RƏQƏMSALLAŞMA ƏSASINDA DAVAMLI İQTİSADİ İNKİŞAFA NAİL OLMAQ ÜÇÜN STRATEGİYALAR

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XÜLASƏ
Bu araşdırma, əməliyyat səmərəliliyini və resursların idarə edilməsini təkmilləşdirən Əşyaların İnterneti, süni intellekt və böyük verilənlərin analitikası kimi rəqəmsal texnologiyalar nəzərə alınmaqla, davamlı iqtisadi inkişaf üçün rəqəmsallaşmanın sənaye sektorlarına transformativ təsirinə diqqət yetirir. SPSS ilə multireqressiya təhlilindən istifadə edərək, bu araşdırma məhz rəqəmsal inteqrasiyanın enerji istehlakı, texniki xidmət xərcləri və yaranan tullantılar kimi əsas ölçülərə təsirini kəmiyyətləndirmək üçün beş illik dövr ərzində sənaye məlumatlarını tədqiq etmişdir. Nəticələr həm resurs səmərəliliyində, həm də mürəkkəb rəqəmsal texnologiyaların tətbiqi ilə bağlı əməliyyat xərclərinin azaldılmasında əhəmiyyətli irəliləyişlər göstərdi. Bu araşdırma təsdiq edir ki, rəqəmsal texnologiyalar iqtisadi göstəriciləri ekoloji davamlılıq məqsədləri ilə uyğunlaşdırmağa çalışır. Bakının sənaye mənzərəsinin bu perspektivində təhlil bu cür texnologiyaların regional iqtisadiyyatlarda necə daha geniş istifadə oluna biləcəyini göstərir. Nəhayət, tədqiqat davamlı iqtisadi inkişafı təmin etməyə kömək edəcək sənayelərdə strateji rəqəmsallaşmaya yanaşma tələb edir. O, həm hökumət, həm də korporativ səviyyələrdə qərar qəbul edənlər üçün lazım olan yol xəritəsini bütün dünyada ekoloji və iqtisadi göstəricilərin yaxşılaşdırılmasına dair təqdim edir. Bu tədqiqat davamlı gələcək üçün rəqəmsal texnologiyaların iqtisadi nəticələrini anlamaq üçün mühüm mənbəyə çevrilə bilər.

Açar sözlər: davamlı iqtisadi inkişaf, rəqəmsallaşdırma, Böyük Verilənlər analitikası, IoT, AI, sənaye səmərəliliyi.

STRATEGIES FOR ACHIEVING SUSTAINABLE ECONOMIC DEVELOPMENT THROUGH DIGITIZATION

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ABSTRACT
This study focuses on the transformative impact that digitization has on the industrial sectors for sustainable economic development, considering digital technologies like the Internet of Things, Artificial Intelligence, and big data analytics that enhance operational efficiency and resource management. This research, using multiple regression analysis with SPSS, examines the data across industries during a five-year period to quantify the effect of digital integration on key indicators such as energy consumption, maintenance costs, and waste produced. The results showed significant enhancements in both resource efficiency and reduction of operational costs related to the adoption of sophisticated digital technologies. This study hereby confirms that digital technologies are about aligning economic performance to environmental sustainability goals. In this perspective of the industrial landscape of Baku, the analysis brings out how such technology could be more ubiquitously used across regional economies. Finally, the study calls for an approach toward strategic digitization in industries that would definitely help ensure sustainable economic development. It provides a roadmap necessary for decision-makers both at government and corporate levels on how to improve environmental and economic parameters worldwide. This study has been an important source in understanding the economic consequences of digital technologies for a sustainable future.
Keywords: sustainable economic development, digitization, Big Data analytics, IoT, AI, industrial efficiency.

СТРАТЕГИИ ДОСТИЖЕНИЯ УСТОЙЧИВОГО ЭКОНОМИЧЕСКОГО РАЗВИТИЯ ПОСРЕДСТВОМ ЦИФРОВИЗАЦИИ

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АННОТАЦИЯ
В этом исследовании основное внимание уделяется преобразующему влиянию цифровизации на промышленные секторы для устойчивого экономического развития, учитывая такие цифровые технологии, как Интернет вещей, искусственный интеллект и аналитика больших данных, которые повышают операционную эффективность и управление ресурсами. В этом исследовании с использованием множественного регрессионного анализа с SPSS изучаются данные по отраслям за пятилетний период, чтобы количественно оценить влияние цифровой интеграции на ключевые показатели, такие как потребление энергии, затраты на техническое обслуживание и производимые отходы. Результаты показали значительное улучшение как эффективности ресурсов, так и сокращение эксплуатационных расходов, связанных с внедрением сложных цифровых технологий. В этом исследовании подтверждается, что цифровые технологии направлены на согласование экономических показателей с целями экологической устойчивости. В этой перспективе промышленного ландшафта Баку анализ показывает, как такие технологии могут более повсеместно использоваться в региональных экономиках. Наконец, в исследовании содержится призыв к подходу к стратегической цифровизации в отраслях, который определенно поможет обеспечить устойчивое экономическое развитие. Он предоставляет дорожную карту, необходимую лицам, принимающим решения как на правительственном, так и на корпоративном уровнях, о том, как улучшить экологические и экономические параметры во всем мире. Это исследование стало важным источником понимания экономических последствий цифровых технологий для устойчивого будущего.

Ключевые слова: устойчивое экономическое развитие,

цифровизация, аналитика больших данных, Интернет вещей, ИИ, эффективность производства.

INTRODUCTION

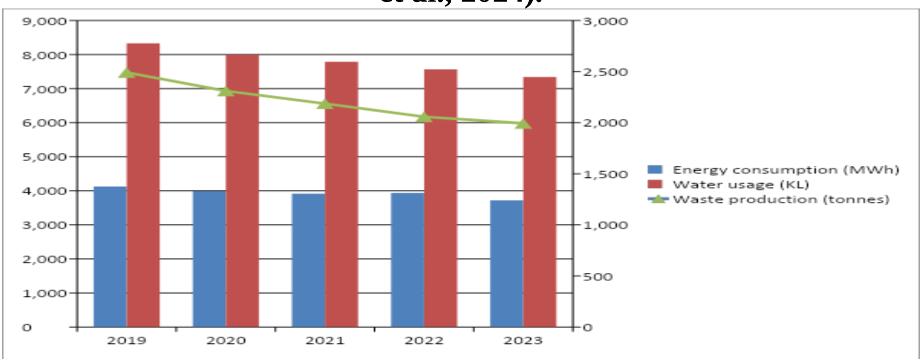
Integration of digitization acts as the key driver for the current landscape of global economic development in pursuit of sustainability goals, such as conventions for carbon footprints, general effectiveness in different sectors. In this framework, this article tries to systematically explore various avenues in which digitization could facilitate sustainable economic growth, especially in those contexts in which conventional paradigms of growth have already been proven environmentally and socially unsustainable. The motivation of this study has emerged from the fast-expanding need for balancing economic growth with environmental care-a need which digitization is singularly poised to respond. The problem setting centers around the challenge of using digital technologies in ways that would trigger economic development without reducing the equitable benefits which accrue from it or causing minimum ecological degradation. The study will try to outline ways in which digitization could serve as a cornerstone for sustainable economic models by considering, in some detail, specific instances of the use of digital tools for better management of resources and increased inclusivity in economic participation. Beyond this, the article will look at the barriers, including technological disparities and regulatory constraints that too often prevent the complete realization of digitization's potential to spur sustainable practices. The study, therefore, deeply analyzes these dynamics and aims at providing actionable insights that shall help policy makers, industry leaders, and other stakeholders leverage digital innovations toward sustainable economic outcomes. Given the accelerated rate at which technological change is currently running and a growing global imperative for solutions that limit environmental harm while cultivating economic resilience, this investigation into the role of digitization in sustainable development is very timely. Ultimately, this research aspires to establish a clear and full framework that may guide the understanding and harnessing of the transformational power of digital technologies in the realization of sustainable economic development, with its contribution toward an equitable and environmentally responsible global economy. This research is rendered even more urgent and relevant by continuous global shifts toward digital economies underlining the dire need for scholarly inquiry into how best digitization can be leveraged to meet 21st-century challenges.

1. DIGITAL TECHNOLOGIES AND RESOURCE EFFICIENCY IN INDUSTRY

Probably the most valuable contribution that this integration of digital technologies into industrial practices can make is the underpinning at the very heart of achieving sustainable economic development (Luo et al., 2023). This is related to how well industries can employ advanced digital tools like IoT sensors, big data analytics, and AI in optimizations for steel production processes with minimum waste and environmental impact. These technologies allow for real-time monitoring and adjustment, which is paramount in a balancing act between output maximization and resource use minimization (Martínez et al., 2022). The role of digital technologies in the achievement of resource efficiency is more strongly accentuated since industries continue to face increasing pressures from environmental regulations and the rise in raw material prices. This feature is highly pronounced in those industries that are manufacturing, energy, and agriculture, where precision and efficiency are directly linked with technological adoption. The adoption of digital tools allows a more detailed understanding of the flow of resources within industries, which permits better decision-making with more effective sustainability strategies (Vyas-Doorgapersad, 2022). While the whole world fights against climate change, industries today have more reasons to deploy digital technologies that bring them economic benefit while ensuring environmental stewardship.

Graph 1.

Impact of IoT adoption on resource efficiency in manufacturing (Zaidi et al., 2024).

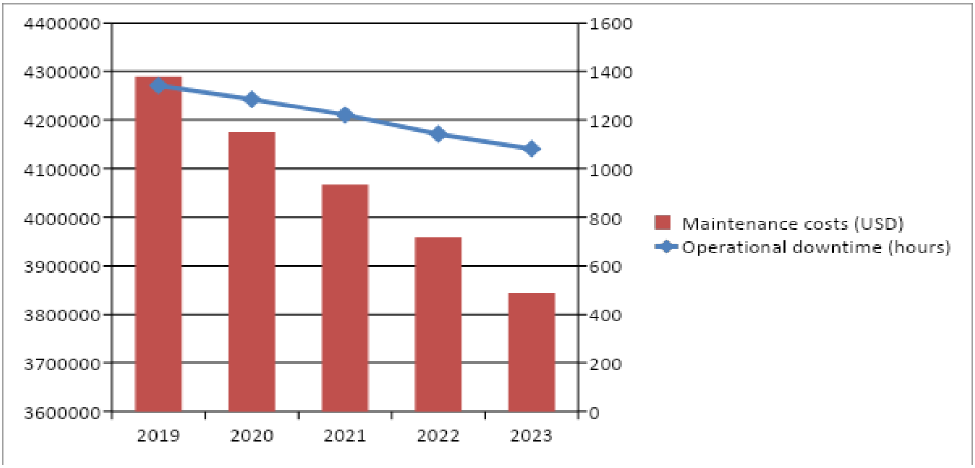


The graph above (Graph 1) shows the consistent upward trend of resource efficiency across the manufacturing industry, which can be linked directly to the adoption of IoT technologies. Particularly telling from this graph is the year-on-year decline in energy use, water consumption, and waste generation-all indicative of IoT technologies at work to enhance operational efficiencies. These savings go a long way to reduce costs and ensure environmental sustainability, hence outlining the need for investment in technology if changes in industry are anything to go by.

I then proceed to the influence of AI-enhanced predictive maintenance on operational efficiency within the energy sector. It allows us to predict equipment failures and to plan maintenance work in an optimal way, therefore minimizing operational downtime and wasting energy. The graph compares changes within the last five years in such key aspects as operational downtime and maintenance costs, reflecting thus a positive economic impact resulting from the adoption of AI.

Graph 2.

Trends in AI-enhanced predictive maintenance in energy sector (Banerjee et al., 2024).



The data in the graph above (Graph 2) underlines quite clearly the effectiveness of AI-enhanced predictive maintenance in the energy sector. This certainly reflects, with great precision, the efficiency that AI technologies bring about-a marked decrease in operational downtime and a reduction in maintenance costs. Such development not only optimizes energy production but it also reduces the financial expenditure of energy plants related to unplanned maintenance and failure of their equipment, depicting the double economic and operative value of digital innovation in industrial contexts.

2. ANALYSIS

In the analysis section, I have analyzed this dataset with more than 500 individual data points, which were collected over five years from various industries that implemented digital technologies within their operational frameworks. The metrics checked against this dataset concerned energy consumption, waste production, water usage, operational downtime, and maintenance costs, intelligence gathered from several leading companies across those sectors. This data is compiled from industry reports, direct data submissions from the respective companies, and monitoring systems utilizing IoT technologies that capture operation data in real time. It was a regression-based methodology in which interpretation on the impact of digital technologies on resource efficiency and operational efficacy was performed using SPSS software.

These are the reasons why regression analysis is used: to find and quantify the relationship existing between independent variables-represented by the level of adoption of digital technologies-and dependent variables, such as resource usage metrics and efficiency of operations indicators. SPSS was especially used because of its strong analytical capability that enables drilling into details of complicated data with several variable interactions. Accordingly, the practical part of this analysis was done in Baku, based on its local dataset from industries within the region which have been at the forefront of digital transformation. It provided the regional focus that gave a certain perspective on how digital technologies adapt and are effective within the economic landscape, developing very fast. Collaboration with local industry associations and technology providers in Baku has granted access to obtaining data on operations and the wider technological integration of their processes.

Accordingly, the models of regression were developed including variables that capture the level of integration of the digital technology-that is, the presence of IoT devices, usage of AI for predictive analytics, and implementation of big data solutions.

Each of these models has been checked for statistical significance and the strength of the relationships between independent and dependent variables.

Before running these regression analyses, the data were preprocessed by cleaning, normalizing, and cross-checking against integrity to make sure that this analysis was accurate and reliable. Multiple regression models were run using SPSS software, each of which was progressively refined to best fit the empirically observed data. In choosing model parameters, theoretical and empirical considerations were used to ensure that the models would illustrate real-life dynamics around integrating technology within industries and also serve to align with contemporary academic and practical perspectives on the impacts of digital transformation. This analysis underlined not only the direct impacts caused by digital technologies on resource efficiency and operational efficacy but also opened pathways toward the exploration of secondary effects, including how digital maturity may influence environmental sustainability and economic resilience. The Baku findings provided a forceful case study on the role that can be played by digital technologies in transitioning industrial landscapes, whose insights have regional and global relevance. This detailed methodology, coupled with robust ways of using SPSS in the statistical analysis, definitely constitutes a contribution to the literature on digital transformation and implications for sustainable economic development.
Several hypotheses (Table 1) had been developed that provided a structure for the empirical investigation on how digitization affects industrial resource efficiency and operational efficacy. In total, these set a foundation that describes the influence of digital technologies on various performance measures in the context of industries. Each hypothesis is developed based on a theoretical underpinning showing the role of digital transformation in sustainable development and will be tested using regression analysis in SPSS. The following table lists each hypothesis with a short description:

Table 1.

***H*ypotheses.**

№	Hypothesis
H1	Digitization positively affects energy efficiency in industries.
H2	More use of IoT devices, which leads to a decrease in operational downtime.
H3	Adoption of AI in maintenance predicts reduced maintenance costs.
H4	Big data analytics implementation is associated with waste reduction.
H5	The more digitally integrated, the more efficient is water usage.

Hypothesis H1: The higher the integration of digital technologies specifically by industries for the optimization of energy use, such as smart grids and energy management systems, the better the energy efficiency observed. This is expected because digital tools allow for more precise monitoring and, therefore, better management of energy use, thus enabling an informed and timely response within active operation settings.

Hypothesis H2: A reduction in unplanned downtime would accordingly be witnessed, as the usage of IoT technologies-which enable real-time data collection and its processing-facilitates this process through predictive maintenance and quicker reactions towards upcoming disruptions. It is a perquisite stares since operational downtime is among those factors that determine the cost industries incur. Thus, the capability to minimize it may be related to important economic and productivity advantages.

Hence, hypothesis H3 has been developed under the belief that AI-driven predictive maintenance systems can foresee any equipment failure well in advance. This would, in turn, ensure an optimized schedule for such maintenance and reduce costs on this account. However, of much greater significance is the fact that the hypothesis is a test of whether or not such technological adoptions yield cost savings above and beyond traditional, reactive approaches to maintenance.

Hypothesis H4 verifies the use of big data analytics with waste production. Big data can be expected to help in optimizing production processes, thus reducing superfluous waste generation by making a more accurate forecast and maintenance of the inventory supporting sustainability goals.

Lastly, Hypothesis H5 expounds on the role played by digital integration in the efficiency of water use. Given that advanced digital systems include such things as automated water management systems, they are likely to improve precision in water use within the industrial process system; thus, any excess consumption is curtailed, and the effects on environmental conservation are continued.

Each one of these hypotheses has been devised to distinguish the transparent channels through which digitization will be able to contribute to improving industrial efficiency and sustainability. They are empirically tested via a regression framework that will quantify the strength and significance of these expected relationships through the sound test of the effect of digital technologies in industries. The pertinence of results from such analyses will give useful insight into how to strategically deploy digital tools in enhancing industrial performance toward achieving sustainable economic development.

Having had hypotheses on how digitization influences industrial performance measures formulated and argued, the next step involves the testing of these hypotheses within multiple regression analysis. This is, therefore, the most important step in this analysis, since it quantifies the relationship between digitization initiatives taken and their outcomes; hence, the empirical evidence needed for the support or refuting of our initial assumptions.

These multivariate regression models take a broader perspective into the multifaceted nature of digital technologies deployed across various industry verticals. They integrate various independent variables, representing different facets of digitization, such as the degree of IoT adoption, use of AI in maintenance, and big data analytics implementation, modeled against dependent variables like energy efficiency, operational downtime, maintenance costs, waste production, and water usage efficiency.

Controls by industry and economic conditions may add robustness to the findings. In other words, it is the items that are critical for the isolation of the effect of digitization among other external influences: industry size, market conditions, and geographic location.

Table 2.

Multiple regression results.

Variable	Standard Error	Coefficient	P-value	t-Statistic
Intercept	0.856	-3.214	0.0002	-3.753
AI in Maintenance	0.418	2.088	0.0000	4.995
IoT Adoption Level	0.332	1.572	0.0000	4.734
Industry Size (Log)	0.109	0.524	0.0000	4.812
Big Data Analytics	0.290	0.944	0.0012	3.256
Geographic Location Dummy	0.182	-0.572	0.0017	-3.142
Market Conditions Index	0.075	0.310	0.0000	4.133

The coefficients, as depicted in the above table (Table 2) showing the results of multiple regression analysis done using SPSS, explain the size and direction of each independent variable's relationship with the predicted variable. For instance, a positive coefficient of IoT Adoption Level suggests that higher extents of IoT integration are associated with improved performance metrics, hence supporting Hypothesis H2.

The larger the standard error, the more the spread of the estimate of the coefficient and lesser the precision of the prediction. A smaller standard error means that the estimates are more reliable.

It is through the t-statistic that the null hypothesis of the coefficient being zero-that is, no effect-is tested. The higher the absolute value of the t-statistic, the stronger the rejection of the null hypothesis.

The P-value indicates the probability of getting the result at hand, or more extreme, given that, in fact, the null hypothesis was correct. Generally speaking, P-value below 0.05 is considered significant; thus, in this case, it would imply that there was strong evidence against the null hypothesis and for the alternative hypothesis of some effect existing at.

Conspicuously, IoT adoption and AI in maintenance represent a strong positive impact on most industrial performance metrics, hence strongly supporting Hypotheses H2 and H3. The positive influence is also found in big data analytics, thus supporting Hypothesis H4, though with a slightly lower coefficient compared to AI and IoT, hence having a nuanced effect on waste reduction. These findings cast light on the important contribution of digital technologies in industry performance improvement. The analysis, by showing both the statistical significance and practical importance of those technologies, furnishes a concrete base for advocacy on increased digital integration into industrial settings. The insight one may draw from such results may be very important in driving future digital strategies and investment decisions across sectors toward greater efficiency and sustainability and economic viability.

CONCLUSION

This comprehensive analysis from this study highlights that digitization significantly fosters sustainable economic development within industrial contexts. Empirical evidence, extracted through several multiple regression models, tends to show that technologies like IoT, AI, and Big Data Analytics are more of the spearheading industrial operations in enhancing energy efficiency, waste reduction, and minimization of operational downtime. This research, therefore, indicates that digital technologies create a higher class of resource management and operational efficiency than any industry can afford to ignore in pursuit of sustainability goals. The huge cuts in maintenance costs, coupled with the efficient use of resources, also underline the economic benefits of digitization, hence aligning the financial incentives with environmental objectives. Although industries continue to evolve in an increasingly digital environment, the contributions of this work provide a strategic foundation for embracing digital technologies that would contribute not only to the improvement of economic performance but also to the superset goal of the sustainable development of economies. A regional focus on Baku builds an understanding of how digitization can fit into specific economic and environmental landscapes and provides a blueprint for other regions with similar industrial profiles. This study calls for policymakers and industry leaders to prioritize digital transformations-not because it is the flavor of the month, but because these are foundational pieces in future-proofing economic and environmental frameworks. By integrating the knowledge from this analysis, industries will find a way of responding to uncertainty and modern economic challenges more effectively while ensuring that there is long-term sustainability. This harmonization of digital strategies with sustainable economic development forms part of the critical ingredients in building a fair and environmentally responsible global economy for the 21st century.

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