that SCS is potentially reversible and has natural limits. The same soils can emit or sequester carbon depending on the methods of cultivation. Degraded soils have more potential to sequester carbon. Therefore, the process of SCS has to be wisely managed and include social and economic caveats.

By applying the right methods, the functions of terrestrial ecosystems can be largely restored, the amount of SOC and soil productivity can be increased and the greenhouse gas emissions can be reduced. A number of SOC conservation and accumulation measures are proposed by the 4 per 1000 Initiative, Earthjustice, the International Federation of Organic Agricultural Movements (IFOAM), and a number of scientists: R. Lal [4]; S. Balyuk & A. Kucher [9]; S. Balyuk, B. Nosko & L. Vorotintseva [11]; V. Medvedev [12]; O. Tarariko et al. [13]; D. Suleiman & T. Westhof [22]; Simionescu et al. [23] etc. First of all, the relevant crops that have the highest yields in certain soil and climatic conditions should be cultivated; this will create the largest number of food with the lowest consumption of fuel, fertilizers and pesticides. It is advised to use crop rotations, which increase the accumulation of soil organic matter and reduce soil erosion, and to reduce tillage, as greenhouse gas is emitted from soil disturbance. Moreover, less tillage will reduce energy consumption. However, the no-till method may require the use of larger amounts of herbicides.

Concerning fertilizers, organic fertilizers are preferable because they increase the amount of soil organic carbon, intensify the soil-forming process and reduce soil contamination with synthetic fertilizers. The methods and techniques of mineral fertilizers application should be improved to reduce the amounts of fertilizers used.

Forest protection strips between crop fields should be planted and preserved to reduce wind erosion of the soil, in particular in the steppe regions where they will contribute to the preservation of moisture. Cover crops or green manures should be used. They increase the accumulation of

C in the soil, reduce surface runoff and, consequently, the removal of nutrients, as well as reduce the use of agricultural machinery. Alley cropping is highly recommended – to grow food, fodder or special crops between rows of trees or shrubs, which will increase C sequestration in trees and shrubs and reduce runoff and erosion conserving the disturbed and degraded soils. Moderate grazing will help to avoid excessive soil compaction and biodiversity reduction, increase pasture bio-productivity and prevent soil degradation. Forest grazing – planting forests or shrubs in forage lands, will increase the sequestration of C in plants. Organic agriculture should be promoted as a production system that allows maintaining the health of soils, ecosystems and people. Complying with legislation on the conservation of coastal buffer zones will contribute to the preservation of C in plants and soils, reduce surface runoff, thereby preserve nutrients in the soil and improve water quality. It is advised to reduce the volumes and influences of industrial agriculture and to form the agro-landscapes according to the principles and provisions of the contour-ameliorative organization of agricultural lands.

Many of these measures have a synergistic effect, so their combined implementation is particularly important.

Conclusions

The potential of carbon sequestration includes preservation of the present carbon reserves in the soils that are in equilibrium and cannot further increase SOC stocks, restoration of the pre-degradation amount of SOC in degraded soils and further SCS stimulation. The soils in equilibrium should be guarded against degradation through sustainable agricultural practices, climate-optimized agricultural technologies, introduction of an effective system of legal protection of soils. Carbon sequestration should be promoted in degraded soils.

The social cost of SOC stock in Ukraine for the year 2025 will be 1.554.5838 bln USD. This large number indicates the economic importance of Ukrainian soils for the humanity. The social cost of carbon, which was used in the estimations is even a little lower than the market price of CO₂ emission permits on the EU market (50 USD/t CO₂e). This would be a sufficient stimulus for SCS in Ukrainian soils, provided the right policy mechanisms will be introduced.

Soil productivity is closely related to the amount of SOC, so the depletion of its reserves has a large-scale impact on the entire ecological and economic system. Soil restoration will contribute to the improvement of the ecological and economic situation in Ukraine. With the increase in the biological productivity of agricultural soils, the yield of cultivated crops will increase, therefore, the food provision and the well-being of people will improve, and the employment of the rural population will rise.

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Економіка ґрунтового карбону та її специфіка в Україні

Марія Андріївна Гнатишин

*Кандидат економічних наук, доцент кафедри аналітичної економіки та міжнародної економіки,
ORCID: <https://orcid.org/0000-0002-0854-0568>*

*Львівський національний університет імені Івана Франка,
79000, вул. Університетська 1, м. Львів, Україна*

Анотація. Антропогенні викиди є однією з головних причин глобального потепління. Діоксид карбону є найбільш поширеним парниковим газом. Секвестрація є одним із варіантів зменшення кількості діоксиду карбону в атмосфері. Одним із основних видів секвестрації карбону є біологічний метод секвестрації карбону ґрунтом. Існують різні оцінки секвестраційного потенціалу ґрунтів, оскільки процеси секвестрації карбону ґрунтом остаточно не з'ясовані. Однак очевидно, що деградовані ґрунти мають більший потенціал для поглинання карбону. Метою статті є аналіз соціальної вартості органічного карбону у ґрунтах України, аналіз різних способів визначення ціни SOC та потенціалу його секвестрації різними типами ґрунтів. Соціальна вартість карбону використана для оцінки вартості запасів органічного карбону в ґрунтах України, оскільки вона відображає уникнені соціальні втрати від викидів карбону. Соціальна вартість вуглецю є чистою теперішньою вартістю впливу додаткового викиду карбону в атмосферу на зміну клімату (гранична вартість глобальної шкоди). Оцінка соціальної вартості запасів SOC у різних типах ґрунтів в Україні дає змогу порівняти альтернативні варіанти землекористування та вибрати правильні політичні інструменти. Результати оцінки свідчать про важливість українських ґрунтів у запобіганні глобальним змінам клімату шляхом утримання карбону. Чорноземні ґрунти особливо багаті на SOC і тому більш цінні з погляду екосистемних послуг, які вони надають. Секвестраційний потенціал більшості типів ґрунтів України перевищує секвестраційний потенціал лісів. У статті запропоновано заходи та методи збереження існуючого SOC та збільшення секвестрації карбону ґрунтом. Реалізація заходів щодо збереження та накопичення SOC сприятиме підвищенню біологічної продуктивності сільськогосподарських ґрунтів і, як наслідок, урожайності вирощуваних культур, що позитивно вплине на продовольчу безпеку та подолання глобальної проблеми нестачі продуктів харчування

Ключові слова: зміна клімату, ґрунтовий органічний карбон, секвестрація карбону, ціна карбону, соціальна вартість карбону

Tax Audits During the Period of Martial Law in Ukraine

Vira Kmit*

*PhD in Economics, Associate Professor of the Department of Finance, Money Circulation and Credit,
ORCID: <https://orcid.org/0000-0001-6845-8139>*

Ivan Franko National University of Lviv, 79000, 1 Universytetska Str., Lviv, Ukraine

Abstract. The article reveals the peculiarities of conducting tax audits by controlling bodies. In Ukraine, a ban on the implementation of tax supervision (control) measures has been in effect since March 18, 2020, from the beginning of the introduction of quarantine restrictions. With the introduction of martial law, the moratorium was extended, but there are a number of exceptions that require detailed study. The purpose of the article is to study the problematic issues of conducting tax audits in conditions of instability of tax legislation: martial law and quarantine restrictions due to COVID-19, as a result of changes to the legal framework. The chronology of changes made to the Tax Code of Ukraine (TCU) during half a year of martial law was analyzed. The first "wartime" law extended the quarantine moratorium on tax audits under martial law, and subsequent ones made changes to the TCU. During martial law, any tax audits cannot be started, and those that have been started are suspended. The exception is cameral and factual audits, as well as unscheduled documentary audits, which are carried out on a voluntary basis at the request of payers. The grounds for such checks are also the receipt by the controlling body of information about the existence of violations of the norms of tax or currency law on the part of the payer. The results of the study were obtained by means of theoretical and methodological analysis of the provisions that highlight the problematic issues of verification of the activities of payers. The goal was achieved as a result of the application of an in-depth content assessment of the norms of tax law, aimed at understanding the essence of the types of tax audits and the peculiarities of their implementation in the conditions of martial law, the official website of the Ministry of Finance of Ukraine and the State Tax Service of Ukraine, as well as a number of scientific publications on this issue of research. The article is aimed at studying key problems in the field of tax administration as a whole and in the context of the implementation of relevant tax control measures

Keywords: tax supervision (control), cameral audits, factual audits, documentary audits, quarantine restrictions

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*Corresponding author

Introduction

Since the beginning of the war (12 April 2014) and the introduction of martial law (24 February 2022), Ukraine has undergone corresponding changes in many financial and economic aspects, among which tax audits, which are an important component of state control, have a significant place.

An important prerequisite for the effective functioning of the tax administration system in the country is the existence of tax supervision (control), which would guarantee the proper tax culture of taxpayers in their relations with the controlling authorities, which have special tax rights and obligations. Taxes, fees and other tax payments that form the revenue part of the state budget are also involved in the processes of regulation of centralised state funds, and, therefore, require proper state control in terms of completeness and timeliness of tax payments, the objectivity of the tax base, timely submission of tax and other reports, and compliance with tax law.

The Tax Code of Ukraine (hereinafter – the TCU) [1], which has been in force for more than a decade – since 2011, clearly distinguishes the functions of tax supervision (control), and substantiates and regulates the procedures and forms of tax control by its types. However, the context of martial law introduces changes to the mechanism of such state control.

With the outbreak of active hostilities, a number of amendments were made to the current Tax Code of Ukraine [1] and a number of other acts of Ukraine on tax law relating to the sphere of tax administration in the conditions of martial law. There are a lot of innovations, in particular regarding the conduct of tax audits, which require thorough study and analysis.

Many studies have been dedicated to the analysis of theoretical and practical aspects of the challenging nature in terms of determining the economic essence and content of tax audits, the specifics of the mechanism of their application. Methodical approaches to the organisation of tax control are studied in the works by V.Z. Bilinsky, P.Yu. Buryak, N.S. Zalutska, B.A. Karpinsky [2], O.V. Dobroskok [3], I.V. Leschuh, M.I. Melnyk [4], M.I. Krupka, R.Yu. Paslavaska & N.B. Demchyshak [5], F.P. Tkachuk [6] and many others. In particular, a group of researchers, P.Yu. Buryak, V.Z. Bilinsky, P.Yu. Buryak, N.S. Zalutska, B.A. Karpinsky [2], focus on tax control and reveal its essence as “the activity of tax authorities to supervise the compliance of the process of taxpayers’ organisation of accounting of taxable objects, methods of calculation and payment of taxes and tax payments under current regulatory and legislative acts of the taxation sphere, identification of deviations made in the implementation of tax legislation, and determination of the impact of the consequences of violations on tax liabilities”. The work by O.V. Dobroskok [3] reveals the theoretical foundations of tax control and characterizes the methods of its main types, criteria and indicators of efficiency of control and inspection actions of tax authorities. The monograph by I.V. Leschuh, M.I. Melnyk [4] describes in detail the institutional deformations of the tax control system and conceptual approaches to its organisation. In a collective

monograph prepared by M.I. Krupka, R.Yu. Paslavaska & N.B. Demchyshak [5] the emphasis is placed on the primary expediency of supervision and “tax supervision (control) is understood as the activity of specially authorised bodies of the state and citizens’ associations aimed at detecting and preventing violations of tax legislation, as well as protecting the rights and interests of taxpayers”, with which I agree since there is an urgent need to move from ineffective total tax control to supervision – a system of prevention of offences and monitoring of taxpayers’ activities, as well as reducing pressure on the business environment and involving the public in such control. I also support the argument of F.P. Tkachuk [6] that the creation and continuous improvement of electronic services for taxpayers “will contribute to the establishment of a closer and constructive dialogue “taxpayer – state fiscal service”, which will be one of the effective preventive measures in the national system of tax control and – as a result – minimise the phenomena of tax evasion.

The recent publications of Ukrainian scientists do not pay enough attention to the timely analysis of the norms of the current tax law in terms of the implementation of such a form of tax supervision (control) as tax audits, in particular in the context of existing conditions determined by quarantine restrictions and martial law. Given the rapidity of changes in tax legislation due to the impact of martial law and the importance of communicating information to taxpayers on aspects of tax regulation, this study is relevant and timely.

The purpose of the article is to study the problematic aspects of tax audits in the context of martial law and quarantine restrictions due to COVID-19 since the analysis of recent studies indicates the instability of tax legislation and significant contradictions in the norms of tax law. The main objective of the investigation is to assess the legality of the current legislation regarding the conduct of tax audits by regulatory authorities as the main form of implementation of tax supervision (control). The analysis of the amendments to the tax legislation contributes to a better understanding by taxpayers of their rights and obligations, which will allow taxpayers to timely and fully fulfil their tax obligations, which is especially important in the conditions of active hostilities and lack of financial resources.

Materials and Methods

The results of the study were obtained through a deep comparative analysis of the works of Ukrainian scientists on the organisation of tax control and official regulations regarding amendments to the Tax Code of Ukraine for certain types of tax audits. In particular, based on the application of empirical methods in identifying the features of a number of applied aspects that highlight the key problems and complex issues of the implementation of control and verification measures by the authorised controlling bodies of Ukraine, attention was focused on the expediency of transition from total control to the supervision of taxpayers. The paper also uses a set of various methods of scientific cognition, in

particular: system analysis (to classify the types of audits), analysis and synthesis (to determine the relationship between the forms of tax supervision (control)), classification (interpretation of concepts, categories, activities of individual bodies that have powers in the field of tax supervision (control): Accounting Chamber of Ukraine, the Ministry of Finance of Ukraine (hereinafter – the Ministry of Finance), the State Audit Service of Ukraine, the State Tax Service of Ukraine (hereinafter – the STSU), the State Customs Service of Ukraine, the State Labor Service, etc.), formalisation (for structuring the process of different types of tax audits), observation (for chronological analysis of changes made to the tax legislation), forecasting (for determining the expected consequences of reforming the national tax administration system in terms of conducting certain types of tax audits and their consequences for taxpayers and the state economy as a whole).

The interpretations of the Ministry of Finance and the State Tax Service of Ukraine on the application of certain provisions of tax law regarding the audit of taxpayers' activities and a number of publications covering certain aspects of the relevance of the chosen topic were subjected to a particularly thorough analysis. This study is aimed at solving the existing issues in the field of tax administration in general and in terms of tax supervision (control) in particular.

Considering the circumstances, which include hostilities in certain territories of Ukraine and quarantine restrictions due to the coronavirus infection, it is advisable for the controlling authorities to solve the existing problems in tax supervision (control) in a balanced manner and to ensure that tax audits do not hinder the activities of

individual taxpayers and allow them to actively contribute to the state treasury.

Results and Discussion

One of the most effective ways to obtain data on the taxpayer's activities in terms of fulfilling their tax and monetary obligations is a tax audit.

Tax audit is a form of supervision (control), which is carried out by authorised controlling bodies and some executive authorities to ensure compliance with the current provisions of tax law by both individuals and legal entities – taxpayers.

The Tax Code of Ukraine distinguishes the following main types of audits:

- Office (Article 76 of the TCU [1] defines the grounds and procedure for implementation);
- documentary (the procedure for conducting them is defined in articles 77-79, 81 of the TCU [1]);
- on-site (Articles 80-81 of the TCU) [1].

In practice, tax audits are classified according to certain criteria:

- according to the source of obtaining data about the payer, tax audits are divided into a documentary or on-site ones;
- in accordance with the method of organisation of such inspections and the schedule of their conduct formed by the State Regulatory Service of Ukraine – scheduled or unscheduled;
- depending on the location of the control measure – on-site or off-site (non-visiting);
- based on the scope of issues that require detailed analysis – complex or thematic; operational, counter or repeated.

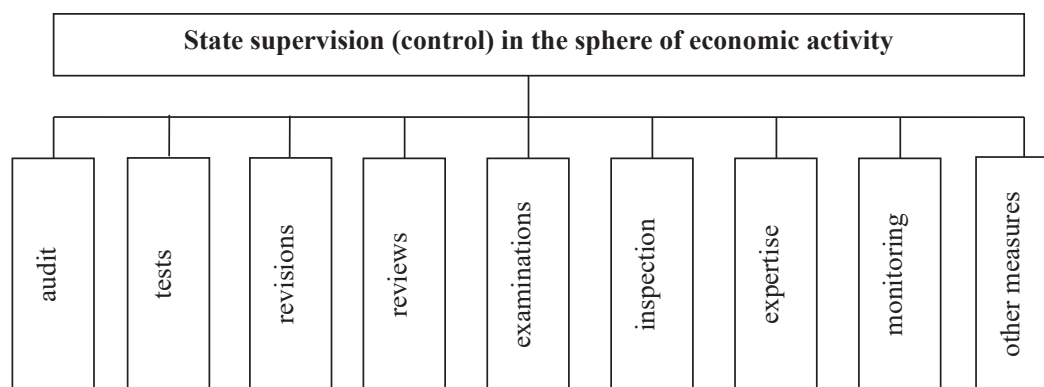


Figure 1. Types of tax audits by classification criteria

Source: [6, p. 83]

Therefore, “all types of tax audits are interconnected, interrelated, complement each other and are aimed at the effective implementation of the main functions of tax supervision (control) over the activities of taxpayers” [6, p.83].

In the practice of the State Tax Service of Ukraine, different types of tax audits are usually applied simultaneously, depending on the tasks set for the supervisory authority – the subject of the tax audit. In addition, all tax audits must be carried out in the context of the subject

matter of the audit, which is indicated by the head of the Supervisory Authority to conduct such an audit.

At the same time, the duty of the taxpayer (Article 85.2 of the TCU) [1] is to provide the representative of the supervisory authority with all the necessary tax documents in full, if such are related to the subject of the audit and are the object of control.

It should be emphasized that until 2020, the controlling authorities carried out inspections of the activities

of business entities in the usual way: scheduled tax audits – according to the official annual plan of such audits, which is published in the media (with an official warning 10 calendar days in advance); unscheduled tax audits are carried out unexpectedly (without warning), but on certain grounds, as provided by the Tax Code.

Starting from March 18, 2020 – with the beginning of quarantine restrictions due to the coronavirus infection – a moratorium on all tax audits was introduced, according to the amendments made to clause 52-1 to Section XX “Transitional Provisions” of the Tax Code [1].

Currently, quarantine restrictions have been extended and martial law has been prolonged in the country, during the six months of which a number of provisions on tax law have been introduced in terms of amendments to the current Tax Code, which are directly applicable to the inspection of business entities by the State Tax Service and other regulatory authorities through various types of tax audits.

Thus, from February 24, 2022, with the introduction of martial law, a moratorium on all types of tax audits was imposed, according to the adopted Law of Ukraine “On Amendments to the Tax Code of Ukraine and Other Legislative Acts of Ukraine on the Features of Taxation and Reporting during the Period of Martial Law” [7], which provided that for the duration of the martial law, all tax audits initiated were suspended and no other tax audits could be initiated. The same law also suspended the limitation periods established for taxpayers and tax authorities. Also, this law exempted all taxpayers from fulfilling their tax obligations and from liability for late submission of tax reports. Regarding its tax obligations, the taxpayer must fulfil such an obligation within 3 months following the termination of martial law or its abolition in Ukraine. Also, according to the Law of Ukraine “On Protection of Interests of Subjects of Submission of Reports and Other Documents During the Period of Martial Law or State of War” [8], after the war ends, legal entities are allowed to submit all reports (both financial and audit, etc.) within the specified period (3 months) for the entire period of non-submission of such reports or other documentation.

Further, the Law of Ukraine “On Amendments to the Tax Code of Ukraine and Other Legislative Acts of Ukraine Regarding the Validity of Norms for the Period of Martial Law” (hereinafter – Law No. 2120) [9] introduced certain clarifications, which allowed the controlling authorities to conduct on-site and office tax audits, but subject to the availability of budgetary reimbursement. In particular, according to the amendments made to para. 69.2 of the TCU, “tax audits are not initiated, and the initiated audits are suspended, except for: office audits of declarations or adjusting calculations (if submitted), to which an application for refund of the amount of budgetary refund has been submitted, the indicators of which are formed on the basis of tax invoices and/or adjustment calculations drawn up and registered in the Unified Register of Tax Invoices and/or customs declarations, except for goods (products)” [9].

It is necessary to highlight that Law No. 2120 [9] provided for the abolition of the moratorium on the collection

of fines, which was introduced during the quarantine restrictions due to the spread of COVID-19. In particular, “in case of detection of violations of the law based on the results of inspections, taxpayers are held liable in accordance with the Tax Code, laws, control over which is entrusted to the controlling bodies, and the requirements of the legislation on the moratorium (suspension) of the application of penal (financial) sanctions (fines) for the period of martial law, state of emergency and/or for the period of quarantine established by the Cabinet of Ministers of Ukraine throughout Ukraine to prevent the spread of coronavirus disease (COVID-19), in this case does not apply [9].

Also, the relevant ban should be in force for the entire duration of martial law, and for another four months from the moment of its cancellation or termination.

It is also worth highlighting that for the period of martial law, tax fines for violations related to the use of cash registers are not imposed.

Law No. 2120 [9] from March 17, 2022, the TCU established the permission to conduct on-site tax audits, namely:

- for the duration of martial law, the taxpayer must bear the appropriate financial responsibility established by the Tax Code of Ukraine and applied by the controlling body over the results of the tax audit;

- certain amendments were made to the TCU, according to which the controlling body has the authority to conduct on-site tax audits also in terms of taxpayers’ settlement transactions, including payments for goods (works, services) using electronic payment terminals (subpara. 80.2.2, 80.2.3.).

The subsequent Law of Ukraine “On Amendments to the Tax Code of Ukraine and Other Legislative Acts of Ukraine on Improving the Legislation for the Period of Martial Law” [10], which entered into force on April 5, 2022, introduced amendments that allow regulatory authorities to carry out in-house audits of officially declared information regarding those taxpayers who are subject to the single tax and the 4th group of taxation. In particular, the term for them has been extended by 6 months to fulfil their tax obligations after the termination or cancellation of martial law in Ukraine if it was not possible to fulfil such an obligation due to military operations. Also, during a state of emergency or martial law, taxpayers are allowed to submit tax reports to the supervisory authority in paper form.

Further, the changes that were introduced with the adoption of the Law of Ukraine “On Amendments to the Tax Code of Ukraine and Other Legislative Acts of Ukraine on the Administration of Certain Taxes during the Period of Martial Law, State of Emergency” [11], which entered into force on April 16, 2022, did not generally narrow the impact of the military moratorium on tax audits but established certain features regarding the execution of the results of office audits. Also, for the duration of martial law, regulatory authorities have the authority to control and monitor pricing. Such control, according to the TCU, is carried out by means of actual inspections, but provided that there is at least one of the following grounds: violations by certain taxpayers of the current tax law on prices or pricing have

been detected; a complaint has been received from a consumer about violation of the established rules that apply to the establishment of state-regulated prices and in the process of their application and formation. The regulatory authorities also are empowered to conduct on-site inspections of taxpayers' activities in terms of their compliance with the applicable tax laws and rules that apply to fixed and marginal prices and determine the margin limits of trade margins [1].

The following innovations in terms of tax audits occurred with the adoption of The Law Of Ukraine "On amendments to the tax code of Ukraine and other laws of Ukraine concerning the specifics of tax administration of taxes, fees and a single contribution during a state of war or emergency" (hereinafter referred to as Law No. 2260) [12], which entered into force on May 27, 2022, and one of the key provisions of which is the exclusion of certain types of tax control from the moratorium.

The new version of the TCU [1], is set out in subpara. 69.2, according to which all tax audits (except for office, documentary unscheduled and on-site) cannot be started, and those that were started earlier are suspended.

As for office inspections, they are currently carried

out exclusively on the premises of the State Tax Service of Ukraine and if there are grounds for reporting tax data reflected in the value-added tax (hereinafter – VAT) declarations of the taxpayer, as well as in other tax information – in terms of VAT accounts of the taxpayer, customs declarations, data from the Unified Register of Tax Invoices (hereinafter referred to as the URTI), the Electronic VAT Administration System (hereinafter referred to as the E-VAT), the Electronic Fuel Sales Administration System (hereinafter referred to as the EFS), the Unified Register of Excise Tax Invoices (hereinafter referred to as the URET), etc. In addition, paras. 75.1. 1 of the TCU [1] states that office inspection may be carried out by the STSU body for compliance by the taxpayer with the established deadlines for filing tax calculations and declarations, in particular: timely registration of tax invoices and adjustment calculations (hereinafter – TI/AC) in the URTI and in the excise invoice and excise invoice adjustment calculation (hereinafter – AN/AC) in the URET; correction of errors in the TI; compliance with the deadlines for repayment of tax/monetary obligations.

When conducting office, an official of the Supervisory Authority monitors VAT tax returns.

Table 1. Terms of office audits of VAT tax returns in 2022

Reporting tax period	Start date	End date
February, March, April, May	The day after July 20, 2022	No later than September 20, 2022
June, July, August	the day after August 20	no later than October 20, 2022

Notes: Compiled by the author according to the source [12]

If prior to the outbreak of the war, adjustments for the reporting tax periods were submitted together with VAT tax returns, they are subject to verification by the State Tax Service of Ukraine within the specified period established for the submission of such calculations.

As for documentary unscheduled audits, according to subpara. 78.1.7 and 78.1.8 of the Tax Code of Ukraine [1], such audits may be conducted only at the request of the taxpayer or on other grounds in case of receiving information about the probability of violations of the currency law provisions by the taxpayer. In particular, for non-compliance with the established deadlines for the delivery of goods for export-import operations. For the period of martial law, such inspections shall be carried out by officials of the regulatory authorities, provided that security is guaranteed during access and admission to: premises, territories or property of the taxpayer, if such are used as an object of taxation or serve to generate income or profit or are related to other objects of taxation; documents and any information related to the financial and economic activities of the taxpayer, its income or expenses. Also, such inspections are carried out in the course of other control measures, including the inventory of tangible assets, audit of inventory, capital, cash balance, etc [12].

If documentary unscheduled audits were started earlier and were not completed before the introduction of

martial law (02/24/2022), they may be resumed and completed within 60 calendar days starting from 05/27/2022. It is established that the renewal of such inspections will take place for the period that has not expired [12].

According to Law No. 2260 [12], it is also allowed to conduct documentary unscheduled audits if the economic rehabilitation procedure has been initiated against the taxpayer, there was an application for a VAT refund from the budget or a negative VAT value of more than UAH 100 thousand was declared. Regarding the conduct of desk audits, in particular VAT tax returns, and the corresponding corrective calculations to the tax invoice in terms of budgetary VAT refund, it is necessary to consider the fact that such changes are effective from 06/02/2022, provided that the taxpayer submits the relevant application to the STSU.

There have also been changes in terms of access to data on the absence of tax arrears on the part of the payer [13]. In particular, the information that was previously available on the official portal of the State Border Guard Service under the heading "Open Data" or the service "Learn more about your business partner" is currently disabled. Restriction of the activity of official information and communication systems and public electronic registers was carried out according to the relevant Government Resolution "Some issues of ensuring the functioning of information and communication systems, electronic communication systems,

public electronic registers under martial law" [14] for the period of martial law. A taxpayer can learn about the status of settlements with the budget and other personal tax information only through a personal "Electronic cabinet" using an electronic digital signature.

The current wartime and quarantine moratoriums give the right to conduct office and on-site audits of the activities of business entities, and documentary unscheduled audits, but only when the taxpayer officially applies on the grounds specified in sub-clauses 78.1.7-78.1.8. of the TCU [1].

Since para. 52-2 of the Tax Code of Ukraine [1] was suspended during the war, the moratorium on tax audits will be suspended upon termination of the martial law (currently until November 21, 2022), but the moratorium due to COVID-19 (established by para. 69.2 of the Tax Code of Ukraine) [1] will be resumed if the quarantine is extended (currently until December 31, 2022).

Thus, the wartime and quarantine moratoriums have very similar permitted forms of tax supervision (control). However, it should be emphasised that the moratorium imposed due to COVID-19 quarantine restrictions does not provide for documentary unscheduled tax audits by the controlling authorities on the basis of information on violations of currency legislation by the taxpayer. In particular, this measure applies in case of violation of the established deadlines for the receipt of foreign exchange earnings from export operations, as well as the receipt of goods under import operations. That is, after the end of martial law in Ukraine, any documentary unscheduled tax audits, if any, that have been initiated and not completed, will continue until the end of the quarantine moratorium due to COVID-19. The situation is similar with office and on-site audits, which are not allowed according to para. 52-2 of the TCU [1].

Thus, if a taxpayer is inspected for a tax audit, it is advisable, first of all, to verify the legality of such an audit, and in particular to check whether it is not included in the moratorium due to martial law – subpara. 69.2 of the TCU, or due to quarantine restrictions – subpara. 52.2 OF THE TCU [1]. If such a control measure falls under any of the moratoriums, the taxpayer will have the full right to appeal against the actions of the controlling authorities in general and the order and referral for such an audit in particular.

It should also be noted that the taxpayer must be warned in advance about the start of a planned documentary tax audit, and the timing of such an audit can be found on the Inspection Portal, where the updated Schedule [15] of such measures for 2022 is available.

Tax audit is understood as an appropriate form of supervision (control) carried out by the authorized

controlling bodies (State Tax and State Customs Services) and some executive authorities (Accounting Chamber, State Audit Service, State Labor Service, etc.) to ensure compliance by taxpayers (individuals or legal entities) with the current provisions of tax legislation enshrined in the Tax Code of Ukraine [1] and other regulatory documents.

Under present conditions, caused by military actions and quarantine restrictions, it is advisable for the controlling authorities to take a particularly careful approach to solve problems in the field of tax supervision (control) and take into consideration that tax audits do not become a fiscal punitive tool in the hands of a tax auditor or inspector.

Given a large number of regulatory authorities, the complexity of tax legislation and the transience of changes that are made to it, it is difficult to form a unified methodological basis for conducting tax audits by various regulatory authorities.

Conclusions

The set objective was achieved by means of in-depth content analysis of the current provisions of official legislative and other regulatory acts on tax law aimed at understanding the importance of tax control and forms of its implementation (supervision, monitoring, audit, inspection, examination, investigation and review). The article also provides the author's interpretation of the content of tax audits and characteristics of its main types (office, documentary planned and unscheduled, on-site, counter, etc.) and specifics of their implementation under martial law.

In further research, it is necessary to focus on the development and implementation of unified methodological techniques of tax supervision (control) (inspections, audits, monitoring, etc.) under martial law for all taxpayers and to unify a number of key indicators for certain sectors of the national economy to develop forecasts of possible violations of tax law provisions. This will allow timely and thorough monitoring of the actual situation for homogeneous groups of business entities, more effectively identify and prevent attempts at tax evasion, and, consequently, ensure full and timely revenues to budgets of different levels. Thus, it will contribute to the restoration of the national economy in the post-war period, while also ensuring transparency, efficiency and transparency of the tax administration system in times of war.

The economic front is especially important during the war, as business entities face enormous challenges in paying salaries and taxes on time. Therefore, unjustified visits with tax audits are not relevant, the goal should be to move from total control to supervision and encourage taxpayers to stay in Ukraine and work to strengthen the national economy.

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Податкові перевірки у період воєнного стану в Україні

Віра Мирославівна Кміть

Кандидат економічних наук, доцент кафедри фінансів, грошового обігу і кредиту,

ORCID: <https://orcid.org/0000-0001-6845-8139>

Львівський національний університет імені Івана Франка,

79000, вул. Університетська, 1, Львів, Україна

Анотація. В статті розкриті особливості проведення податкових перевірок контролюючими органами. В Україні діє заборона на здійснення заходів з податкового (нагляду) контролю з 18.03.2020 р. – з початку впровадження карантинних обмежень. З введенням воєнного стану дію мораторію продовжено, однак є низка винятків, які потребують детального вивчення. Мета статті полягає у дослідженні проблемних питань проведення податкових перевірок в умовах нестабільності податкового законодавства – воєнного стану та карантинних обмежень через COVID-19, внаслідок внесення змін до правової бази. Проаналізовано хронологію змін, що були внесені впродовж пів року дії воєнного стану до Податкового кодексу України (ПКУ). Перший «воєнний» закон продовжив дію карантинного мораторію на податкові перевірки в умовах воєнного стану, а наступні внесли зміни до ПКУ. На час дії воєнного стану будь-які податкові перевірки не можуть розпочинатися, а ті, що були розпочаті – призупиняються. Винятком є камеральні та фактичні перевірки, а також позапланові документальні перевірки, що здійснюються на добровільній основі – за зверненням платників. Підставами для таких перевірок також є одержання контролюючим органом інформування про наявність порушень з боку платника норм податкового чи валютного права. Результати дослідження були одержані способами теоретично-методологічного аналізу положень, що висвітлюють проблемні питання здійснення перевірки діяльності платників. Мету досягнуто внаслідок застосування глибокої контент-оцінки норм податкового права, спрямованих на розуміння сутності видів податкових перевірок та особливостей їх здійснення в умовах воєнного стану, офіційного сайту Мінфіну України та Державної податкової служби України, а також низки наукових публікацій за даною проблематикою дослідження. Стаття спрямована на вивчення ключових проблем у сфері податкового адміністрування в цілому та в контексті здійснення відповідних заходів із податкового контролю

Ключові слова: податковий нагляд (контроль), камеральні перевірки, фактичні перевірки, документальні перевірки, карантинні обмеження

**Documenting, Accounting, and Valuing Material Damages
Caused by Armed Aggression to the Non-Current Assets of the Company**

Andrii Kulyk*

PhD student of the Department of Accounting and Consulting,

ORCID: <https://orcid.org/0000-0001-7791-3551>

*National Economic University named after Vadym Hetman,
03057, 54/1 Peremohy Ave., Kyiv, Ukraine*

Abstract. Apart from massive losses in human capital, armed aggression in Ukraine commenced in the late February 2022 has brought about significant negative material consequences to the business. These include interruptions or termination of operations, damages non-current and other assets, disruptions in supply chains, etc. This in turn aggravated certain accounting and valuation challenges as well. In Ukrainian practice, for such matters as documentation, accounting, and valuation of damages, there were no established and generally accepted approaches and algorithms. The purpose of this study is to explore theoretical and methodological, as well as empirical aspects of documenting, accounting, and valuing of material damages caused by armed aggression to the non-current assets of the business. Methods of theoretical cognition and empirical research constitute a methodological basis of the study, particularly systematization and generalization, induction and deduction, comparison and measurement, analysis, and synthesis. The paper systematises the opinions of the local experts on recording the damages, namely provides a joint step-by-step algorithm for identification of affected assets and documentation of damages. The analysis outlines key accounting treatment issues related to affected non-current assets such as necessity to conduct impairment and revaluation, loss of control or significant influence over assets, going concern uncertainty and provided the basis for further more detailed investigation of each of the matters in next research. The practical significance of the study is to present extent and nature of disclosures provided regarding the impact of armed aggression by Ukrainian companies in their interim financial reports. Such empirical analysis is possible to repeat and broaden later in the next studies after publication of annual financial statements

Keywords: armed conflicts, conflict impact, losses, affected property, assets impairment, assets revaluation, going concern

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*Corresponding author

Introduction

The armed aggression in Ukraine which commenced on February 24, 2022 led to unbearable implications in terms of harm to human capital, displacement of people, as well as destruction of manufactured capital. In particular, about 4.8 million jobs have been lost in respect to the pre-conflict situation as of mid-May 2022, and another 3 million is likely to be lost in case of further military escalation, that have taken place in the 2nd half 2022 [1]. At the same time, as of September 2022, over 7.5 million Ukrainian refugees have been registered outside Ukraine, and up to 7 million were forcibly displaced inside the country [2]. Considering the harm to economy and destruction of infrastructure across the country, according to the recent rapid damage and needs assessment published in August 2022, the total amount of damage comprised over USD 97 billion, while losses reached USD 252 billion [3]. However, one should bear in mind that results of such assessment do not provide asset-level information and are not intended for legal or compensatory claims. In other words, mentioned analysis omits detailed valuation of damages on company-by-company level and only indirectly indicates that the amount

of such damages undergone by companies is likely to be significant.

Considering business, there is evidence that as of beginning of August 2022, total damages to small and medium-sized enterprises (SME), namely lost resources, goods, fixed assets, forced overpayments, relocation costs, reached USD 87 billion [4]. Nevertheless, the precise value of damages is not clear; at the moment, it is evident that businesses were significantly exposed to the impact of aggression. Moreover, as 2022-year end approached, companies are required to reflect in financial statements the negative effect of the armed aggression both in quantitative terms (e.g., loss of assets, impairment), as well as in quantitative terms (e.g., communication to stakeholders, substantiation of going concern). This makes scrutiny of the impact of armed aggression to the company's activities even more relevant.

The impact of armed aggression in Ukraine is revealed in multiple dimensions, in particular in damage to inventory, fixed and other assets, closure of roads, ports and other infrastructure facilities in the affected regions, disruptions in supply chains, etc. (refer to Fig. 1).

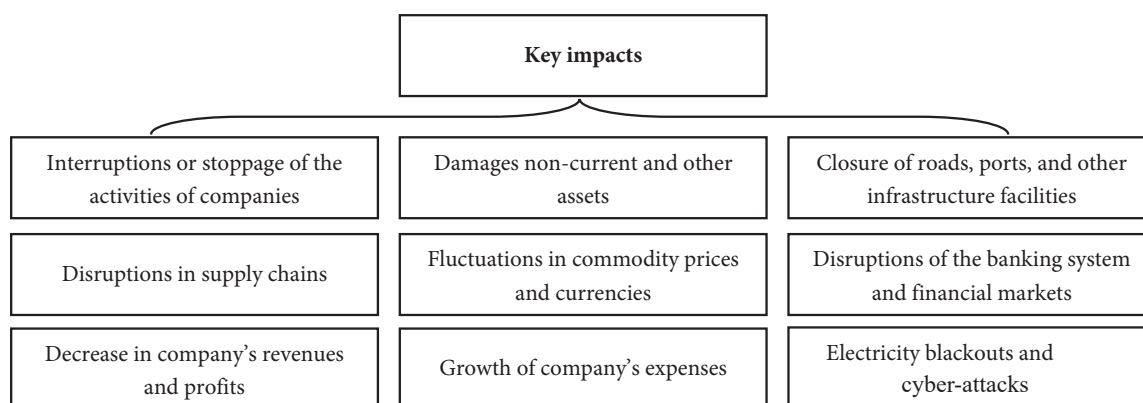


Figure 1. Key impacts of Russia-Ukraine armed aggression

Source: prepared on the basis of research data [5; 6]

Among mentioned effects, the study of damage to non-current assets is of a particular importance and unfolds *the purpose of the study*. This is because, firstly, non-current assets constitute the core of the company's manufactured capital forming a basis for conduction of operating cash-generating activities, secondly, the benefits associated with the use of non-current assets are allocated over the long-term that emphasizes the specifics of their valuation, thirdly, damages caused to non-current assets is a common object for compensation in courts, tribunals, and arbitrations. To study the issue of damage to non-current assets due to the armed aggression, the following objectives should be addressed:

- documentation of damages and identification of affected assets;
- valuation of material damages;
- accounting treatment and financial reporting of the impact of war.

The first of these objectives include discovering the specifics of physical observation of affected assets, primary documentation of damages, as well as outlining key steps on establishing a reliable evidence base regarding the act of harm in connection with an act of aggression. In broad context, the second objective might be divided into the following components: accounting estimate of damages for the purposes of financial accounting and reporting, independent valuation of damages for submitting compensatory claims. The documentation and accounting estimate as the first stage of damage valuation are described below. Such choice is supported by the following arguments: firstly, documentation and proper accounting treatment of damages is a good starting point to reflect changes in financial position, performance and cash generating capacity of the business in financial statements for the management-decision purposes, as well as communication with stakeholders; secondly, accounting estimate and financial reporting of damages is a

basis for subsequent damage valuation by independent experts for the purposes of submitting compensation claims to courts or tribunals. Finally, the third objective aims to study the accounting specifics and reporting of the impact of war, as well as empirically analyze the disclosures carried out by Ukrainian companies in their financial and management reports.

Literature Review

The issue of damage caused by armed aggression to the companies is not new for national business and science. Since the outbreak of the invasion in Crimea and Donbas, some empirical reports and scientific researches might be found. Among first practical studies it is worth noting the recovery and peace building assessment conducted by the World Bank Group in 2015 in order to analyse the crisis impact and needs in the Eastern Ukraine [7]. According to this study, the monetary value of recovery needs in Donbas was estimated in the amount of ca. USD 1.5 billion. Considering more scientific-like works, it is worth mentioning the monograph of S. Ivanov of 2015 dedicated to discovering the impact of armed conflict on the enterprise value [8]. Additionally, later S. Ivanov together with S. Yudina and others developed a detailed classification of damages and losses from the armed aggression. In particular, depending on the place and time of manifestation the scientists have distinguished direct (damage to assets) and indirect (lost profit) damage, while depending on the spheres of manifestation – medical and biological, military, and political, social and economic, ecological, external and internal political [9]. Critical analysis of loss and damage concepts, including company-level classification, was studied by O. Palekiene and others, particularly by analyzing damages on the company level scientists subdivide them into material, work, financial, time and specific losses [10]. A more industry specific study on estimating economic loss of seaports due to disasters, namely COVID-19, was conducted by X. Zhou and others [11]. This study suggests that economic nature of damages and losses is not limited by the armed conflicts but can also result from natural or man-made disasters.

Even without directly harming the assets, such disasters might negatively impact economic benefits associated with the assets. This results in necessity to conduct assets impairment or revaluation. In this regard, T. Poerwati and others on the sample of public companies from Indonesia Stock Exchange studied the factors that influence assets revaluation, such as company size, fixed assets intensity, operating cash flows dynamics [12]. Conducting a similar empirical study on revaluation practice, B. Solikhah and others broadened the list factors by adding leverage, liquidity, and company's growth [13]. Primary importance of fixed assets revaluation is to maintain transparency of financial reporting by providing fair value disclosures to the stakeholders. In this regard J. Bae and others concluded that the impact of fixed assets revaluation and stock price cash risk was dependent upon management's motivation for honesty during the revaluation process [14]. Apart from accounting the fixed assets using revaluation model, management may apply cost model. In this case, in

the conditions of conflicts and disasters the impairment of assets is likely to be recognized. Despite no studies were found out on impairment in terms of armed conflicts there are some works exploring the effect of crises and disasters on assets impairment. C. Gaio and others researched the impact of financial crisis (e.g., 2008-2009 crises) on the non-financial assets' impairments and concluded that European companies recognized less impairment during the crisis [15]. Considering Eastern European markets to which Ukraine belongs as well, B. Lisicki focused on examining the impact of the reported impairment of assets on the market reaction on the example of Warsaw Stock Exchange in the crisis conditions driven by the COVID-19 pandemic [16].

Armed aggression as an extreme form of social conflict, as well as disasters, brings about one more important consequence for companies – going concern issue. This is corroborated by recent studies performed by T. Baskan [17] & K. Savova [18] dedicated to the impact of COVID-19 pandemic on the concept of going concern that underpins the development of the financial statements. In terms of conflicts, disasters and crisis management have to address the going concern uncertainty by assessing the ability of company to recurring conduct operating over next year or operating cycle and corroborate such assessment with reliable business plans and budgets. Otherwise, company faces the issue hindering preparation of financial statements on a recurring basis and issuing the independent audit report.

Literature review indicates presence of some materials dedicated to accounting treatment and estimation of non-current assets of the company in terms of conflicts, disasters, and crises. Conclusions from these studies are a valuable input toward exploring the accounting and valuation consequences of armed aggression in Ukraine on national companies. However, there is a lack of studies on the topic of damage valuation caused by the armed aggression. This further emphasizes on the novelty of this study.

Materials and Methods

Theoretical and methodological basis of the study consisted of scientific researches of Ukrainian and international scientists, methodological standards, analytical materials of national and international organizations, practical comments and recommendations and experts and companies. Literature review indicated that there was a limited amount of researches on the topic of accounting and assessing the impact of armed aggression on the companies' activities. However, assuming that negative impact on the company from disasters and crises is similar to armed aggression, the analysis of materials exploring the effects of disasters and crises have been made as well. In this regard, it is relevant to recall the research of J. Roczanski & P. Kopczynski [19] dedicated to the influence of financial crisis 2008-2009 on the listed Polish companies or analysis of C. Holt [20] on the impact of COVID-19 disaster on asset impairment considerations.

The subject matter was subdivided into the three objectives considering step-by-step approach. After the harmful event, the first step is to identify the affected assets and document the damages. The second step deals with

determination of monetary value of damages, namely initially as of the date of harmful event and subsequently as of the reporting period end. The third step is about disclosing the effect of armed aggression in financial statements.

Method, techniques, and actions were applied by each of these steps. Analysis of damage documentation procedures consisted of empirical and rational components. As there is already some experience on documentation of damages caused by the armed aggression to companies, the empirical component is paramount in this context. It included systematization and generalization of practical lawyers' recommendations collected by participation in webinars, meetings, discussions devoted to damages' recording and documentation. The latter, namely rational component, included overview of recently published legal acts on damages' documentation. It should be noted that foundation of legal base for documenting of damages is still in progress; therefore the scope of such review is somehow limited. By starting from practical comments and finishing with review of legal acts, the method of induction was applied.

Considering the novelty of damage valuation in national professional practice, it was important to apply method of deduction, i.e., start by exploring theoretical and methodological aspect of damage valuation for accounting and financial reporting purposes. To do this, the methods of analysis and synthesis were applied to study internationally accepted standards in accounting and valuation, namely International Accounting Standards (IAS), International Financial Reporting Standards (IFRS) related to assets valuation as well as International Valuation Standards (IVS). Additionally, the analysis was supplemented by fundamental studies of Ukrainian and international researchers and scientists in the field of economic, finance, accounting, and valuation. Among Ukrainian works, it is relevant to take the study of S. Ivanov on the impact of armed aggression of business value on the example of conflict in Donbas [8]. Considering fundamental international works, it is worth noticing the full-fledged research of R. Peterson [21] on different aspects of accounting for fixed assets.

To investigate the accounting treatment and financial reporting of the impact of armed aggression in Ukraine as

a starting comparison of guiding recommendations published by top audit companies was carried out. Extracts of such recommendations is to form a theoretical and methodological basis for accounting and estimation of material damages caused by armed aggression to the non-current assets of the company. To uncover practical results, the empirical investigation and measurement of the disclosure of the impact of war in the financial statements of Ukrainian companies was carried out. To do this as a sample Ukrainian companies included into the stock index WIG-Ukraine have been chosen.

To draw the conclusions, the methods of generalisation and systematization of the findings were applied.

Results and Discussion

The armed aggression in Ukraine resulted in significant damages to the companies of public and private sectors. According to the legislation, the responsibility of proof for any damage is imposed on the injured party. Considering damages resulted from armed aggression, it was concluded that to carry out the documentation procedures, it was necessary to accomplish the following objectives:

- establish and record the fact of damage to property and causing the harm;
- identify the event led to property damage and its illegality, in particular the illegal act of armed aggression of the Russian federation;
- establish cause-and-effect relationship between the illegal act event and property damage;
- estimate the financial scope of damage to assets and losses to company activities.

To accomplish these objectives, for the company's management it is necessary to follow the algorithm of certain actions including organization of the work of personnel, documentation of caused damage, contact of local authorities, transfer of information on damage to online platforms and registers (refer to Fig. 2). It should be noted that there is no solely prescribed algorithm of actions; rather there are different practical recommendations from the experts such as Arzinger [22], Ligazakon [23], Ukrainian Agri Council [24] and others, with certain steps to follow.

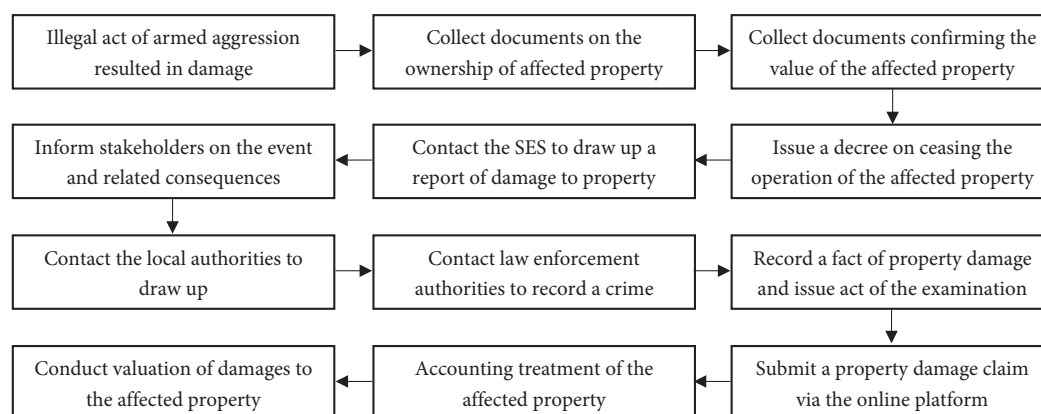


Figure 2. Proposed algorithm of identification of affected assets and documentation of damage

Note: SES stands for State Emergency Service

Source: prepared on the basis of research data [22; 23; 25]

The process of documentation begins with collection of ownership documents. These include agreements, technical passports, extract from the register, etc. Such documents are applicable to both real estate and other assets: vehicles, goods, raw materials, etc. If the documents are lost or missing, it is necessary to record this in the documents compiled in the next steps. Together with ownership documents, it is important to collect any documents that directly or indirectly substantiate the value of the damaged or destroyed property, such as accounting certificates, information from accounting registers, statement of financial position, latest appraisal reports [22]. Information from these documents can be used as a basis for quantifying the monetary value of damage.

Mentioned steps constitute a preparatory stage of damage documentation. As a result of the study, it was concluded that the main stage of documenting process began with issue of internal corporate documents, one of the simplest of which was decree on ceasing the operation of the damaged or destroyed property. Such documents are necessary for internal control and decision making. This is followed by contacting with the bodies of the State Emergency Service (SES) that must draw up a report of destruction or damage to property with an indication of the cause such as shelling, rocket attack and fire [23]. After compiling the report form SES, the management can officially inform all stakeholders on the event and its consequences. The list of potential stakeholders might include mortgagees and mortgagors, banks, and insurance companies as well as counterparties to whom obligations had to be fulfilled using affected property. It was concluded that such step was of great importance, because it enabled the stakeholders to make appropriate decisions having bared in mind the fact of property destruction or damage. If possible, it is recommended to contact the local authorities such as state administration, local council, military-civilian administration. These bodies can additionally confirm the fact and draw up a certificate of property destruction or damage. Next important action is contacting the law enforcement authorities with a statement about the act of crime, in which it is necessary to describe the fact and reasons for the destruction or damage of property. It is of prime importance to receive not just evidence of acceptance of the application, but also the evidence of its record into the Unified Register of Pretrial Investigations [24]. The final goal of submitting such a statement is to record the fact of

destruction or damage to property with the demonstration of cause-and-effect relationships and the creation of legal grounds for compensation of its value in the future.

After contacting relevant parties and authorities the next stage is to take all possible measures to record the fact of property destruction or damage, including [22]:

- Indicating exact address and place where the property was located, if possible – with geolocation;
- describing the circumstances under which property was destroyed or damaged;
- drawing up a diagram of the scene with an indication of the nature of the destruction;
- photo and video recording of the object before and after destruction;
- getting written explanations from witnesses and company officials (indicating each person with contact information);
- receiving communications from mass media and authorities related to the damage to affected property.

The result of the fixation is the inspection act or report on the examination, in which together with items mentioned above there is a comprehensive list of damaged or destroyed property and goods. The inspection act or report should contain a conclusion on the technical condition of the affected property, as well as the possibility and feasibility of its further use [26]. This information directly influences subsequent accounting treatment and valuation of affected property. The inspection report is carried out by the commission of relevant specialists in accordance with the procedure approved by Resolution No. 257 of the Cabinet of Ministers of Ukraine (CMU) as of April 12, 2017 [27]. After the restoration of safe access to the affected property, it is also necessary to carry out the physical verification in accordance with the decree of the Ministry of Finance of Ukraine No. 879 as of 09/02/2014 [28]. The commission prepares physical check descriptions, compares verified data with accounts before the start of armed aggression, prepares a register, in which records shortages and losses, and forms a protocol, which notes the results of the inspection and the reasons for the destruction of assets. Such information forms a basis for disclosing the impact of armed aggression in company's accounts and financial reports. Considering legal side of damages documentation and affected property identification there is a list of recently published legal acts, brief overview of which is given below (refer to Table 1).

Table 1. Legal acts for damage recording

Legal Act	Brief overview
CMU Resolution No. 380 dated 03/26/2022 [29]	The resolution regulates the procedure for entering and recording information about damaged and destroyed property of individuals and legal entities on the Diya portal
CMU Resolution No. 423 dated 04/05/2022 [30]	The resolution amends Resolution No. 257 of the CMU dated April 12, 2017 regarding the inspection of construction facilities put into operation in accordance with the procedure established by law. The specified Procedure is used during the inspection of objects damaged as a result of emergency situations, military actions or acts of terrorism in order to make a decision on the possibility of further exploitation and development of restoration measures. The procedure contains links to which specialists should be involved in the examination. Inspection of objects and damaged objects is carried out in accordance with this Procedure and the methodology approved by the Ministry of Development of Communities and Territories of Ukraine, which determines the specifics of performing the specified works
CMU Resolution No. 473 dated 04/19/2022 [31]	The procedure defines the mechanism of operational response of the executive bodies of village, settlement, city councils, military administrations, central executive bodies, management bodies and civil defense forces, aimed at eliminating the consequences of the armed aggression of the Russian federation, related to the damage to buildings and structures, in the territories, on which the active phases of combat operations are absent or completed. The procedure can be used to record damage to state-owned buildings and structures
Decree of the Ministry of Development of Communities and Territories of Ukraine No. 65 dated 04/28/2022 [32]	The methodology defines the specifics of the inspection of buildings and structures damaged as a result of emergency situations, military actions or terrorist acts of objects, which is carried out in accordance with the Procedure for conducting an inspection of construction objects put into operation, approved by Resolution of the CMU dated April 12, 2017 No. 257, with for the purpose of making a decision on the possibility of further exploitation of such facilities and development of restoration measures

Note: CMU stands for Cabinet of Ministers of Ukraine

Together with recording the fact of property damage or destruction on the place, the company can submit a claim via online platforms. The following websites provide an opportunity to document the crimes caused by armed aggression: damage reporting module on Diya Portal [33], damage portal on the website of Prosecutor General's Office [34], etc.

After the initial recording of damages, it is necessary to reflect the consequences in accounting and financial reporting, in particular, perform a review of accounting assumptions regarding the recognition, classification and assessment of assets and liabilities, income, and expenses. Considering affected non-current assets, it was concluded that such review might include writing down the carrying amount of destroyed or damaged as of the date of damage documentation, as well as testing non-financial non-current assets for impairment, or their revaluation as of the end of reporting period.

The assessment mechanism and sources of compensation for damages are currently in the process of development. Damage assessment should be carried out according to the directions and methods provided for by the Resolution of the CMU of March 20, 2022 No. 326 "On Approval of the Procedure for Determining Damage and Losses Caused to

Ukraine as a Result of the Armed Aggression of the Russian Federation" [35]. Nevertheless, review of guiding recommendations published by top audit companies indicates the following accounting and valuation considerations of the armed aggression related to non-current assets [5], [36]:

- impairment or revaluation of non-financial non-current assets;
- loss of control or cessation of operations, abandonment and idling of assets;
- going concern uncertainty.

In connection with armed aggression, it is likely that many enterprises would need to perform an asset impairment test or perform revaluation (Fig 3), because armed aggression gives rise one or more triggering events such as substantial decrease in market demand and prices, supply chain disruptions, curtailment, or cessation of operations. In case of applying cost model, according to IAS 36 "Impairment of assets" impairment testing procedures (e.g., property, plant and equipment, intangible assets, and goodwill) commonly requires development of cash flow forecasts and the determination of the discount rate [37]. This in turn is complicated by significant uncertainty due to armed aggression.

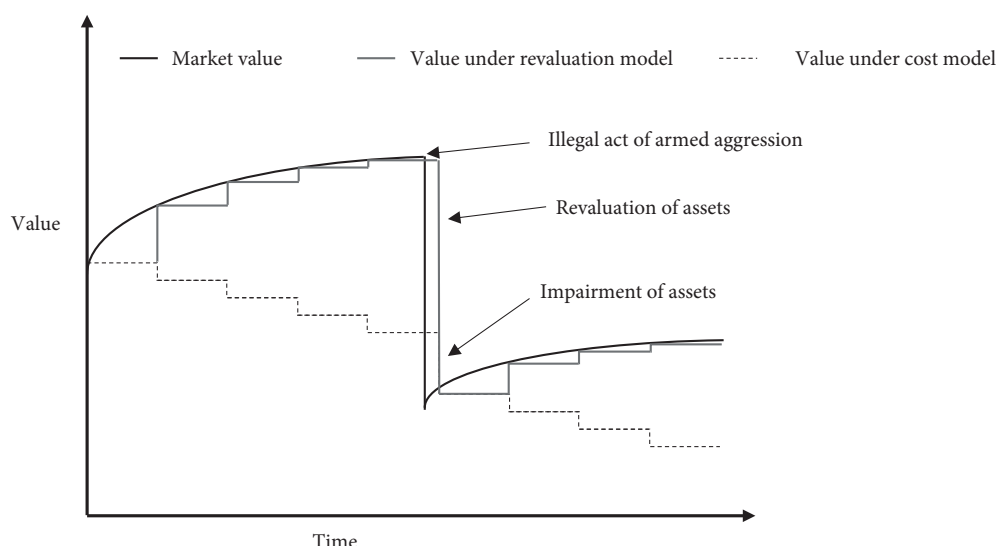


Figure 3. Value of non-current assets under revaluation and cost models

Source: developed by the author

On the other hand, in case a company applies revaluation model for fixed assets accounting, it has to perform a revaluation as of the end of reporting period [38]. Therefore, it is necessary to estimate fair value of fixed assets using methodological approach prescribed in IFRS 13 “Fair Value Measurement” [39] by applying valuation approaches and methods provided by IVS [40], that is cost, market, and income approaches. To estimate the fair value of the assets of already established business it is necessary to estimate replacement cost of the underlying assets using cost, and thereafter test for physical, functional, and economic obsolescence to come at depreciated replacement cost. Testing for economic obsolescence in practice requires building a discounted cash flow model, which is in turn complicated due to limited ability to create reliable long-term cash flow forecasts. On the other hand, even for assets for which it is possible to come at fair value using market approach there is completing with finding comparables, because markets tend to be volatile and speculative during conflicts and disasters.

It was concluded that armed aggression caused significant changes in the economic and political environment so that companies that had subsidiaries or long-term investments in affected regions might lose control or the ability to exercise significant influence over such operations. Moreover, companies may decide to cease operations and abandon the assets in the regions affected by the armed aggression. Such changes lead to accounting consequences related to necessity to review the assumptions on

consolidation of subsidiaries or application of the equity method to affiliated entities.

Uncertainty driven by armed aggression requires the management to reconsider the ability of the company to continue operations as a going concern at least, but not limited to, twelve months from the reporting date. The assessment of the ability of the company to continue as a going concern involves management judgment on such matters as nature and extent of disruption in operations, expectations regarding diminished market demand, ability to perform contractual obligations, supply chain issues, liquidity and working capital deficits, access to sources of financing. Considering the relevant period, when making such assessment IAS 10 “Events after the reporting period” requires management to consider the events happened up to the date of authorization of the financial statements [41].

Considering an empirical side of accounting treatment and financial reporting of the impact of armed aggression, it is important to show a summary of analysis of companies included in WIG-Ukraine stock index (refer to Table 2). Out of eight companies included in the index, there was relevant financial reporting data for six of them. Out of these six companies only one, Coal Energy, provided almost no relevant disclosure of the armed aggression in Ukraine. In the interim financial report of Coal Energy for the period ended June 30, 2022, the management stated that it could not evaluate the impact of ongoing armed aggression on the business. For the rest five companies, there were disclosure of the impact of war on the business operations.

Table 2. Disclosure of the impact of armed aggression by companies included in WIG-Ukraine index

Company	Kernel	Astarta	IMC	Ovostar Union	Coal Energy	KSG Agro
Interim reports, reporting period	March 31, 2022 [42]	June 30, 2022 [43]	June 30, 2022 [44]	June 30, 2022 [45]	June 30, 2022 [46]	March 31, 2022 [47]
Going concern issue	Yes	Yes	Yes	Yes	No	Yes
Supply chain disruptions	Yes	Yes	Yes	Yes	No	Yes

Table 2, Continued

Company	Kernel	Astarta	IMC	Ovostar Union	Coal Energy	KSG Agro
Management response plan	Yes	Yes	No	Yes	No	Yes
Debt servicing issue	Yes	Yes	Yes	Yes	No	No
Loss of control over assets	Yes	No	No	Yes	Yes	Yes
Damage to assets	Yes	No	No	Yes	No	Yes
Impairment of assets	Yes	No	No	No	No	No

Note: (1) “Yes” means this is relevant disclosure in financial statements, “No” – there is no such disclosure; (2) There are no latest interim financial reports for Agroton and Milkiland, so that they were excluded from the samp

Armed aggression in Ukraine resulted in accounting and valuation consequences for national companies that require response. These matters include identification of affected non-current assets and documentation of damages, estimation of monetary value of damages, and accounting treatment of such damages. Proposed algorithm of damage documenting procedures includes set of steps aimed at establishing the fact of damage to property, identify the event that led to property damage and its illegality, corroborating cause-and-effect relationship between the illegal act event and property damage as well as estimation of the monetary amount of damage in terms of values mentioned in accounting documents or recent appraisal reports. As a result, this documenting process creates a basis to perform independent valuation of damages. The assessment mechanism and sources of compensation for damages are currently in the process of development. Nevertheless, recording of damages is followed by review of accounting assumptions regarding the recognition, classification, and assessment of affected non-current assets. It includes writing down the carrying amount of destroyed or damaged as of the date of damage documentation as well as testing non-financial non-current assets for impairment, or their revaluation as of the end of reporting period. Empirical analysis on national companies included in WIG-Ukraine index indicates that key disclosures on the impact of war on business activities inter alia included substantiation of going concern issue, description of supply chain disruptions, outlining management response as well as describing extent and value of assets affected by armed aggression. Minor of companies included disclosures on the impairment of assets in their

interim financial reports. Issues described by companies in their financial reports are generally in line with accounting treatment issues provided by top audit firms.

Conclusions

It is concluded that main issues disclosed in interim financial reports in relation to armed aggression included substantiation of going concern issue, description of supply chain disruptions and its impact on the business, outlining management response plans, and analyzing sustainability of financing from third parties (servicing of existing debt and ability to attract new financing). It was also concluded that when assessing going concern, it was common for the management to build projections on the assumptions that temporary occupied area would not enlarge significantly; current land supply routes with European countries would be retained, etc. Together with these interim financial reports of some companies described issues related to the assets, in particular damage caused to assets, assets located in temporary occupied territories or area of active military operations. The performed empirical analysis suggested that among all companies reviewed, only Kernel has recognized impairment of assets, namely impairment charge against goodwill related to oilseed processing plants. It was proved that disclosures provided in the interim financial reports were generally in line with recommendations provided by top audit firms as well as corresponded to general accountancy logic. It was concluded that in the full year financial reports, it was quite rational to expect the updated disclosures on the impact of the armed aggression on companies' operations, as well as more detailed disclosures on damages to assets, revaluations and impairments.

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Документування, облік та оцінка матеріальних збитків, завданих збройною агресією необоротним активам підприємства

Андрій Андрійович Кулик

Аспірант кафедри бухгалтерського обліку та консалтингу,

ORCID: <https://orcid.org/0000-0001-7791-3551>

*Київський національний економічний університет імені Вадима Гетьмана,
03057, просп. Перемоги, 54/1, м. Київ, Україна*

Анотація. Окрім масштабних втрат у людському капіталі, збройна агресія в Україні, яка розпочалася наприкінці лютого 2022 року, призвела до значних негативних матеріальних наслідків для бізнесу. До них відносяться перерви або зупинка операцій, пошкодження необоротних та інших активів, збої в ланцюгах поставок тощо. Це, у свою чергу, також ускладнило певні питання з обліку та оцінки. В українській практиці щодо таких питань, як документування, облік та оцінка збитків, не існувало усталених та загальноприйнятих підходів і алгоритмів. Метою цієї статті є дослідження теоретичних, методологічних та емпіричних аспектів документування, обліку та оцінки матеріальних збитків, завданих збройною агресією необоротним активам компанії. Методологічну основу дослідження складають методи теоретичного пізнання та емпіричного дослідження, зокрема систематизація та узагальнення, індукція та дедукція, порівняння та вимірювання, аналіз та синтез. В дослідженні систематизовано думки вітчизняних експертів щодо первинного обліку збитків, а саме наведено узагальнений покроковий алгоритм ідентифікації постраждалих активів та документування збитків. Аналіз окреслює ключові проблеми бухгалтерського обліку, пов'язані із необоротними активами, який завдана шкода, такі як необхідність проведення знецінення та переоцінки, втрата контролю або значного впливу над активами, невизначеність щодо концепції безперервної діяльності, і забезпечує основу для подальшого більш детального дослідження кожного з зазначених питань в наступних дослідженнях. Практичне значення дослідження полягає в представленні масштабу та характеру розкриття інформації щодо впливу збройної агресії на українські компанії у їхніх проміжних фінансових звітах. Такий емпіричний аналіз можна повторити та розширити пізніше в наступних дослідженнях після публікації річної фінансової звітності

Ключові слова: збройні конфлікти, вплив конфлікту, втрати, постраждале майно, знецінення активів, переоцінка активів, безперервна діяльність

**Prospects of Participation of Scientific Institutions and Higher Education
Institutions in Targeted Regional Programmes of Odesa Region
in the Context of Economic Recovery**

Tetiana V. Neboha*

PhD in Economics, Senior Researcher, ORCID: <https://orcid.org/0000-0002-5025-7299>

*State Organization "Institute of Market and Economic and Environmental Research
of the National Academy of Sciences of Ukraine", 65044, 29 Frantsuzkyy bulvar, Odesa, Ukraine*

Abstract. The article presents a generalising analysis of targeted regional programs of the Odesa region in the context of identifying direct participants in their implementation, analyses the data on the possible integration of the results of research work carried out by scientific institutions and higher education institutions (HEIs) within the regional target and comprehensive programmes of the region. The study was based on such information resources as regulatory legal acts of Ukraine, analytical materials of the State Statistics Service of Ukraine, Strategic and Programme Documents of the Odesa Regional Council, analytical data on the scientific activities of scientific institutions and higher education institutions of Odesa region. According to the author, the post-war rehabilitation of the country is impossible without scientific, technical and innovative development, which is manifested in the practical application of scientific developments. Therefore, it is important to study the prospects of participation of scientific institutions and higher education institutions in the regional development programmes of the Odesa region in the context of economic recovery. It was found that the amount and share of funding for the activities of the programmes implemented with the participation of scientific institutions and higher education institutions of Odesa region are insignificant in the total funding of individual programmes. The article shows that the engagement of scientific institutions of the National Academy of Sciences of Ukraine (NAS of Ukraine) and higher education institutions of Odesa region in the realisation of the regional targeted and complex programs will allow optimising the costs of research works and avoiding double funding since most of the operations are carried out at the expense of state funding. Participation of scientific institutions in the process of development, elaboration and implementation of regional target programs will contribute to their credibility, will allow for detailed planning. This, in turn, will ensure effective implementation with the achievement of the set tasks and goals, thus influencing the development of the market, (including innovation infrastructure), integration of science, education, small and medium business and public authorities

Keywords: scientific research, science development, science funding, regional development programmes, post-war reconstruction of the national economy

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*Corresponding author

Introduction

At the present stage of the formation of the information society, achieving competitive advantages in socio-economic development is impossible without the development of knowledge, science, technology, and scientific personnel. Scientists of the leading countries of the world have identified a correlation between the dynamics of investment in research and innovation and the growth rate of gross domestic product. That is, with the constant role of traditional factors of production, scientific knowledge becomes the main driving force and factor of economic development, including in the context of economic recovery. And in the post-war economic recovery of Ukraine, the elaboration of regional development plans should rely on the results of scientific research and development, where science is the key. Increasing the efficiency of the implementation of regional target programmes in the Odesa region should be supported by effective mechanisms of cooperation and interaction of scientific and educational potential, business, and government, which will ultimately ensure the effective implementation of economic and social policies of the national economy.

In 2021, scientific and educational institutions in Odesa region of the country conducted world-class fundamental research in the following areas of scientific activity: physics and astronomy, chemistry, mathematics, computer science and cybernetics. Research of the state all-Ukrainian level was carried out in the field of agro-industrial complex, economics, environmental protection and in the field of jurisprudence. Regional studies were conducted in the field of pedagogy, cultural studies, archaeology, and history. Some world-class developments have been achieved in the field of modern biotechnology and medicine.

The negative trend of reducing the volume of scientific research in Odesa region, and in the southern regions in general, requires an urgent solution, as the scientific sphere is part of the statehood, and even more so – in the period of martial law and economic recovery after the war. The above set the author the task of researching the target regional programmes of the Odesa region in the context of identifying the direct participants in their implementation and determining the possibilities and prospects for the participation of scientific institutions and higher education institutions of the Odesa region in them in the conditions of economic recovery (martial law economy). Scientific institutions of NAS of Ukraine and higher education institutions can be included in the implementation of more regional targeted and comprehensive programmes of Odesa region, and most importantly – as direct participants.

The purpose of the study is to conduct a generalised analysis of the target regional programmes of the Odesa region in the context of identifying the direct participants in their implementation and to determine the prospects for the participation of scientific institutions and higher education institutions (HEIs) of the Odesa region in them during economic recovery (economics of martial law).

The issues of financial support of research works, and prospects for effective use of intellectual capital in

Ukraine were studied by such scientists: L. Burdonos [1], V. Geitsa [2], L. Ovcharova & V. Bodeko [3], V. Koval & L. Geiko [4], I. Novikova, O. Zhylynska, V. Osetskyi & O. Bediukh [5], G. Ostrovska, V. Demianyshyn, L. Maliuta, R. Sherstiuk, T. Kuz & N. Reznik [6] and others.

Some aspects of the implementation of state and regional programmes, issues of regional governance efficiency, assessment of the place and role of the programme-targeted approach in the management of regional development, and outsourcing as a tool for strategic planning in public administration are studied in the works of N. Stolbunenko [7], E.A. Ivchenko, M.M. Buchniev, I.V. Morgachov and N.O. Derzhak [8], R. Kostiukevych, L. Melnyk and A. Kostiukevych [9], P. Mykytyuk, I. Semenets-Orlova, K. Blishchuk and G. Skoryk [10] and others.

However, the question of the need to involve scientific institutions and higher education institutions in the substantiation and implementation of targeted regional programmes has not been sufficiently studied.

Materials and Methods

The study was conducted from May to July 2022 in the following stages:

- 1) important scientific research carried out by scientific institutions and universities of Odesa region;
- 2) analysis of target regional programmes of Odesa region in the context of identification of scientific institutions of NAS of Ukraine and higher education institutions involved in their implementation;
- 3) identification of prospects for the participation of scientific institutions and higher education institutions in regional targeted and comprehensive programmes of Odesa region.

The framework of the study were such information resources as regulatory legal acts of Ukraine, analytical materials of the State Statistics Service of Ukraine, Strategic and programme documents of the Odesa Regional Council, publications of Ukrainian and international scientists on the subject of research, analytical data on the scientific activities of scientific institutions and higher education institutions of the Odesa region, namely, the existing programmes of regional development of Odesa region in the field of science, education, culture, agrarian development and health protection system, the youth of the region according to the reference list [14], generalised information on the results of scientific research in the southern regions of Ukraine, and important achievements of scientific institutions of the southern region of Ukraine in the field of fundamental, applied research and innovation, etc.

The author used the following scientific methods as part of the research: empirical (description, comparison), theoretical (analysis, synthesis, generalisation) and systematic.

Results and Discussion

The scientific potential of the Southern region of Ukraine is generated by the scientific institutions of the National Academy of Sciences of Ukraine, higher education institutions and sectoral institutions of Odesa, Mykolaiv and

Kherson regions. Results of scientific activity in the Southern region are represented by an array of annual scientific achievements which in 2021 amounted to 210 studies in various fields.

The volume of scientific research is characterised by the dynamics of the total number of important scientific

research both in the Southern region as a whole and in Odesa region. Analytical data on the dynamics of scientific research carried out in scientific institutions of NAS of Ukraine, and in higher education institutions of Odesa region are presented in Table 1.

Table 1. Analytical data on important scientific research carried out by scientific institutions and higher education institutions in Odesa region

Research	Number of scientific researches					
	2016	2017	2018	2019	2020	2021
Total number in the Southern region	362	320	343	313	284	210
including in Odesa region	260	197	207	178	183	161
share in the total number, %	71	61	60	57	64	77
Fundamental research	236	216	240	198	188	135
including in Odesa region	174	127	141	114	126	96
share in the total number, %	74	58	59	57	67	71
Innovative developments	126	104	103	115	96	75
including in Odesa region	86	70	66	64	57	65
share in the total number, %	68	67	64	56	61	87

Source: compiled by the author according to [11-13]

As shown in Table 1, Odesa region for six years lost 38% of the total number of research (Southern region – 42%), including 45% of fundamental research (Southern region – 43%), and 24% of innovative developments (Southern region – 40%).

At the same time, the volumes of implemented innovative developments both in the southern regions and in the Odesa region have had a negative trend over the years. The analysis of priority innovative proposals and basic and applied research conducted by scientific institutions of the Southern region of Ukraine shows that in 2020 there were 284 proposals, and in 2021 – by 74 proposals less compared to the previous year, and amounts to 210 proposals, of which 75 are innovative developments and 135 are fundamental and applied research [12; 13]. Innovative developments in 2021 were dual in nature, as there was a decrease in the quantitative value of innovative developments by about 29% compared to 2018-2020, while the number of implemented completed developments increased. In 2018, 60% of all completed innovative developments were implemented in the economic complex, and in 2019-2020, they decreased to 45% and 37%, respectively. In 2021, innovative developments were implemented at a rate of 55% of the total volume of complete developments. Meanwhile, the number of implemented innovations in the field of economics (74%) – 25 developments out of a total of 34. Replication has decreased – only 4 developments at 16 enterprises, 7 of them are in the field of art. Fundamental research in the southern regions of the country is largely implemented at the expense of national funds, namely: state budget funds by 42% in 2020 and 65% in 2021, at the own expense of enterprises – 2% in 2020 and 6% in 2021. The implementation of initiative research projects on a pro bono basis is 13% in 2020 and 20% in 2021 [12; 13].

The share of the total number of scientific researches conducted by scientific institutions and higher education institutions in Odesa region in the total volume of the Southern region has increased and showed the maximum level for this period, namely – 77%. Similarly, the rate of innovative developments has increased over six years – it amounted to 87% of all research conducted in the Southern region. Odesa region plays a directly dominant role among other regions of the Southern region. It accounts for an average of 60% of the total number of scientific research, including 41% of basic and applied research and 19% of innovative developments.

At the same time, the share of the total number of scientific researches conducted by scientific institutions and higher education institutions in Odesa region in the total volume of the Southern region has increased and reached the maximum rate for this period, namely 77%. Similarly, the rate of innovative developments has increased over six years – it amounted to 87% of all research conducted in the Southern region. Odesa region plays a directly dominant role among other regions of the Southern region. It accounts for an average of 60% of the total number of scientific research, including 41% of basic and applied research and 19% of innovative developments [13].

The essential differences between fundamental and applied research are in their meaning, purpose and nature. Thus, fundamental research expands the theoretical foundations of existing scientific knowledge and at the same time acts as the basis for further theoretical research, and is universal in nature. Applied research is aimed at solving a specific problem in practice, that is, it has a limited field of application.

In 2021, scientific and educational institutions of Odesa region carried out fundamental research in the

following areas: physics and astronomy, mathematics, chemistry, computer science and cybernetics. Research of the state all-Ukrainian level was carried out in the field of agro-industrial complex, economics, environmental protection and in the field of jurisprudence. Research at the regional level (Odesa region) was conducted in the field of pedagogy, cultural studies, archaeology and history.

The given statistical data (Table 1) indicate that the negative tendency of decrease in the volume of scientific research in Odesa region, and in the Southern region as a whole, requires an urgent solution, since the scientific sphere is part of the statehood, and even more so – during the period of martial law and economic recovery after the war. The above set the author the task of researching the target regional programmes of the Odesa region in the context of identifying the direct participants in their implementation and determining the possibilities and prospects for the participation of scientific institutions and higher education institutions of the Odesa region in them in the conditions of economic recovery (martial law economy).

The main body of research works by scientific institutions of NAS of Ukraine and higher education institutions of Odesa region is carried out at the expense of the state or local budget. There are relevant topics, for example, in the agricultural sector, which have no funding and are implemented free of charge. There is an insufficient amount of work that could be implemented in the field of

digitalisation, which is especially relevant under martial law. No information is available on the scientific research of the Filatov Institute of Eye Diseases and Tissue Therapy of the National Academy of Medical Sciences of Ukraine, which is a unique scientific institution not only in the region but also in the country. The ultimate goal of each study is its direct implementation in the economic system, which is possible, according to the author, through their engagement in regional targeted and comprehensive programmes.

Effective implementation of targeted regional programmes is the key to ensuring the socioeconomic development of the region and promoting the welfare of the inhabitants of its villages and towns. At the same time, the participation of scientific institutions in the process of development, elaboration and implementation of regional target programs will contribute to their credibility, will allow for detailed planning. This, in turn, will ensure effective implementation with the achievement of the set tasks and goals, thus influencing the development of the market, (including innovation infrastructure), integration of science, education, small and medium business and public authorities.

Each programme provides for specific priority tasks, the solution of which should contribute to overall socio-economic development (recovery). The list of programmes involving representatives of the scientific and educational sphere of Odesa region is provided in Table 2.

Table 2. List of programmes, which involve representatives of the scientific and educational sphere of Odesa region

Areas of the programme, in the implementation of which scientific institutions and higher education institutions of Odesa region are involved	Implementers from the scientific and educational sphere of Odesa region	Funding, UAH million		
		Total for the event (approved/adjusted)	including regional budget (approved/adjusted)	funds from other sources
The agricultural development programme of Odesa region for 2019-2023 “Agrarian Odesa region”				
Measures aimed at the introduction of the System of Geographical Indications for viticulture products and the Vineyard Cadastre	NSC V. Ye.Tairov Institute of Viticulture and Winemaking of NAS of Ukraine	3.6/1.95	3.6/1.95	–
Development and implementation of molecular marker technologies in the selection process to create varieties of cereals and legumes	Odesa State Agricultural Research Station of NAS of Ukraine	1.3	0.6	0.7
Implementation of a programme to create soft and durum winter wheat varieties with high grain quality that will adapt to global climate change	Breeding and Genetics Institute – National Centre of Seed Science and Variety Research of NAS	1.7	0.9	0.8

Table 2, Continued

Areas of the programme, in the implementation of which scientific institutions and higher education institutions of Odesa region are involved	Implementers from the scientific and educational sphere of Odesa region	Funding, UAH million		
		Total for the event (approved/adjusted)	including regional budget (approved/adjusted)	funds from other sources
The agricultural development programme of Odesa region for 2019-2023 “Agrarian Odesa region”				
Creating a cluster for the production of secondary products of winemaking in the region	Institute of Market Problems and Economic and Environmental Research of the National Academy of Sciences of Ukraine; Association “Winegrowers and Winemakers of Odesa Region”; Agro-ecological and recreational cluster “Frumushyka-Nova”; Odesa National Academy of Food Technologies	3.4/3.1	0.8/0.5	2.6
Measures to assess the land and soil status in Odesa region. Optimisation of costs for measures to preserve and protect soil fertility	Odesa I. I. Mechnykov National University	3.0	3.0	–
Total funding of the programme activities, which involve scientific and higher education institutions of Odesa region, UAH million		13,0/11,05	8,9/6,95	4,1
Total funding under the programme, UAH million		114,2/138,4	92,8/117,0	21,4
The share of financing of programmes, in the implementation of which scientific and higher education institutions of Odesa region are involved, in the total amount of financing of the programme, %		11.38/7.98	9.59/5.94	19.16
Programme “Youth of Odesa Region” for 2021-2025				
Activities aimed at forming an understanding of the need for lifelong learning among young people in the region	Izmail State Humanitarian University	0,902	0,540	0,362
Total funding of the programme activities, which engage representatives of the scientific and educational sphere of Odesa region, UAH million		0,902	0,540	0,362
Total funding under the programme, UAH million		6,187,5	3,792,00	2,395,5
The share of financing of programmes, in the implementation of which representatives of the scientific and educational sphere of Odesa region are involved, %		0.015	0.014	0.015

Source: compiled by the author [14]

As evidenced by the data in Table 2, the amount and share of funding for the activities of the programmes implemented with the participation of scientific institutions and higher education institutions of Odesa region are insignificant in the total funding of individual programmes.

A generalising analysis of regional targeted and integrated programmes of the Odesa region in the context of identifying direct participants in their implementation showed the following.

Regional Programme for the development of the agro-industrial complex of the Odesa region for 2019-2023 "Agrarian Odesa Region" (decision of the Regional

Council of December 21, 2018, No. 837-VII) [14]. Among the directions and activities of this Programme are: increasing the competitiveness of the agricultural sector of the region through the use of advanced agricultural production technologies; creation of modernised selection and seed bases of agricultural production; organisation of information and exhibition events; introduction of waste-free production technologies [14]. Each of these areas can and should be implemented through the direct support of scientific institutions of academic level and higher education institutions, namely – the State Institution "Institute of Market and Economic and Environmental Research of

the National Academy of Sciences of Ukraine” (SI IMEER of NAS of Ukraine”), Odesa National Economic University, Danube Biosphere Reserve (Vylkove), Odesa State Agrarian University (OSAU). At the same time, the OSAU is not only not listed among the executors of the Programme but also carries out its research work on the basis of initiative, that is, pro bono [14].

Section 3 of the Programme, which deals with the substantiation of ways and means of solving problems, sources and volumes of financing, states that the development of the agro-industrial complex will be ensured, inter alia, through scientific and methodological support of agricultural production, application of information and communication technologies, exhibition activities and advisory services. The expected result should be the process of introducing the results of scientific developments into agricultural production applying the best world experience, entering the foreign market with competitive products and conducting training and educational work in rural areas.

Section 4 of the Programme “Activities and events of the Programme” provides for the organisation and holding of scientific and practical conferences, agricultural events, such as exhibitions or fairs, the purpose of which is to promote and introduce Ukrainian products to domestic and world markets [14].

These provisions can be implemented through participation in the program, and this is determined by the programme itself – district state administrations, agrarian policy departments of regional state administrations, the Breeding and Genetic Institute – National Centre for Seed Science and Variety Studies of the National Academy of Agrarian Sciences of Ukraine (NCSS NAAS of Ukraine), SRC V.Ye. Tairov Institute of Viticulture and Winemaking of NAS of Ukraine, “Odesa State Agricultural Research Station” of NAS of Ukraine, Institute of Market Problems and Economic and Environmental Research of the National Academy of Sciences of Ukraine, Municipal Enterprise “Odesa Regional Fund for Support of Individual Housing Construction in Rural Areas”, Association “Winegrowers and Winemakers of Odesa Region”, agro-ecological and recreational cluster “Frumushyka-Nova”, Odesa National Academy of Food Technologies, Odesa Mechnykov National University.

The development of the agro-industrial complex of the Odesa region is a priority and is a kind of foundation of the national economy in the conditions of martial law or post-war reconstruction of the country. The integration of science, education and business can become a reliable guarantee of food security in the region. Science provides theoretical and applied foundations for the introduction of the latest technologies necessary for the cultivation of agricultural crops or the production of livestock products in the industry. Together, science, education and business form the basis for creating effective conditions for the development of market infrastructure, providing new opportunities for the growth of small and medium-sized businesses in the agricultural sector.

Regional programme for the development of education in Odesa region for 2022-2024 [14]: there is

no higher education institution or scientific institution of academic level among its participants. The responsible executor of the Programme is the Department of Education and Science of the Regional State Administration, and the current control is carried out by the Standing Commission on Education, Science, Youth Policy, Sports, Culture and Tourism. The participants of the Programme are – Training and Methodological Centre of Vocational Education in Odesa region, Odesa Academy of Continuing Education of Odesa Region Council, Richelieu Lyceum, Odesa Region Specialised Children and Youth Sports School of Olympic Reserve, G.S. Bolgrad Gymnasium Rakovskyi, Municipal Extracurricular Educational Institution “Black Sea Flotilla of Young Sailors”.

The activities of the **regional comprehensive programme “Culture of Odesa region – 2020-2022”** should address the issues of building a successful community in Odesa region with the formation of its own model of cultural development. The programme covers such types of cultural activities as educating with the formation of the information space of the region, creating the image of the Odesa region at the international level. Among the activities of the Programme are cultural and educational, namely – popularisation of the history of the Ukrainian state; organisation of events to disseminate the positive experience of art education institutions; research, cultural and educational activities, acquisition of museum collections, exposition, restoration work; improvement of museum management and marketing [14]. However, there are no academic institutions or higher education institutions in the region among the participants of the Programme.

Programme of implementation of the EU Strategy for the Danube region for 2020-2022 in Odesa region [14].

Section 3 of the Programme “Promotion of culture and tourism development, communication between people” envisages the creation of a museum eco-centre in Vylkove, and the promotion of green tourism in the Danube sector of the Black Sea basin, respectively, the executors are designated as Vylkove and Reni City Councils. According to the author, such areas of the programme should be covered directly, and not on the basis of outsourcing, by the scientific and practical work of competent specialists of the State Institution IMEER of NAS of Ukraine”, Odesa Archaeological Museum, Odesa I.I. Mechnikov National University, Odesa State Environmental University.

Among the executors of Section 5 of the Programme “Environmental Risk Management” (including a comprehensive solution to the environmental disaster of Lake Sasyk as part of the Lower Danube protected area) are the Department of Transport and Communications Infrastructure of the RSA, the State Agency of Water Resources, the Basin Water Resources Administration (BWRA) of the Black Sea and Lower Danube rivers, Vylkove and Reni city councils. At the same time, according to the author, the implementation of subsection 51, which refers to the creation of complexes for wastewater treatment, “Ecoport” thermal disposal of waste in the waters of Reni and Izmail seaports, the responsible executor of which is the Department of Transport

and Communications Infrastructure of the RSA, should be based on scientific developments and justifications with the direct determination of scientific and educational institutions of the region among the executors.

Measures of Section 6 on the protection of biodiversity, air quality, soils, and landscapes include: water exchange between the Tuzly Estuaries and the Black Sea; conservation of biodiversity of the Tarutino Steppe, and the executors are the National Park "Tuzly Estuaries", the Department of Agrarian Policy of the RSA and the Department of Ecology and Natural Resources of the RSA [14]. Scientific institutions or higher education institutions are not listed among the implementers of this programme.

Section 7 "Creation of an integrated educational platform" as one of the measures provides for the creation of an integrated educational platform with the expected result in the form of cooperation between higher education institutions, organisation of scientific and practical conferences within the framework of the implementation of the EU Strategy for the Danube Region [14]. The executor is the Department of Education and Science of the RSA. The estimated amount of funding is not defined by the Programme.

The estimated amount of funding is not defined by the Programme. However, the analysis of the **comprehensive programme for the restoration and preservation of the Akkerman fortress and infrastructure development in Bilhorod-Dnistrovskiy for 2018-2022** [14] showed that among the participants of the Programme there is not a single scientific institution or higher education institution, but only the Odesa Regional Council, Bilhorod-Dnistrovskiy City Council, and the Municipal Enterprise "Fortress". One of the main tasks of this Programme is the implementation of a complex of scientific research works, proper scientifically grounded protection by conservation, restoration and rehabilitation works [14]. Section 3 of the Programme provides for historical-architectural, archaeological and hydrological research. Section 4 among the priority measures includes providing scientific and methodological support for the implementation of restoration works. In particular, it is to engage such scientific institutions and higher education institutions of Odesa region as the Odesa Archaeological Museum of the National Academy of Sciences of Ukraine, the State Institution IMEER of NAS of Ukraine", Odesa I.I. Mechnykov National University, Odesa State Academy of Civil Engineering and Architecture.

The sixth section of the Programme states that the expected results of its implementation should be thorough historical, architectural and archaeological information, data on engineering, geological and hydrogeological conditions in the protected area [14]. However, it is not clear how such a result can be achieved without the participation of local scientists.

Besides, according to the author, scientific institutions and higher education institutions of the region can be integrated into the implementation of such directions of the Programme as monitoring of the environment and facilities, creation of a data bank, and organisation of scientific seminars and conferences.

Akkerman fortress is one of the largest monuments of archaeology and architecture of Ukraine, and therefore its preservation should be carried out with the direct participation of scientific institutions and universities of Odesa region.

The passport of the regional target programme **Health of Odesa Region for 2021-2023** [14] also does not contain any scientific institution or higher education institution among its participants, although the Programme itself in its content requires the participation of scientists in the implementation of such areas as providing the necessary financial and social conditions for attracting young medical specialists; improving information support of health care institutions in the region. Potential participants in the implementation of the Program, according to the author, may be: Odesa National Medical University, the State Institution Ukrainian Research Institute of Medical Rehabilitation and Balneology of the Ministry of Health of Ukraine, the Filatov Institute of Eye Diseases and Tissue Therapy of the National Academy of Medical Sciences of Ukraine.

Regional Programme for the Conservation and Restoration of Water Resources in the Kuialnyk Estuary Basin for 2019-2023 [14]. Part 3 of the Programme "Scientific support and survey of changes in the hydro-ecological state in the basin of the Kuialnyk estuary" envisages scientific research of the hydro-ecological state of the Kuialnyk estuary (hydrological and medical-biological survey); scientific research of the impact on the hydrobiological state of the Kuialnyk estuary of its long-term filling with seawater from the Black Sea; filling the Kuialnyk estuary with fresh water. Among the executors of these initiatives are the Department of Ecology and Natural Resources of the Odesa Regional State Administration, institutions according to the results of public procurement, business entities [14]. The scientific institutions and universities are not among the direct participants of the programme implementation. Although the programme envisages educational activities through the organisation and holding of scientific and technical conferences, but, for some reason, only with the help of public organisations and through the publication of educational and scientific printing products on environmental issues of the Kuialnyk estuary basin.

Regional target energy efficiency programme of Odesa region for 2020-2022. The key objective of the Programme is the implementation of projects to replace traditional fuels with alternative energy sources, the development of an energy management system, and the formation of a new format of consciousness of the population with energy-saving skills, organisational events of informational and educational nature – round tables, forums, meetings [14]. Among the direct participants of the Programme implementation, there are no scientific institutions or higher education institutions of Odesa region.

Programme of legal education of the population of Odesa region for 2019-2022. Among the ways and means of implementing this Programme is the recognition of the importance of legal education among the population as one of the necessary factors in the formation of legal

consciousness and legal culture; methodological and coordination activities; a high level of teaching legal disciplines in educational institutions; a set of educational and educational activities for young people [14]. The participants of the Programme are structural subdivisions of the Odesa Regional State Administration, including: the Department of Education and Science; the Department of Social and Family Policy; the Main Territorial Department of Justice in Odesa Region; youth NGOs.

Programme for promoting the development of international and investment activities of Odesa region for 2021-2023. The purpose of the programme is to create a competitive regional investment product with its further promotion on the world market. Participants of the Programme: Odesa Region Council, Department of International Relations of Odesa Region State Administration, Odesa Regional Development Agency (by agreement), executive committees of village, settlement and city councils. One of the expected results of the Programme implementation is the development of partnerships, cooperation, and conclusion of agreements with other regions or countries of the world economy [14]. There are no scientific institutions and higher education institutions of Odesa region among the participants of the Programme.

Programme of tourism and resort development in Odesa region for 2021-2023. The key objective of the Programme is to create the basis for the development of domestic tourism in the region, which is possible through the creation of a set of favourable conditions: social, economic, environmental, investment, infrastructure. Responsible participants in the implementation of this Programme are the Department of Tourism, Recreation and Resorts of the RSA, Odesa Regional Council, NGOs, and local authorities [14].

According to the author, Section 3 of the Programme "Promoting the development of recreational and resort potential of the region" can be implemented with the support of scientific institutions and higher education institutions of the Odesa region, since such measures as assessment of the territory, formation of grounds for determining the prospects for the development of resort areas with their subsequent declaration as resorts of local or national importance cannot be implemented without their scientific substantiation.

Regional target social programme Youth of Odesa Region for 2021-2025. This Programme provides conditions for the development and self-realisation of young people in Ukraine, their participation in public life. The executor is the Department of Education and Science of the RSA. Participants of the Programme – Odesa Region Council; Municipal Institution "Odesa Region Centre for Patriotic Education and Leisure of Children and Youth", executive bodies of city (cities of region significance) councils and councils of territorial communities, district state administrations, civil society institutions [14]. The Izmil State University of Humanities is indirectly involved in the Programme through the implementation of the findings of the research work "Theoretical and methodological foundations of the formation of professional identity of future

specialists in preschool, primary and special education". This research is fundamental, performed on a free basis, has no analogues in Ukraine and corresponds to such an important priority area of science and technology as fundamental research on the most important problems of development of scientific and technical, socio-economic, socio-political and human potential to ensure Ukraine's competitiveness in the world and sustainable development of society and the state.

Regional target comprehensive programme of national-patriotic education of children and youth for 2021-2025. The purpose of this Programme is to establish and further develop the system of patriotic education of young people; the principles of respect for the native tongue, state, history; awareness of the responsibility for the successful development of the country and self-welfare. The implementation of the Programme will allow, through the establishment of systematic training, educational, and awareness-raising work, to engage young people more and more in projects (activities) of national patriotic education. Among the participants of the Programme are the Department of Education and Science; the Municipal Institution "Odesa Regional Centre for Patriotic Education and Leisure of Children and Youth", executive bodies of city (cities of regional significance) councils and councils of territorial communities, district state administrations, civil society institutions [14].

The analysis of the existing regional target and complex programmes of the Odesa region in the context of their responsible executors and direct participants showed that the scientific and educational sphere is involved in the implementation of such programmes through the Department of Education and Science of the Odesa Region State Administration and the permanent commission on education and science.

Scientific institutions and higher education institutions of the region, according to the approved current target regional programmes of Odesa region, were directly included in participation only in the following programmes (Table 2): Regional Programme for the Development of the Agro-Industrial Complex of Odesa Region for 2019-2023 "Agrarian Odesa Region" for 2019-2023; Regional Targeted Social Programme "Youth of Odesa Region" for 2021-2025.

At the same time, from the data in the volume "Science in the Southern Region of Ukraine. Important Achievements of Scientific Institutions of the Southern Region of Ukraine in the Field of Fundamental, Applied Research and Innovation Activities" [13] on the subject of research and development, it can be concluded that scientific institutions of NAS of Ukraine and higher education institutions can be included in the implementation of more targeted regional programs of Odesa region, and most importantly – as direct participants. The data presented in the mentioned collection [13] show that a number of studies conducted by scientific institutions of NAS of Ukraine and higher education institutions of Odesa region correspond to the activities of regional targeted and integrated programmes, and therefore can be integrated into their implementation. This will optimise expenses for research works

and avoid their double financing, as most research projects are financed by public funds, or are initiative projects and are carried out free of charge.

In the conditions of martial law in the country, the participation of scientific institutions and higher education institutions of the Odesa region in the implementation of regional targeted and comprehensive programmes can be provided only if there is a set of material objects capable of ensuring the implementation of scientific and educational functions of higher education institutions and scientific institutions of the country while creating sufficient conditions for the activities of all subjects of such institutions. It is about the scientific and educational infrastructure, which is part of the social infrastructure of the country, performs the function of implementing social policy and is subject to state regulation. Today, economic recovery in science is interpreted as a system of measures aimed at restoring the economic advantages of the country, establishing production, improving the living standards of people and their effective demand. According to the author [15], the economic recovery after the armed conflict should be based on the development of special programmes for the “resuscitation” of the country’s economic activity, and on the development of measures necessary for the return of the population and ensuring decent living conditions, restoration of infrastructure in certain regions with its further integration with other regions of the country [15].

At the present stage of the formation of the information society, achieving competitive advantages in socio-economic development is impossible without the development of knowledge, science, technology, and scientific personnel. With the constant role of traditional factors of production, scientific knowledge becomes the main driving force and factor of economic development, including in the context of economic recovery.

Conducting fundamental, applied and innovative scientific research contributes to the formation of the information society and knowledge economy. However, during the war, a significant number of scientists went abroad. Therefore, in the conditions of economic recovery, it is necessary to implement the following priority directions of science development in Ukraine: restoration of scientific and educational infrastructure (educational institutions, laboratories, purchase of modern equipment, access to international scientific libraries, etc.); targeted direction of applied scientific research to solve the problems of economic recovery after the war; creation of mechanisms to facilitate the return of scientific personnel from abroad to Ukraine (financial incentives for highly qualified and competent personnel, availability of conditions for research); development of international scientific cooperation with

the possibility of free internships in European scientific and educational institutions; formation of mixed models of financing research (public, private, grant funding, foreign investment); scientific institutions supervision of the transformation of scientific research into innovative developments.

Conclusions

In the context of economic recovery, the efficient implementation of regional target programmes in Odesa region and the solution of socio-economic issues should be carried out with the active participation of the effective scientific potential of the region. And the implementation of the priority directions of science development in the country will contribute to the preservation of scientific potential and further development of fundamental and applied research both in the country and in the regions, which will ultimately contribute to the development of science in Ukraine in the context of economic recovery.

Increasing the efficiency of the implementation of regional target programmes in the Odesa region should be supported by effective mechanisms of cooperation and interaction of scientific and educational potential, business and government, which will ultimately ensure the effective implementation of economic and social policies of the national economy.

According to the author, greater efficiency in the implementation of targeted regional programmes can be ensured through the direct engagement (and not indirectly, through the Department of Education and Science) of scientific institutions of the National Academy of Sciences of Ukraine and higher education institutions of the region. At the same time, a positive externality will be the motivation of scientists, and the attraction of creative young people among university students to scientific research, which will contribute to their further scientific work and, ultimately, to the formation of public awareness of the importance of science in society. At the same time, it should be noted that it is through the education system, being the largest and most comprehensive social institution among the population, that culture is transmitted to society. Subsequently, through the scientific sphere, culture, which directly combines science, education, art, and worldview – through the mechanisms of integration processes reaches the global level and assumes the function of a transmitter of the country’s image.

Further research on the potential participation of scientific institutions and higher education institutions of Odesa region in the implementation of regional targeted and comprehensive programmes in the context of economic recovery can be focused on substantiating the state and prospects of integration of science, education and business in Odesa, Mykolaiv and Kherson regions of Ukraine.

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Перспективи участі наукових установ і закладів вищої освіти у цільових регіональних програмах Одеської області в умовах економічного відновлення

Тетяна Василівна Небога

*Кандидат економічних наук, Старший науковий співробітник,
ORCID: <https://orcid.org/0000-0002-5025-7299>*

*Державна установа «Інститут ринку і економіко-екологічних досліджень
Національної академії наук України», 65044, Французький бульвар, 29, м. Одеса, Україна*

Анотація. У статті представлено узагальнюючий аналіз цільових регіональних програм Одеської області у контексті ідентифікації безпосередніх учасників їх реалізації, проаналізовано дані щодо можливої інтеграції результатів науково-дослідних робіт, які виконуються науковими установами і закладами вищої освіти (ЗВО) до регіональних цільових та комплексних програм області. Базою дослідження стали такі інформаційні ресурси, як нормативно-правові акти України, аналітичні матеріали Державної служби статистики України, Стратегічні та програмні документи Одеської обласної ради, аналітична інформація щодо наукової діяльності наукових установ і ЗВО Одеської області. Післявоєнне відродження у країні, на думку автора, неможливе без науково-технічного та інноваційного розвитку, яке виявляє себе у практичному застосуванні наукових розробок, а тому актуальним є дослідження перспектив участі наукових установ і ЗВО в регіональних програмах розвитку Одеської області в умовах економічного відновлення. Встановлено, що сума та питома вага фінансувань заходів програм, які реалізуються за участю наукових установ і закладів вищої освіти Одеської області – незначні у загальному обсязі фінансування окремих програм. Показано, що залучення наукових установ Національної академії наук України (НАН України) та ЗВО Одеської області, до реалізації заходів програм регіональних цільових та комплексних програм, дозволить оптимізувати витрати на проведення науково-дослідних робіт, та уникнути подвійного їх фінансування, оскільки більшість робіт здійснюються за рахунок державного фінансування. Участь наукових установ у процесі розробки, обґрунтування та реалізації регіональних цільових програм забезпечить їх обґрунтованість, дозволить здійснити детальне планування, що, в свою чергу, забезпечить ефективне впровадження з досягненням поставлених завдань та цілей, що вплине на розвиток ринкової, (у тому числі інноваційної інфраструктури), інтеграції науки, освіти, середнього та малого бізнесу та органів державної влади

Ключові слова: наукові дослідження, розвиток науки, фінансування науки, програми регіонального розвитку, післявоєнне відновлення національної економіки

Application of Digital Technologies in Accounting and Auditing at Enterprises of Ukraine

Zoryana Tenyukh^{1*}, Ulyana Pelekh², Nadiia Khocha³

¹PhD in Economics, Associate Professor, ORCID: <https://orcid.org/0000-0002-2392-0534>
Ivan Franko National University of Lviv, 79000, 1 Universytetska Str., Lviv, Ukraine

²PhD in Economics, Associate Professor, ORCID: <https://orcid.org/0000-0002-4717-3334>
Ivan Franko National University of Lviv, 79000, 1 Universytetska Str., Lviv, Ukraine

³PhD in Economics, Associate Professor, ORCID: <https://orcid.org/0000-0001-7787-8426>
Ivan Franko National University of Lviv, 79000, 1 Universytetska Str., Lviv, Ukraine

Abstract. The rating of Ukraine among European countries in the field of digitalization of economic processes is high. Ukraine has chosen the path of maximum digitization of the national economy. To ensure successful economic activity at Ukrainian enterprises, it is important to introduce and use digital technologies in accounting and auditing. In the practice of accounting, a number of digital technologies are used, each of which has its own advantages and disadvantages. When choosing one or another digital technology, the management apparatus of enterprises takes into account its capabilities and peculiarities of activity. The relevance of the work lies in the importance of introducing digitization of accounting and auditing processes to facilitate the monotonous and uniform work of enterprises and to minimize errors in documents and reporting. The purpose of the article is to study the peculiarities of the use of digital technologies in accounting and auditing at enterprises of Ukraine. When writing the article, general scientific and specific methods were used, among which preference was given to the following: analysis, comparison, observation, synthesis, generalization, abstraction, induction, deduction, graphic. Based on the results of the research, the main types of digital technologies used by Ukrainian enterprises in accounting and auditing were identified, and the specifics of their use were determined. The paper analyzes the level of use of various types of digital technologies in accounting and auditing, outlines their advantages and disadvantages. Statistical data on the use of cloud technologies in accounting and technologies for working with large data sets at enterprises of Ukraine in 2018-2021 were analyzed. Conclusions were made regarding the prospects of using digital technologies in accounting and auditing at Ukrainian enterprises. The practical significance of the obtained results lies in the application of the block diagram by Ukrainian enterprises, which will help in choosing the implementation of a particular digital technology in the enterprise's activities. The manager will be able to familiarize himself with the advantages and disadvantages of each digital technology and make the optimal decision

Keywords: digitalization, cloud technologies, Artificial Intelligence, blockchain technologies, Big Data, internet of things

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*Corresponding author

Introduction

Since the outbreak of hostilities between Ukraine and Russia in 2014, and especially during the full-scale war that began on February 24, 2022, businesses have faced an urgent need to optimise accounting and auditing. It was the development and application of the latest software that allowed Ukrainian enterprises to transform the management process, especially accounting systems [1]. Therefore, the active introduction of digital technologies in accounting and auditing at Ukrainian enterprises is becoming even more relevant.

Scientist O.V. Butkevych examined the impact of digital technologies on the arrangements of accounting for tax payments [2]. The study provides a detailed analysis of software products used by enterprises for accounting and taxation (cloud technologies; artificial intelligence; blockchain; technologies for working with large data sets (Big Data); Internet of Things). The author argued for the necessity of digitalisation of accounting for tax payments of enterprises, which will prevent penalties from regulatory authorities. At the same time, the share of use of software products at Ukrainian enterprises is not presented. Y.M. Popivnyak studied the transformation of the accounting method in the era of digital technology development [1]. The author proposed and considered the process of digitalisation of elements of the accounting method in documentation, inventory, valuation, calculation, accounts, double entry, balance sheet and reporting. However, the proposed approach is rather theoretical and needs to be improved for application in the practical operations of Ukrainian enterprises.

The study by T. Korolyuk & O. Mazurenok examined the digitalisation of enterprises towards digital accounting [3]. The authors substantiate the features of further enhancement and main directions of development of digitalisation of accounting during the COVID-19 pandemic. However, the authors do not specify the features of the introduction of digital technologies in the accounting process in the context of Ukrainian enterprises depending on the type of economic activity. M.B. Kulynych studied the digitalisation of accounting, analysis, and taxation in the enterprise management system [4]. The author conducted an in-depth investigation of the implementation of artificial intelligence, machine learning, cloud technologies, and Big Data into the practice of accounting, analysis, and taxation. At the same time, the advantages and disadvantages of each of the technologies are not defined. S. Syrtseva analysed digital technologies in the organisation of accounting and control of settlements of tax liabilities [5]. The authors propose to create a modern information and analytical resource of the tax service at the enterprises, which can optimise the accounting and control system. This resource will ensure the de-shadowing of the economy and strengthen control over cash circulation. However, the study it concerns the obligations of budgetary institutions, and the proposed resource does not cover the digitalisation of accounting of enterprises for various types of economic activity. Thus, the issues of the application of digital technologies in accounting

and auditing at Ukrainian enterprises have not been fully considered, which prompted interest in further research.

The purpose of the study is to determine the theoretical and practical features of the use of digital technologies in accounting and auditing at Ukrainian enterprises. The tasks that will contribute to the achievement of this objective are the following: to investigate the theoretical foundations of digital technologies in accounting and auditing at Ukrainian enterprises; to analyse the trends of digitalisation of accounting and auditing at Ukrainian enterprises; to identify the issues of digitalisation of accounting and auditing at Ukrainian enterprises; to outline the prospects for the introduction of digital technologies in accounting and auditing at Ukrainian enterprises.

Materials and Methods

The content of the study was based on the materials of the publication "Digital Transformation in Ukraine: Do Domestic Institutional Conditions Meet External Challenges and the European Agenda?" [6], created within the framework of the project "Support to the Ukrainian National Platform of the Eastern Partnership Civil Society Forum". The publication contains analytical reports of the Cabinet of Ministers of Ukraine, the Ministry of Digital Transformation of Ukraine, the results of the Digital Riser Report rating, data from the State Statistics Service of Ukraine, the Institute for Economic Research and Policy Consulting, the National Platform of the Eastern Partnership Civil Society Forum. The sources of information in the article were scientific articles and materials of scientific conferences.

The methodological basis of the article is formed by the general scientific and specific methods used. Methods of analysis, comparison, and graphical methods were used to assess the trends in the implementation of digital technologies in accounting and auditing at Ukrainian enterprises. These methodological approaches were used to assess the dynamics of the share of cloud computing in accounting at Ukrainian enterprises by type of economic activity and by the number of employees in 2018-2021. The methods of observation, synthesis, and generalisation were used to identify the challenges of introducing digital technologies in accounting and auditing, and to highlight their advantages and disadvantages. Methods of abstraction, induction, deduction, comparison and synthesis are used to determine the prospects for the digitalisation of accounting and audit.

The study was conducted in the following stages:

- The following types of digital technologies were characterised: cloud technologies; artificial intelligence; blockchain technologies; Big Data technologies; Internet of Things;
- the statistical data on the use of cloud computing in accounting and Big Data technology at Ukrainian enterprises in 2018-2021 were analysed. The absolute deviation of the above indicators by types of economic activity of enterprises is calculated and reflected in table and graphic form;
- a flowchart for selecting digital technologies in accounting and auditing at Ukrainian enterprises is compiled;

– the results of the study were compared to the findings of other scientists on this issue. The difference in the results of these studies is substantiated;

– the conclusions define the prospects for the development of digital technologies in accounting and auditing at Ukrainian enterprises. The directions of further scientific research are outlined.

Results

The modern trend in the development of the Ukrainian economy is its digitalisation, which is an important factor

in the economic growth of the state. The digital economy involves the widespread use of digital information and communication technologies in the implementation of any type of economic activity [7].

Digital information and communication technologies are actively used in accounting and auditing at Ukrainian enterprises. The study determines that enterprises use certain types of digital technologies in accounting and auditing. Thus, most scientists [8-10] distinguish the following types of digital technologies that are used in accounting and audit (Fig. 1).

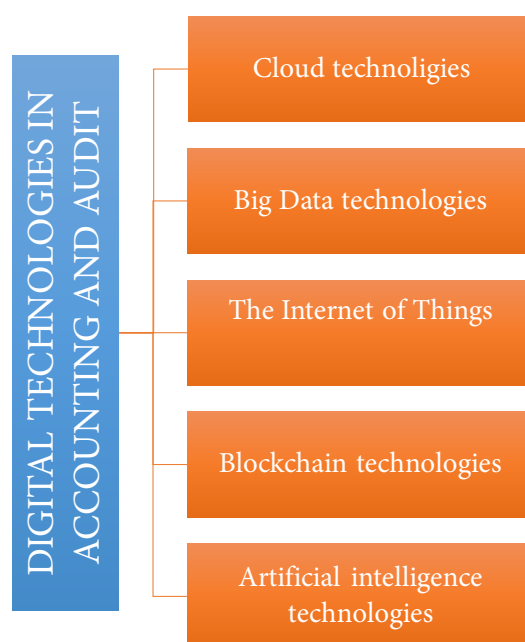


Figure 1. Types of digital technologies in accounting and audit

Source: compiled by the authors based on data [2-4]

According to S.Ya. Korol & A.O. Cloud: “cloud technologies are technologies for storing and working with data online in the cloud rather than on the hard drive of a computer or laptop” [8]. This technology allows accessing the computer resources of the server and using the software remotely, that is, the user can be anywhere and use any device that has an Internet connection to process and store electronic data. It is determined that at the enterprises

of Ukraine the most common is the application of cloud technologies, both in accounting and audit.

The analysis of scientific sources [11-13] showed that cloud technologies in accounting and auditing are used according to three models: Software as a Service (SaaS) – software as a service; Platform as a Service (PaaS) – platform as a service; Infrastructure as a Service (IaaS) – infrastructure as a service. The characteristics of each model are shown in Table 1.

Table 1. Characteristics of cloud technology models used in accounting and auditing at Ukrainian enterprises

Model	Characteristics
SaaS	– using software remotely via the Internet; – temporary use if necessary without purchasing the software product; – minimal engagement of the system administrator; – the availability of the service at any location
PaaS	– a virtual platform consisting of one or more servers with installed operating systems and specialised applications; – providing the consumer with an option to choose the necessary cloud environment out of many solutions; – the consumer manages software products (applications), and the provider manages the operating system (OS)

Table 2, Continued

Model	Characteristics
IaaS	– lease of computer infrastructure, while the provider supplies and maintains servers, data storages, network components; – providing the user with a virtual server with a personal IP address; – providing a software interface

Source: compiled by the authors according to data [3; 8; 11]

Researchers T.M. Korolyuk, O.P. Mazurenok [3], & L.A. Kozachenko & O.A. Predchuk [14] determined that artificial intelligence technologies in accounting and audit are used by creating and using intelligent programmes, applications, services, and so on. Application of such technologies can improve the quality of accounting and the efficiency of operations. It is the use of artificial intelligence technology in accounting and auditing at Ukrainian enterprises that will significantly speed up the processing of accounting information.

Blockchain is a technology for distributing a peer-to-peer public network where permanent information about transactions is stored without the possibility of changing them, which is protected by cryptographic means [8]. The technology contains a decentralised and interconnected database that allows verifying and transmitting information in real time. In accounting and auditing, blockchain technology can reduce the cost of accounting and verification of consolidated registers, as it reduces the number of errors and manipulations with accounting records and reduces the time for auditing due to the automation of these processes [15]. According to KPMG, in 2018, only 1% of enterprises actively used blockchain technology. Ukraine has just begun to introduce blockchain technology, in particular in accounting and auditing [16].

Big Data technologies are a set of methods and tools for processing a large amount of information used in the conditions of the continuous and rapid growth of data collected from various sources [9]. Using Big Data, enterprises were able to improve the segmentation of analytical information. This approach made it possible to improve the flexibility of the business process scenario, which promoted a positive economic result [17]. The technology of working with large data sets in modern economic conditions is arguably one of the most promising for application in accounting and auditing. This is associated with the simplicity of searching, processing, transferring, and storing a large amount of information, which is typical for accounting. The necessity of full implementation of Big Data technology in accounting and auditing at Ukrainian enterprises requires adaptation to the requirements of these systems, which involves a significant amount of work at the initial stage [17].

The Internet of Things technology in accounting and auditing is the interaction of physical devices that have built-in technologies with each other through the use of the Internet in an automated manner. At the same time, there is no need for the constant support of such interaction by people, in particular regarding the collection and transmission of data. For example, if an industrial enterprise has mechanisms equipped with sensors and all primary

information is received using internet technologies, then it automatically enters the database for accounting, which facilitates the collection of primary data and ensures their reliability due to the automation of these processes.

According to the Digital Riser Report 2021, Ukraine actively implements digital technologies and constantly improves them in all types of economic activity, although over the past year its position has decreased by 66 points [18]. Digitalisation is also slowing down in Europe, while digitalisation processes and access to digital technologies are more active in East Asia, particularly in China and Vietnam.

European countries use DESI (The Digital Economy and Society Index) to assess the level of technological development of individual countries, including in economic terms. In particular, this tool is used to assess the volume of human capital, the level of integration of digital technologies, services, the quality of communication and the Internet [19]. According to the data collected to calculate the DESI index [20], it was found that as of 2022, the three countries with the highest digitalisation rates are Finland, Denmark, and the Netherlands. Finland had 17.8% of human capital, 15.1% of communication quality, 14.8% of integration level and 21.8% of service digitalisation. Denmark ranked second, with 14.8% in the human capital sector, 19.3% in the communications sector, and 14.5% and 20.8% in the integration and digitalisation of services sectors, respectively. The Netherlands closed the top three countries in Europe by the degree of implementation of the latest technologies – 15.8% in human capital, 17.5% in the field of quality assurance of communication systems, 13.0% in the level of integration and 21% in the digitalisation of services. Among the European countries that are currently lagging behind in technological development are Greece, Bulgaria and Romania. According to the published data of the DESI index, in 2022 Greece had 10.0% of human capital, Bulgaria had 8.15% in the same category and Romania had 7.73%. The quality of communication for these three countries was comparatively higher: 12.4% in Greece, 12.7% in Bulgaria and 13.8% in Romania. The lowest values of the index are observed in the sector of the integration level – 6.66% in Greece, 3.88% in Bulgaria and 3.79% in Romania. In terms of integration among the three countries, Bulgaria received the highest indicators (13.0%), followed by Greece (9.85%), and Romania completed the indicators of the sector (5.26%). Analysing the European Union as a whole, the DESI index scores 16.8% in the digitalisation of services, 9.02% in the integration of technology, 15.0% in the quality of communication and 11.4% in human capital. Ukraine is pursuing a clear course of accession to the European Union, but as can be seen from the statistics, even European countries do

not always have high performance in the field of the digital economy.

The importance of digital technologies in accounting and auditing is confirmed by the analytical information of the Cabinet of Ministers of Ukraine, the Ministry of Digital Transformation of Ukraine, the Institute for Economic Research and Policy Consulting, the National Platform of the Eastern Partnership Civil Society Forum on strengthening cybersecurity and cybersecurity in Ukraine. This is especially relevant to critical information infrastructure facilities, so it is planned to create a State Register of such facilities

and a unified system of accounting and data storage [6]. To implement such a project, it is reasonable to introduce Big Data technology.

According to the State Statistics Service of Ukraine [13; 21], it is determined that cloud computing is the most widespread among digital technologies used in accounting, although the level of their use is still low and ranges from 5.5-6%. Table 2 estimates the dynamics of the share of the number of enterprises using cloud computing technologies in accounting in the total number of enterprises in Ukraine by type of economic activity in 2018-2021.

Table 2. Dynamics of the share of cloud computing application in accounting at Ukrainian enterprises by types of economic activity in 2018-2021, %

Types of economic activity	Years			Absolute deviation, (+/-)	
	2018	2019	2021	2021-2019	2021-2018
Processing industry	5.2	5.8	5.3	-0.5	0.1
Electricity, gas, steam and air conditioning supply	4.9	6	3.9	-2.1	-1
Water supply; sewerage, waste management	4.2	5.4	4.6	-0.8	0.4
Construction	5.4	5.8	3.7	-2.1	-1.7
Wholesale and retail trade, repair of motor vehicles	5.6	6.4	5.9	-0.5	0.3
Transport, warehousing, postal and courier activities	3.9	4.8	3.4	-1.4	-0.5
Temporary accommodation and catering services	5.2	5.6	5.9	0.3	0.7
Information and telecommunications	7.3	9.6	11.7	2.1	4.4
Real estate transactions	3.8	4	2.8	-1.2	-1
Professional, scientific, and technical activities	6.2	7.2	6.2	-1	0
Administrative and support services activities	5	5.1	3.3	-1.8	-1.7
Total	5.3	5.9	5.5	-0.4	0.2

Source: compiled by the authors according to [13]

In 2021, the share of enterprises using cloud computing in accounting among the total number of enterprises in Ukraine decreased by 0.4% compared to 2019, although it increased by 0.2% compared to 2018. Cloud computing was used most by enterprises in the Information and telecommunications type of economic activity, in 2021 the share increased by 2.1% compared to 2019 and by 4.4% compared to 2018. Cloud computing was least used by enterprises in the economic activity "Real

estate operations", in 2021 the share decreased by 1.2% compared to 2019 and by 1% compared to 2018. The decrease in shares was achieved due to the growth of the number of enterprises and the slower growth rate of the use of cloud computing technology in accounting at Ukrainian enterprises [13]. Figure 2 shows the dynamics of the share of cloud computing in accounting for the total number of enterprises in Ukraine by the number of employees in 2018-2021.

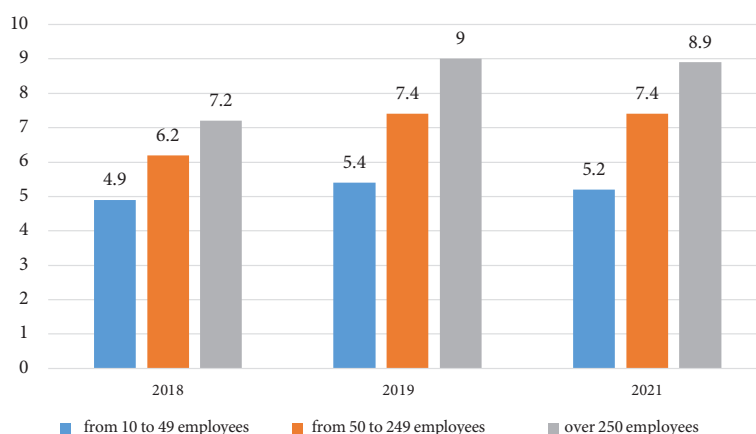


Figure 2. Dynamics of the share of cloud computing use in accounting at enterprises in Ukraine by the number of employed employees in 2018-2021, %

Source: compiled by the authors according to [13]

Analysis of Figure 2 shows that the largest share of cloud computing use is among large enterprises, in particular, during 2019-2021, the share of large enterprises using cloud computing in accounting fluctuated between 8.9-9% of the total number of enterprises in Ukraine. An analysis of the dynamics of the share of cloud computing use shows a slight decrease in 2021 compared to 2019 at

small and large enterprises, while at medium-sized enterprises it remained unchanged at 7.4%. In 2019, the share of cloud technology use increased in all types of enterprises compared to 2018. Table 3 assesses the dynamics of the share of the number of enterprises using Big Data technology in their total number by type of economic activity in 2018-2020.

Table 3. Dynamics of the share of Big Data use at Ukrainian enterprises by types of economic activity in 2018-2020, %

Types of economic activity	Years			Absolute deviation, (+/-)	
	2018	2019	2020	2020-2019	2020-2018
Processing industry	11.9	11.6	12.2	0.6	0.3
Electricity, gas, steam and air conditioning supply	18.8	18.2	17.2	-1	-1.6
Water supply; sewerage, waste management	12.8	12.6	12.1	-0.5	-0.7
Construction	10.4	9.8	11.5	1.7	1.1
Wholesale and retail trade, repair of motor vehicles	13.4	12.5	13.4	0.9	0
Transport, warehousing, postal and courier activities	14.2	14	15.1	1.1	0.9
Temporary accommodation and catering services	12	11.1	10.6	-0.5	-1.4
Information and telecommunications	14.5	14.5	17.7	3.2.	3.2.
Real estate transactions	10.7	9.7	10.5	0.8	-0.2
Professional, scientific, and technical activities	12.4	12.3	13.3	1	0.9
Administrative and support services activities	11.6	11	10.6	-0.4	-1
Total	12.5	11.9	12.7	0.8	0.2

Source: compiled by the authors according to [21]

In 2020, the share of Big Data use at Ukrainian enterprises increased by 0.8% compared to 2019 and by 0.2% compared to 2018 and amounted to 12.7%. Big Data technology was mostly used at enterprises engaged in the supply of electricity, gas, steam, and air conditioning, but in 2020 there was a decrease in the share by 1.0% compared to 2019 and by 1.6% compared to 2018. The

smallest share of Big Data technology was used at enterprises by type of economic activity "Real estate operations", in 2020 the share increased by 0.8% compared to 2019 and decreased by 0.2% compared to 2018 [21]. Figure 3 illustrates the dynamics of the share of Big Data use at Ukrainian enterprises by the number of employees in 2018-2020.

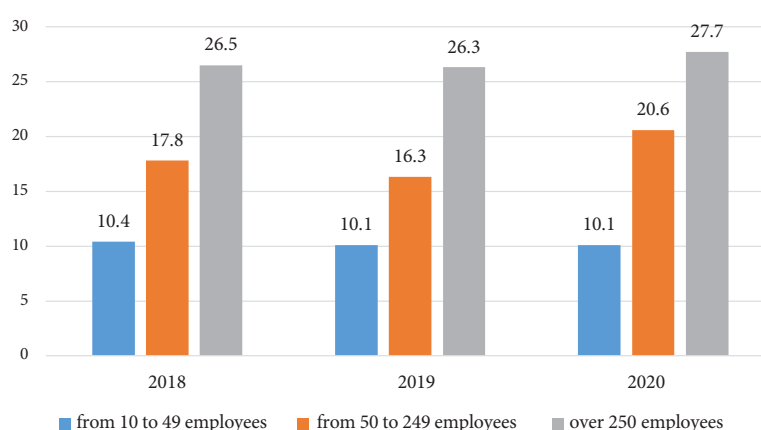


Figure 3. Dynamics of the share of Big Data use at Ukrainian enterprises by the number of employees in 2018-2020, %

Source: compiled by the authors according to [21]

Analysis of Figure 3 shows that the largest share of Big Data technology use is in large enterprises, which ranges from 26.5-27.7% during the analysed period. The

share of their application in 2020 increased by the number of employees at large and medium-sized enterprises and amounted to 27.7% and 20.6% of the total number

of enterprises in Ukraine, respectively [21]. Based on the study, a flowchart of selecting the best option for the use of

digital technologies in accounting and auditing was compiled, as shown in Figure 4.

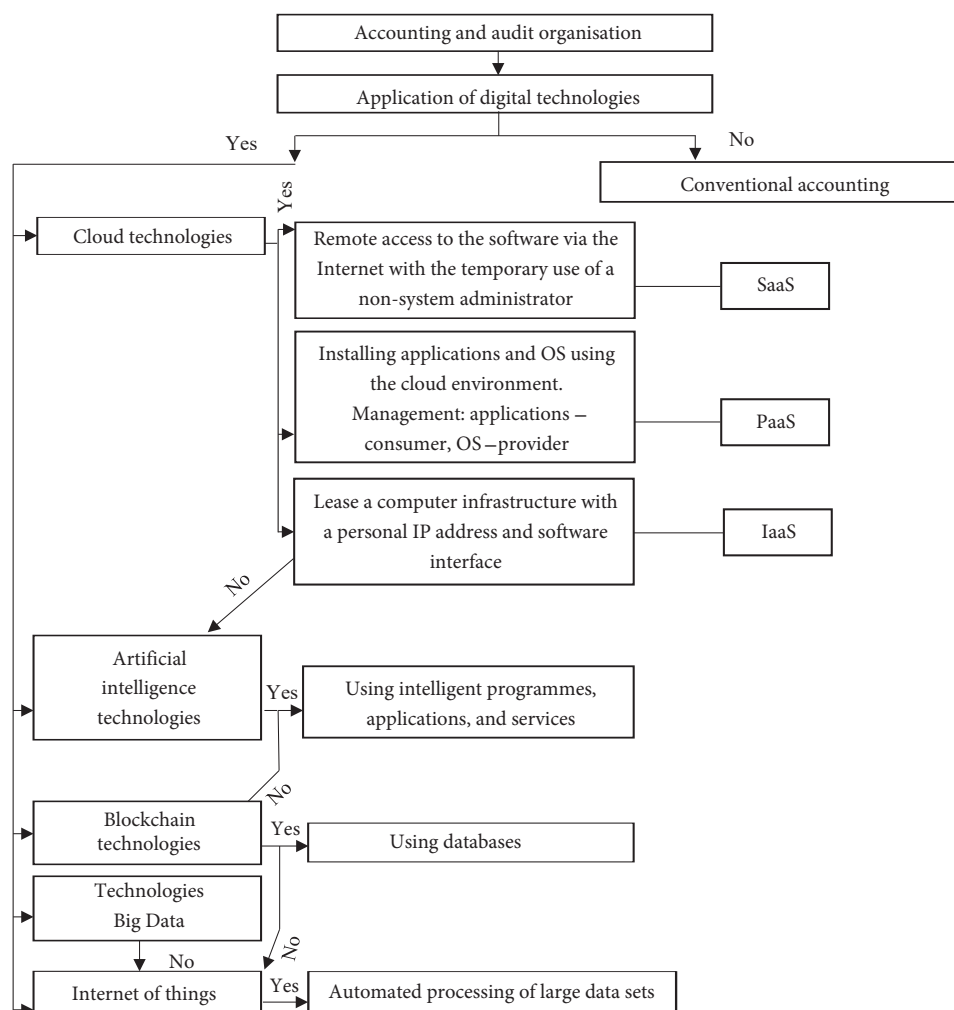


Figure 4. Flowchart of the selection of digital technologies in accounting and auditing at Ukrainian enterprises

Source: compiled by the author of this study.

The proposed flowchart will allow management to choose the best option for the use of digital technologies in accounting and auditing at the enterprise, given its needs and capabilities.

Discussion

It is determined that in the process of accounting and auditing at Ukrainian enterprises, cloud technologies and Big Data technologies are widely used, as evidenced by the data in Tables 2, 3 and Figures 2, 3, although the level of their use in comparison with the leading countries of the world is still low. In the study by M.V. Plekan, T.S. Hayduchok & G.V. Golovchak, it is determined that a necessary prerequisite for the integration of digital technologies is planning technological changes, the sequence of technical tasks, and the construction of a plan for the financial costs of technology implementation [22]. The authors agree with the views of the researchers. It is also worth considering that the proposed ways of using digital technologies are a prerequisite

for the application of the flowchart of the selection of digital technologies in accounting and auditing at Ukrainian enterprises from Figure 4. Also, the authors reviewed the advantages and disadvantages of accounting automation programmes, as well as online accounting using digital technologies. The advantages of digital technologies include: relevance, accessibility, economy, and security. The disadvantages are: automation of work with staff reduction, high dependence on electronics, protection from external interference.

Scientists L.V. Kononenko, G.B. Nazarova & V.I. Kuts identified the priority of the use of digital technologies in accounting [23]. They stressed that the use of digital technologies in accounting transforms the algorithm of information processing from the moment of receiving primary information to the moment of reporting. The authors of this study believe that the Internet of things and Big Data technologies simplify primary accounting. The use of digital technologies, regardless of their type, optimises the costs of

the enterprise, allows for an accurate form of accounting and tax reporting, and conducting an audit.

S.L. Bezruchuk & I.L. Grabchuk claims that the use of digital technologies expands the possibility of the flexibility of accounting processes [24]. The authors share the belief that the use of any digital technology facilitates management decision-making.

S.V. Bardash & I.L. Grabchuk divided the process of applying digital technologies in accounting at Ukrainian enterprises into three stages: collection and registration of primary data, formation of business transactions, and obtaining results for the reporting period [10]. The authors believe that this approach is a prerequisite for the use of a flowchart for selecting digital technologies in accounting and auditing at Ukrainian enterprises. Researchers have described in detail the types of digital technologies but have not supported the level of their use with statistical information, which is done in this study. These statistics show the prevalence of digital technologies in accounting at Ukrainian enterprises.

S.Y. Korol & A.O. Klochko believes that it is convenient to use blockchain technology in auditing because it "... creates the prerequisites for displaying both sides of the transaction simultaneously in the general ledger in real time, even if the accountant and auditor maintain a private database" [8]. The authors of this article agree with this argument. Blockchain technologies facilitate the work of auditors, especially the analysis of transactions between consumers and businesses. Blockchain technology will help automate the audit process and carry it out at a faster pace, minimizing the cost of its implementation.

Scientists of Singapore Management University G. Pan & B. Lee substantiated the feasibility of transforming accounting functions in small and medium-sized businesses [25]. Scientists emphasise that most small and medium-sized businesses do not use digital technologies in accounting and auditing. This study also determined that digital technologies (cloud computing, Big Data) are mainly used by large enterprises, while the share of their use in small and medium-sized enterprises is not high (Tables 2 and 3). The authors fully agree with the conclusion of G. Pan and B. Lee on the presence of technical, behavioural, and project barriers in the activities of small and medium-sized enterprises.

Scientists of the University of Zagreb D. Gulin, M. Hladika & I. Valenta studied the challenges of digitalisation of accounting for the profession of accountant [26]. They proved that digital technologies have a significant impact on the strategic and competitive goals of enterprises. According to the results of the study conducted by the authors, it can be argued that this is not entirely true. Strategic and competitive objectives of any enterprise are formed on the basis of the main mission of the enterprise, i.e., they relate to the overall activities of the enterprise, not just accounting. It has been established that the use of digital technologies in accounting and auditing will allow a specialist to easily compare and analyse planned and reporting

indicators in the outlined strategic and competitive objectives of enterprises. The authors agree with the expert opinion of D. Gulin, M. Hladika & I. Valenta that the use of digital technologies in accounting will increase the speed, quality, and accuracy of data. This is exactly what was described in the detailed description of each type of digital technologies used in accounting and audit. The digitalisation of accounting will ensure the smooth operation of any enterprise. One of the issues of introducing digital technologies in accounting and auditing is the high cost of acquiring digital technologies, which explains the low level of digitalisation in small and medium-sized businesses.

Scientists of the Helsinki School of Economics Sh. Kruskopf, Ch. Lobbas, H. Meinander, K. Soderling, M. Martikainen & O. Lehner believe that the future accounting at enterprises will be based on robotics and artificial intelligence [27]. We can only partially agree with this argument, because the use of robotics and artificial intelligence is important but cannot completely replace a highly qualified analyst in the field of accounting and auditing. Although in present conditions every enterprise should apply digital technologies in its activities, especially in the field of accounting and auditing, to be able to easily adapt to new digital challenges in the future.

Conclusions

Thus, the study of the use of digital technologies in accounting and taxation at Ukrainian enterprises made it possible to conclude that in present circumstances, when Ukraine has chosen the path of digitalisation, their use is a prerequisite for enhancing it and, accordingly, improving the efficiency of business processes in general. The proposed flowchart of the selection of digital technologies in accounting and auditing at Ukrainian enterprises will allow the management to choose one or another digital technology in accordance with the set task. It is determined that the most common digital technologies in accounting at Ukrainian enterprises are cloud technologies and technologies for working with large data sets.

It was revealed that in the last reporting year, the share of cloud technologies has decreased at Ukrainian enterprises, but the share of using technologies for working with large data sets has increased. Blockchain technologies are being actively implemented in the activities of international companies. Unfortunately, in Ukraine, this technology is implemented only in the operations of foreign companies or companies with foreign investments. Artificial intelligence technologies are not used in accounting and auditing at Ukrainian enterprises. The prospects for the development of digital technologies in accounting and auditing are: reduction of "paperwork"; simplification of accounting through a simple interface; simplification of the reporting procedure; optimisation of financial risk assessment; transparency of the tax administration mechanism; reduction of the shadow economy; cost savings for enterprises. For small and medium-sized businesses, to overcome technical, behavioural and project barriers in the implementation

of individual provincial regions of the country, where the issue of outdated accounting methods is quite acute. Ways to introduce digitalisation in the accounting departments of small cities, towns and villages can be elaborated on the basis of similar processes in large cities, but with regard to the specifics of each individual place. Special attention should be paid to the issue of ensuring a high-quality stable Internet connection, on the basis of which new digital approaches to settlements at local enterprises are gradually being introduced.

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Застосування цифрових технологій в бухгалтерському обліку й аудиті на підприємствах України

Зоряна Ігорівна Тенюх¹, Уляна Василівна Пелех², Надія Володимирівна Хоча³

¹Кандидат економічних наук, доцент, ORCID: <https://orcid.org/0000-0002-2392-0534>

Львівський національний університет імені Івана Франка,
79000, вул. Університетська, 1, м. Львів, Україна

²Кандидат економічних наук, доцент, ORCID: <https://orcid.org/0000-0002-4717-3334>

Львівський національний університет імені Івана Франка,
79000, вул. Університетська, 1, м. Львів, Україна

³Кандидат економічних наук, доцент, ORCID: <https://orcid.org/0000-0001-7787-8426>

Львівський національний університет імені Івана Франка,
79000, вул. Університетська, 1, м. Львів, Україна

Анотація. Рейтинг України серед країн Європи у сфері цифровізації економічних процесів є високим. Україна обрала шлях максимальної діджиталізації національної економіки. Для забезпечення успішної економічної діяльності на підприємствах України важливим є впровадження та застосування цифрових технологій в обліку й аудиті. У практиці ведення бухгалтерського обліку використовують низку цифрових технологій, кожна з яких має свої переваги та недоліки. При обранні тієї чи іншої цифрової технології, управлінський апарат підприємств зважає на свої можливості та особливості діяльності. Актуальність роботи полягає у важливості введення діджиталізації процесів бухгалтерського обліку й аудиту для полегшення монотонної та однотипної роботи підприємств та мінімізації помилок у документах і звітності. Метою статті є вивчення особливостей застосування цифрових технологій в бухгалтерському обліку й аудиті на підприємствах України. При написанні статті використано загальнонаукові та специфічні методи, серед яких перевага надана таким: аналізу, порівняння, спостереження, синтезу, узагальнення, абстрагування, індукції, дедукції, графічному. За результатами дослідження виокремлено основні види цифрових технологій, що застосовуються українськими підприємствами у бухгалтерському обліку й аудиті, та визначено особливості їх використання. У роботі проаналізовано рівень використання різних видів цифрових технологій в бухгалтерському обліку й аудиті, окреслено їх переваги і недоліки. Проаналізовано статистичні дані застосування на підприємствах України у 2018–2021 роках хмарних технологій в бухгалтерському обліку та технологій роботи з великими масивами даних. Зроблено висновки щодо перспектив застосування цифрових технологій в бухгалтерському обліку й аудиті на підприємствах України. Практична значущість одержаних результатів полягає у застосуванні українськими підприємствами блок-схеми, що допоможе у виборі впровадження тієї чи іншої цифрової технології у діяльність підприємства. Керівник зможе ознайомитися із перевагами і недоліками кожної цифрової технології і прийняти оптимальне рішення.

Ключові слова: діджиталізація, хмарні технології, штучний інтелект, блокчейн-технології, Big Data, інтернет речі

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Мукачівський державний університет
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Закарпатська область, Україна
тел./факс: (03131) 2-11-09, (03131) 2-11-09
E-mail: info@economics-msu.com.ua
www: <https://economics-msu.com.ua/uk>