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TECHNOLOGY AND PRODUCTIVITY – THE ROLE OF MODERN TOOLS IN INDUSTRY AND AGRICULTURE

A B S T R A C T

The purpose of the research is to examine the factors influencing the future of management accounting in the process of digital transformation.

The methodology of the research is qualitative in nature, based on thematic review and correlation analysis. Information obtained from the literature has been systematized according to the principles of "from general to specific" and "from theory to practice." International experience and the current situation in Azerbaijan have been studied in a comparative manner.

The practical importance of the research - the findings may contribute to the adaptation of management accounting in industry and agriculture to digital transformation, the implementation of smart agricultural technologies, more efficient use of resources, and the achievement of sustainable development goals.

The results of the research - it has been identified that digital transformation shapes a new proactive approach in management accounting, while smart technologies enhance productivity, reduce costs, and have already shown initial results in Azerbaijan's technoparks.

The originality and scientific novelty of the research - the scientific novelty lies in the conceptual restructuring of management accounting under digital transformation, the integration of Industry 4.0 and Agriculture 4.0–5.0 approaches, and the first scientific evaluation of the potential for applying digital technologies in Azerbaijan's agro-industrial environment, along with the substantiation of development prospects in this direction.

Keywords: technology, productivity, industry 4.0, agriculture 4.0, automation, smart farming, sustainability, digital transformation.

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INTRODUCTION

One of the defining factors of 21st-century economic development is technology. Technological innovations are no longer limited to the IT sector – they are transforming traditional sectors such as industry and agriculture. Increased productivity, more efficient use of resources, and the optimization of production processes are now driven by technological potential. This essay analyzes how technology impacts these sectors, what benefits it brings, and what challenges must be addressed. Modern technologies are increasingly penetrating agriculture, transforming it and making it more efficient and sustainable. Technologies in agriculture include a wide range of tools and methods, from simple devices to complex systems. They help to increase yields, reduce costs, improve product quality and make the production process more environmentally friendly.

Among the main technologies used in agriculture, the following can be highlighted:

Precision agriculture: the use of modern technologies for precise control of agricultural processes.

Biotechnology: the use of biological methods and technologies in agriculture.

Use of drones: the use of unmanned aerial vehicles to monitor fields and crops.

Robotics: the use of robots to automate routine operations.

In the new millennium, when globalization reached its peak, digital transformation, manifested by advances in digital technologies, particularly since 2010, initiated a process of radical changes in the economic and social spheres worldwide. Digital transformation is also a significant driver of Industry 4.0. Today, we see the 4th Industrial Revolution taking shape with technological advancements such as digital technologies, autonomous machines, smart robots, the Internet of Things, 3-D printing, and virtual environments. With the high-level digitalization brought about by digital transformation and Industry 4.0, industry, the economy, and social life are undergoing transformation. One of the key areas that this transformation will impact is the accounting system. With digitalization in the accounting system, margins of error can be minimized, auditing systems will be enhanced, and internal accounting systems, in particular, will become more transparent, faster, and more accurate. Businesses, particularly in terms of management accounting, need to reexamine this transformation process.

For example, German companies like Bosch and Siemens utilize real-time data collection and analytics to predict equipment failures and reduce downtime. In Azerbaijan, technology-based industrial zones such as Pirallahi and Sumgait Technology Parks represent local steps in this direction.

In addition, many enterprises across the world are now focusing on building digital ecosystems that connect suppliers, customers, and regulators through shared platforms. These ecosystems enable faster decision-making, improve data transparency, and reduce operational risks, marking a new phase of industrial modernization.

This study aims to discuss the factors affecting the future of management accounting during the digital transformation process. The concepts of digital transformation and Industry 4.0 are explained, and the historical development of management accounting up to digital transformation is presented within a conceptual framework.

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Technological Evolution and Digital Transformation

The beginning of the First Industrial Revolution was the design of mechanical production using water and steam to achieve competitive advantage in commercial life. The transition to the Second Industrial Revolution was achieved with the implementation of mass production using electric power. The Third Revolution saw the automation of production through the use of electronics and information technologies. With the development of digitalization, which began in the Third Revolution, the Fourth Industrial Revolution began. This new revolution envisions a brand new production and service cycle in which living beings, physical and non-physical objects, will communicate with each other [1,2].

Unlike earlier industrial changes, the Fourth Industrial Revolution emphasizes the fusion of technologies that blur the boundaries between the physical, digital, and biological spheres. It is not only changing what we do but fundamentally transforming who we are and how we interact as societies and economies.

The digitalization of global data sources falls primarily within the purview of computer science. For example, capturing an image, a sound, or the humidity level of an environment through various sensors, converting it into digital data, and processing this data is the domain of computer science. Furthermore, the digitalization of a business should be considered beyond the digitization of data or data sources, but rather the digitalization of a process, perception, and management.

For example, the digitalization of a business is not limited to simply transferring processes previously managed manually or using analog methods to a digital environment, that is, a computer environment. It also includes the more efficient use of new capabilities offered by this environment, such as business intelligence, and the effective management of new problems specific to this environment [3,4,5].

Digital transformation, also known as digitization, refers to a business model driven by "the changes associated with the application of digital technology in all aspects of human society." It is typically implemented through digitization, that is, "transforming existing products or services into digital derivatives, thereby offering advantages over physical products" [6,7].

The acceleration of technological innovation has transformed the use and behavior of individuals and organizations, as well as market structures. In fact, consumers, especially those born into an environment where today's technology exists and who have grown up with new technologies, learning technology as if they were their mother tongue, are increasingly connected to the internet, changing the way they choose, purchase, and consume products and services [8,9,10,11].

Digital technologies such as mobile technologies, collaborative technologies, and the Internet of Things are enabling companies to improve their performance. Market volatility has been further exacerbated by the emergence of new disruptive actors offering new offerings through web applications. One of these is the "uberization of markets", a new term that characterizes this trend: the sharing economy. This transformation driven by digital technologies is of crucial strategic importance for companies. On the one hand, organizations must contend with new disruptive actors that are profoundly disrupting traditional industries.

The new process, called Industry 4.0, has a structure that will completely transform the relationship between production and consumption. On the one hand, it defines production systems that instantly adapt to changing consumer needs, and on the other, automation systems that

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are in constant communication and coordinate with each other. It also encourages close collaboration between various disciplines in product development [12]. The goals of Industry 4.0 can be listed as enabling mass customization of products produced by information technologies, achieving automatic and flexible adaptation of the production chain, simplifying communication between parts, products, and machines by monitoring parts and products, implementing human-machine interaction (HMI) paradigms, enabling production optimization with the Internet of Things in smart factories, and creating new types of value-added services and business models [13].

Moreover, digital transformation introduces a new paradigm of decision-making in management. Data-driven decision-making supported by real-time analytics, artificial intelligence, and predictive models allows organizations to respond rapidly to market fluctuations. This not only enhances productivity but also reduces uncertainty and operational risks. For example, predictive maintenance in factories can prevent costly downtime and prolong the lifespan of equipment.

Governments also play a pivotal role in promoting digital readiness through innovation policies, digital skills programs, and infrastructure investments. The European Union's "Digital Europe Programme" and China's "Made in China 2025" initiative exemplify national efforts to integrate technology into all sectors of production. Such policy frameworks ensure that digital transformation does not remain limited to large corporations but extends to small and medium enterprises (SMEs), enabling inclusive and competitive industrial ecosystems.

Furthermore, ethical and regulatory challenges are emerging as crucial dimensions of digitalization. Issues such as data privacy, cybersecurity, and algorithmic bias are shaping global debates on responsible innovation. For sustainable progress, countries need to establish strong legal and institutional frameworks that balance innovation with human rights, data ethics, and transparency.

Bridging industry and agriculture, a decisive success factor is the creation of interoperable data ecosystems supported by a digitally skilled workforce. When production lines, logistics networks, financial systems (e.g., management accounting), and farm operations exchange standardized data in real time, organizations can coordinate inventory, energy use, and quality controls across the entire value chain. This integration enables cross-sector analytics (for example, linking input prices to yield forecasts and cash-flow planning), shortens decision cycles for SMEs, and strengthens resilience to shocks such as supply disruptions or extreme weather. Complementary investments in broadband connectivity, cybersecurity practices, and continuous upskilling ensure that digital tools translate into measurable productivity and sustainability gains rather than isolated pilot projects.

Furthermore, partnerships between the private sector, academic institutions, and government agencies are essential for advancing digital transformation across industries. Collaborative innovation ecosystems encourage the co-creation of new technologies, patents, and digital platforms that strengthen national competitiveness. Such cooperation not only supports industrial efficiency but also ensures that technological progress benefits society as a whole through inclusive growth and employment opportunities.

Digital Transformation in Agriculture

The agricultural sector has been one of humanity's fundamental sources of livelihood throughout history and has undergone significant transformations in parallel with technological

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advancements. While traditional farming methods were shaped by human and animal power, the Industrial Revolution and digitalization processes have made production processes more efficient. Today, agriculture has become more sustainable and highly productive thanks to smart technologies and digital systems. This study aims to analyze the current state of technology supported agricultural practices in Azerbaijan, the challenges faced, and the strategic steps that need to be taken in the future. This qualitative study is designed as an action research study based on thematic review and relational analysis. Data obtained from the literature has been integrated in a flow from general to specific and from theory to examples. According to the findings, the agricultural sector faces global challenges such as increasing food demand, climate change, and the sustainable use of natural resources.

Digital agriculture is also helping governments design evidence-based agricultural policies. By collecting real-time data from sensors, satellites, and mobile applications, policymakers can better monitor crop yields, water use, and soil fertility. This data-driven approach supports targeted subsidies, risk management programs, and early warning systems for food security. As a result, digital transformation strengthens not only farm-level productivity but also national food governance and resilience against global disruptions.

The transformation from traditional farming methods to smart agricultural technologies and its impact on agricultural productivity, sustainability, and economic growth have been examined. While classical agriculture requires intensive labor and long production processes, digital agriculture provides higher productivity with less labor. Digital agricultural applications optimize agricultural production by offering advantages such as early detection of plant diseases, precise predictions and analyses, low input usage, and high efficiency. Successful smart agriculture practices in countries like the USA, the UK, the Netherlands, Japan, and Taiwan have been examined, and the current state of smart agriculture in Turkey has been evaluated. While the technological inclination of the young population is seen as a significant opportunity for the widespread adoption of these technologies in Turkey, low awareness levels and high investment costs have been identified as obstacles.

Today, the agricultural sector is undergoing a major transformation from traditional methods to digital agricultural technologies. While traditional agriculture has been a production method used for many years and relies largely on human labor, digital agriculture utilizes modern technologies to offer a more efficient, sustainable, and precise production process.

The agricultural sector has been one of humanity's primary sources of livelihood throughout history and has undergone major transformations in parallel with technological advancements. While traditional agriculture relied on human and animal power, the integration of mechanization into agriculture with the Industrial Revolution ushered in the Agriculture 1.0 era. The Green Revolution of the 1950s increased productivity with mass production techniques and the widespread use of tractors, while precision agriculture applications were introduced with computer and automation systems from the 1990s onwards. Today, the digital agriculture era, referred to as Agriculture 4.0, combines information and communication technologies with innovative systems such as artificial intelligence, big data, and the Internet of Things, making agriculture more efficient, sustainable, and intelligent [14].

Following these transformations, Agriculture 5.0, which will shape the future of agriculture, offers a human-centered and environmentally friendly agricultural production model by

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combining artificial intelligence, robotic technologies, biotechnology, and sustainable energy solutions. Agriculture 5.0 aims to promote food security, reduce carbon footprints, and promote the widespread adoption of smart farm systems. In this new era, more autonomous systems will be used in agricultural production processes, providing producers with more effective and informed decision-making opportunities.

In developing countries, however, the digital divide remains a major challenge. Limited access to reliable internet, inadequate infrastructure, and low levels of technological literacy hinder the adoption of smart agricultural tools. Bridging this gap requires coordinated investment in rural broadband, affordable technologies, and digital education initiatives. Only by ensuring equal access can digital transformation achieve its full potential in improving agricultural productivity and social equity.

Smart agriculture is an approach that optimizes agricultural processes, increases productivity, and promotes sustainable production through the integration of technological innovations. Effective management of agricultural land holds great potential for resource efficiency and environmental sustainability. In this context, significant advances have been made in areas such as land classification supported by remote sensing and sensor technologies, map-based fertilization, yield mapping, smart irrigation, livestock practices, plant health and disease control, and greenhouse farming. Advanced technologies such as artificial intelligence, big data analytics, the Internet of Things (IoT), and autonomous systems have made agricultural decision support systems more effective, thus enabling more controlled and efficient production processes.

Smart agriculture, by integrating technology into the agricultural sector, increases productivity, reduces environmental impact, and enables more efficient use of resources. This approach has been adopted and implemented by various countries worldwide. Many countries are making extensive investments to develop smart agricultural technologies and encouraging their use by providing training and support to farmers. Countries such as the United States, the United Kingdom, the Netherlands, Japan, and Taiwan offer prominent examples of digital agricultural practices and their remarkable success in this area. These countries' agricultural innovations, digitalization processes, and sustainable production methods are leading to significant changes in the global agricultural sector. This section evaluates the successes of these countries in digital agricultural practices.

In addition, the integration of satellite imaging, artificial intelligence, and blockchain is creating a new era of transparency and traceability in food production. Farmers and consumers can now track the origin of products, monitor sustainability indicators, and ensure compliance with environmental standards. Furthermore, digital agricultural platforms are fostering collaboration between researchers, governments, and agribusinesses to share best practices and accelerate technological adoption. In Azerbaijan, these global experiences provide valuable insights for developing a resilient and technology-driven agricultural model aligned with the country’s green growth strategy.

Climate change adaptation has become one of the most critical motivations behind agricultural digitalization. Advanced data systems now help predict weather extremes, manage water scarcity, and model crop resilience. Through AI-based simulation tools, farmers can plan optimal planting schedules and choose the most resistant crop varieties to minimize losses from drought or pests.

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The use of blockchain technology is also gaining importance in agriculture for ensuring transparency across the supply chain. Consumers can track the origin, storage, and distribution history of agricultural products, which enhances food safety and builds trust in global markets. Additionally, governments and research institutions are developing digital platforms that connect farmers with markets, financial institutions, and innovation networks, thus reducing rural isolation and improving income equality.

In the case of Azerbaijan, digital transformation in agriculture aligns closely with the "Green Growth and Circular Economy Concept 2023–2030." This strategic vision aims to establish smart agricultural zones, encourage renewable energy use in rural areas, and foster data-driven land management. Such efforts reflect a broader goal to harmonize agricultural modernization with national sustainability priorities.

CONCLUSIONS

There is no single, globally accepted definition of sustainable development or sustainability in the literature. Both concepts have been used by different authors in different contexts.

Historically, sustainable development first emerged due to environmental concerns and later began to play a significant role in national policies by ensuring both sustained economic growth and the efficient use of limited natural resources, while also encompassing social concerns.

Sustainable development requires minimizing inequalities between and within generations and meeting the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, sustainable development is a matter of equity and balance related to social, economic, and environmental sustainability.

In the digital era, sustainability increasingly depends on how effectively societies integrate technological progress with ecological awareness and human-centered values. Digitalization promotes sustainable solutions by enabling precision monitoring of resources, energy optimization, and circular economy practices that reduce waste and emissions.

Furthermore, education and digital literacy are vital for sustainable digital transformation. Without a skilled workforce capable of operating and managing new technologies, many developing countries risk falling into a digital divide that reinforces existing inequalities. Thus, investing in human capital, vocational training, and innovation ecosystems is essential for equitable and resilient development.

Finally, the synergy between digital transformation and sustainability holds the potential to redefine global competitiveness. Countries that successfully combine digital efficiency with environmental responsibility will lead the transition toward an inclusive, low-carbon economy. This path requires cooperation between governments, academia, and private enterprises to ensure that technological innovation benefits both people and the planet.

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TEXNOLOGİYA VƏ İSTEHSALAT – SƏNAYE VƏ KƏND TƏSƏRRÜFATINDA MÜASİR VASİTƏLƏRİN ROLU

X Ü L A S Ə

Tədqiqatın məqsədi – rəqəmsal transformasiya prosesində idarəetmə uçotunun gələcəyinə təsir edən amilləri araşdırmaqdır.

Tədqiqat metodologiyası – keyfiyyət xarakterli olub, tematik icmal və əlaqələndirmə analizi əsasında qurulmuşdur. Ədəbiyyatdan əldə edilən məlumatlar "ümumidən xüsusiyə" və "nəzəriyyədən praktikaya" prinsipi ilə sistemləşdirilmiş, beynəlxalq təcrübə və Azərbaycanın mövcud vəziyyəti müqayisəli şəkildə öyrənilmişdir.

Tədqiqatın tətbiqi əhəmiyyəti – sənaye və kənd təsərrüfatı sahələrində idarəetmə uçotunun rəqəmsal transformasiyaya uyğunlaşdırılmasına, smart kənd təsərrüfatı texnologiyalarının tətbiqinə, resurslardan daha səmərəli istifadəyə və davamlı inkişaf məqsədlərinin reallaşmasına xidmət edə bilər.

Tədqiqatın nəticələri – rəqəmsal transformasiyanın idarəetmə uçotunda yeni proaktiv yanaşma formalaşdırdığı, smart texnologiyaların isə məhsuldarlığı artıraraq xərcləri azaltdığı və Azərbaycanın texnoparklarında ilkin nəticələr verdiyi müəyyən edilmişdir.

Tədqiqatın orijinallığı və elmi yeniliyi – idarəetmə uçotunun rəqəmsal transformasiya şəraitində konseptual əsaslarla yenidən qurulması, Sənaye 4.0 və Kənd təsərrüfatı 4.0–5.0 yanaşmalarının inteqrasiyası əsasında Azərbaycanın aqrar-sənaye mühitində rəqəmsal texnologiyaların tətbiq imkanlarının ilk dəfə elmi qiymətləndirilməsi və bu istiqamətdə inkişaf perspektivlərinin əsaslandırılmasıdır.

Açar sözlər: texnologiya, məhsuldarlıq, sənaye 4.0, kənd təsərrüfatı 4.0, avtomatlaşdırma, ağıllı kənd təsərrüfatı, davamlı inkişaf, rəqəmsal transformasiya.

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ТЕХНОЛОГИИ И ПРОИЗВОДСТВО – РОЛЬ СОВРЕМЕННЫХ ИНСТРУМЕНТОВ В ПРОМЫШЛЕННОСТИ И СЕЛЬСКОМ ХОЗЯЙСТВЕ

Р Е З Ю М Е

Цель исследования - изучение факторов, влияющих на будущее управленческого учета в процессе цифровой трансформации.

Методология исследования - исследование носит качественный характер, основано на тематическом обзоре и корреляционном анализе. Информация, полученная из литературных источников, систематизирована по принципам «от общего к частному» и «от теории к практике». Международный опыт и современное состояние в Азербайджане изучены в сравнительном аспекте.

Практическая значимость исследования - результаты могут способствовать адаптации управленческого учета в промышленности и сельском хозяйстве к условиям цифровой трансформации, внедрению технологий «умного» сельского хозяйства, более эффективному использованию ресурсов и реализации целей устойчивого развития.

Результаты исследования - установлено, что цифровая трансформация формирует новый проактивный подход в управленческом учете, а «умные» технологии повышают производительность, сокращают издержки и уже дали первые результаты в технопарках Азербайджана.

Оригинальность и научная новизна исследования - заключается в концептуальной реконструкции управленческого учета в условиях цифровой трансформации, интеграции подходов «Индустрия 4.0» и «Сельское хозяйство 4.0–5.0», а также в первом научном оценивании возможностей применения цифровых технологий в агропромышленной среде Азербайджана с обоснованием перспектив развития в данном направлении.

Ключевые слова: технологии, производительность, промышленность 4.0, сельское хозяйство 4.0, автоматизация, интеллектуальное земледелие, устойчивое развитие, цифровая трансформация

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