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# Perception of the Potential for Blockchain Technology Adoption Across Different Sectors of the Polish Economy

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***Abstract:***

***Purpose:*** *This article aims to investigate the perception of the potential for application of blockchain technology in specific sectors of the Polish economy and to identify the factors that determine the benefits of using this solution.*
***Design/Methodology/Approach:*** *The methodology proposed in this article enables the identification of key factors that describe the perceived potential, depending on the classification of economic activity. For the study, a questionnaire was developed, and the responses were examined using exploratory factor analysis. This approach, combined with a review of the literature on the subject, has resulted in the identification of differences in the potential of individual sectors of the Polish economy.*
***Findings:*** *The research enabled the assessment of the benefits of implementing blockchain technology in specific sectors of the Polish economy and the identification of four key factors describing the perceived benefits. The analysis led to the identification of barriers to economic activity and factors preventing entry into the ecosystem. In this context, the risk of possible market fragmentation was defined.*
***Practical Implications:*** *This method identifies sectors of the Polish economy where the implementation of blockchain technology is perceived as most beneficial. It demonstrates the*

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*need for research in this field from a complex perspective, covering all sectors of industry. The conclusions drawn by the authors provide a potential starting point for in-depth analysis and may inspire future research directions in this field.*
***Originality/Value:*** *This comprehensive study, which considers all sectors of the Polish economy, demonstrates the potential of innovative blockchain technology.*

***Keywords:*** *Information services, innovation diffusion, digital transformation, technological change.*

***JEL codes:*** *L86, O33.*

***Paper type:*** *Research article.*

## 1. Introduction

Blockchain is a decentralized technology based on a distributed ledger of information (Sienkiewicz-Małyjurek, 2022). It is a relatively new solution aimed at achieving decentralization, wherein a peer-to-peer network updates data in real time, ensuring anonymity, transparency, irreversibility, and overall data integrity (Tijan, Aksentijevic, Ivanic, and Jardas, 2019). The use of blockchain facilitates the acquisition, storage, and transmission of information.

The use of blockchain opens up new opportunities in both collaborative activities and resource sharing. Literature on the subject suggests that, much like the steam engine and the Internet—which powered previous industrial revolutions—blockchain has the potential to transform existing economic and business models.

The innovative nature of this technology may drive increased productivity across various industries. The prospect of positive change is especially apparent in the financial sector, energy markets, supply chains, intellectual property management, and the public sector (International Fund for Agricultural Development, 2019).

When analyzing the distinguishing features of this solution compared to other technologies available on the market, it is important to note that blockchain capacity through its ability to provide intermediation, enhance transparency, and improve audits quality, enables a significant reduction in transaction costs. Additionally, it contributes to market openness and increases the efficiency of existing value chains (Matyskevic and Kremer-Matyskevic, 2022).

Among the advantages that make blockchain both innovative and widely applicable across various industries are:

- independence from any organization or individual,

- immutability of data,
- elimination of intermediaries,
- reliability (Chen *et al.,* 2022).

This results from the fact that, during transactions, data entries must be verified and confirmed by all other participants. Moreover, the integration of smart contracts and the chronological ordering of records ensures the technology's efficiency in terms of both security and resilience to failure. Additionally, the complete transaction history remains transparent and verifiable for all users.

While blockchain is often associated with cryptocurrencies, its practical applications and measurable benefits for market entities extend far beyond this domain. Notably, blockchain systems contribute to reducing the cost of data breaches for organizations. By enabling companies to avoid legal disputes, minimize losses, secure sensitive data, and prevent costs arising from operational disruptions, blockchain enhances organizational resilience.

A significant share of security-related expenditures in large enterprises stems from exposure to malicious software – introduced either internally by employees or externally by cyber attackers. This risk can be substantially mitigated through the deployment of blockchain technology. Systems affected by such attacks often require months of repair; blockchain, by contrast, eliminates many of these vulnerabilities (Habib *et al.,* 2022; Rupeika-Apoga and Thalassinos, 2020; Tyagi *et al.,* 2023).

Document verification process within organizations remain both time-consuming and labor-intensive. Completing supply chains and finalizing transactions may take several days (Jóźwik and Malinowski, 2019). Beyond economic and operational inefficiencies, market participants face increased exposure to fraud and unnecessary costs.

In response, various blockchain-based platforms have emerged, including IBM's Batavia, R3's Marco Polo, Digital Trade Chain, and the Hong Kong Trade Finance Platform. These systems significantly shorten transaction times and reduce financial burdens (Morris, 2018).

Within the financial sector, blockchain technology plays a crucial role in lowering the costs of cross-border transactions, which are executed in near real-time and at a fraction of traditional processing costs. It also supports the development of digital payment infrastructures, money transfer systems, and operations involving complex financial instruments. Its implementation has a profound impact on the insurance industry and transforms activities related to deposits, loans, capital raising, and investment management. From the perspective of the financial sector, blockchain represents a highly attractive tool for global payments, trade finance, and automated regulatory compliance (Kołodziej, 2019; Velinov *et al.,* 2023; Grima *et al.,* 2023).

The benefits of blockchain solutions extend beyond market participants such as households, businesses and financial institutions. An increasing number of government organizations are also leveraging its potential. For example, national identity data can be secured using blockchain technology. Estonia serves as a notable case, having implemented a blockchain-based digital identity system to digitize national identity registers, safeguard citizen data, and eliminate inefficiencies inherent in legacy platforms—thereby significantly reducing associated maintenance costs.

The Estonian Information Systems Authority (RIA) functions as a key governmental provider, facilitating access to the blockchain network for state agencies through the use of the X-Road infrastructure (Semenzin *et al.,* 2022).

Blockchain technology offers a range of new opportunities and benefits, both for individual users and for enterprises adopting it for commercial purposes. While its architecture and potential may initially appear complex and difficult to implement, the technology's universal applicability allows for effective deployment across a wide array of industries and even in daily life.

The application areas outlined in the preceding sections represent only a preliminary overview within a continually expanding spectrum of use cases. When strategically deployed, blockchain has the potential to revolutionize numerous fields of human activity and technological development (Rot and Zyguła, 2018).

The ongoing changes and pace of digital transformation in the global economy highlight the need to understand how new technologies are perceived and implemented across different sectors. As indicated in the preceding paragraphs, the potential range of blockchain applications is extensive; however, there remains a shortage of empirical studies analysing the perceived benefits of its use across various branches of the economy—particularly in the context of emerging markets.

This study aims to fill this gap by assessing how the potential of blockchain technology is perceived in different sectors of the Polish economy, taking into account their varying levels of digital maturity.

## 2. The Research Problem

The main research problem addressed in this paper concerns the relationship between the perceived benefits of implementing blockchain technology and the degree of digitalisation within a given economic sector. Accordingly, the main research question was formulated as follows: Is the perception of benefits resulting from the implementation of blockchain technology related to the digital maturity of a given sector? To answer this question, the following specific research objectives were defined:

(1) to identify the sectors of the Polish economy in which blockchain is perceived as a technology with the greatest potential;

(2) to determine the key factors characterising the perceived benefits of implementing this technology;

(3) to examine the barriers and limitations that may hinder its diffusion across sectors.

The study adopts a quantitative research approach that combines a literature review with a survey-based analysis. The empirical part was carried out using an original questionnaire addressed to representatives of various sectors of the economy, classified according to the NACE Rev. 2 system.

The collected data were subjected to Exploratory Factor Analysis (EFA), which allowed for the identification of latent dimensions describing the structure of perceived benefits. The applied research methodology made it possible to obtain a multidimensional picture of the assessment of blockchain technology's usefulness in the context of different branches of the Polish economy.

The novelty of this study lies in its comprehensive scope—it covers the entire economic activity rather than focusing solely on individual sectors most commonly associated with this solution. The integration of the concept of digital maturity with the perception of blockchain usefulness enables a better understanding of how sector-specific characteristics influence the process of adopting new technologies. The research also contributes to the theoretical discussion on innovation diffusion and digital transformation by providing empirical evidence on the significance of blockchain as a new general-purpose technology (GPT).

The sources of information used in the study include academic literature, institutional reports, industry analyses, and primary data collected through the survey. However, certain methodological limitations should be noted. The perception-based data are subjective in nature and may reflect respondents' opinions rather than the actual level of blockchain implementation.

Moreover, the cross-sectional design of the study does not allow for an analysis of changes over time. Despite these limitations, the obtained results constitute a valuable starting point for further comparative and longitudinal research.

## 3. Research Methodology

The perceived benefits of implementing blockchain systems across selected sectors of the Polish economy were assessed using a self-constructed questionnaire comprising 19 items. Each item was rated on a 10-point Likert scale, ranging from 1 ("no impact on sector development") to 10 ("significant impact on sector development"). The study was conducted in 2024. The survey instrument consisted of two parts.

The first part included questions designed to collect demographic information from respondents. The second part focused on evaluating the expected benefits of blockchain implementation in various economic sectors, classified according to NACE Rev. 2 (Eurostat, 2008). Data collected from the second part of the questionnaire were subjected to exploratory factor analysis (EFA) to identify underlying dimensions that characterize the perceived usefulness of blockchain technology across sectors.

## 4. Research Results

Before performing the exploratory factor analysis (EFA), the dataset was assessed for suitability. The distribution of responses was found to be acceptable, and the data were preprocessed accordingly. Outliers were removed, and the dataset was cleaned to eliminate errors and ensure reliability (Table 1).

***Table 1.*** *Descriptive statistics for variables characterizing the usefulness of the blockchain system in selected sectors of the Polish economy.*

| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 | A12 | A13 | A14 | A15 | A16 | A17 | A18 | A19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 | 202 |
| $\overline{x}$ | 4,87 | 5,54 | 7,37 | 6,96 | 6,35 | 6,47 | 7,20 | 7,71 | 6,66 | 8,29 | 8,26 | 7,51 | 7,67 | 7,31 | 7,61 | 6,71 | 6,97 | 5,96 | 5,48 |
| **σ** | 2,17 | 2,23 | 2,15 | 2,11 | 2,27 | 2,14 | 2,15 | 2,05 | 2,17 | 2,19 | 2,06 | 2,08 | 2,15 | 2,19 | 2,26 | 2,40 | 2,36 | 2,34 | 2,52 |
| **V** | 0,45 | 0,40 | 0,29 | 0,30 | 0,36 | 0,33 | 0,30 | 0,27 | 0,33 | 0,26 | 0,25 | 0,28 | 0,28 | 0,30 | 0,30 | 0,36 | 0,34 | 0,39 | 0,46 |

***Notes:*** *N – number of observations,* $\overline{x}$ *- arithmetic mean, σ – standard deviation, V –coefficient of variation.*

*Main question: Please rate on a scale from 1 to 10 the potential benefits associated with the implementation of blockchain systems in selected sectors of the Polish economy. Description of individual items – selected economic sectors:**

*A1: Agriculture, forestry, and fishing; A2: Mining and quarrying; A3: Manufacturing; A4: Electricity, gas, steam, and air conditioning supply; A5: Water supply, sewerage, waste management, and remediation activities; A6: Construction; A7: Wholesale and retail trade; repair of motor vehicles and motorcycles; A8: Transportation and storage; A9: Accommodation and food service activities; A10: Information and communication (IT and telecommunications sector); A11: Financial and insurance activities; A12: Real estate activities; A13: Professional, scientific, and technical activities; A14: Administrative and support service activities; A15: Public administration and defense; A16: Education; A17: Human health and social work activities; A18: Arts, entertainment, and recreation; A19: Activities of households as employers.*

***Source:*** *Own compilation in 2025.*

The items were grouped into four factors, each demonstrating acceptable to good internal consistency, as indicated by their Cronbach's alpha coefficients: Factor 1 ($\alpha = 0.924$), Factor 2 ($\alpha = 0.819$), Factor 3 ($\alpha = 0.81$), and Factor 4 ($\alpha = 0.699$) (Taber, 2018; Cortina, 1993). Table 2 presents the factor structure underlying the assessment of blockchain technology's perceived usefulness across selected sectors of the Polish economy.

***Table 2.*** *Structure of the obtained factor loadings for individual variables*

| | **Factor 1** | **Factor 2** | **Factor 3** | **Factor 4** |
|---|---|---|---|---|
| **A8** | 0.926 | | | |
| **A10** | 0.857 | | | |
| **A7** | 0.813 | | | |
| **A12** | 0.810 | | | |
| **A11** | 0.759 | | | |
| **A13** | 0.664 | | | |
| **A3** | 0.663 | | | |
| **A4** | 0.625 | | | |
| **A14** | 0.500 | | | |
| **A9** | 0.447 | | | |
| **A2** | | 0.902 | | |
| **A1** | | 0.795 | | |
| **A5** | | 0.585 | | |
| **A6** | | 0.414 | | |
| **A15** | | | 0.725 | |
| **A17** | | | 0.621 | |
| **A16** | | | 0.529 | |
| **A19** | | | | 0.705 |
| **A18** | | | | 0.658 |

***Source:*** *Own compilation in 2025.*

Exploratory factor analysis was performed using polychoric correlations, with factor extraction based on the minimum residual factor analysis method (MRFA). Parallel analysis was applied to determine the number of factors, and an oblique cluster rotation was used to allow for potential correlations between factors. Data analysis was conducted using the JASP software (JASP, 2025).

Items with factor loadings below 0.41 or with significant cross-loadings on multiple factors were excluded from the final model (see Table 2). A factor loading above 0.41 is considered an acceptable threshold for inclusion (Stevens, 2012). The final factor structure included four factors, which together explained 64.6% of the total variance (Table 3).

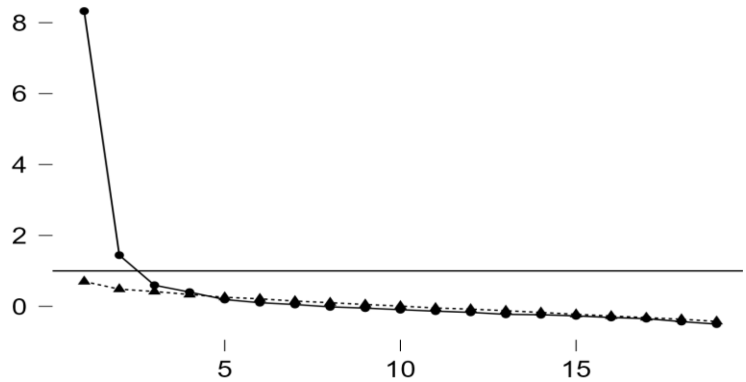
***Table 3.*** *Characteristics of the obtained factors*

| **Factor / indicator** | **Sum of squared loadings** | **Percentage of variance** | **Cumulative variance** |
|---|---|---|---|
| Factor 1 | 5.958 | 0.314 | 0.314 |
| Factor 2 | 2.564 | 0.135 | 0.449 |
| Factor 3 | 2.275 | 0.120 | 0.568 |
| Factor 4 | 1.474 | 0.078 | 0.646 |

***Source:*** *Own compilation in 2025.*

Figure 1 presents the scree plot of the final eigenvalues corresponding to the factors explaining the variance in the perceived usefulness of blockchain technology across selected sectors of the Polish economy, following the exclusion of statistically insignificant variables.

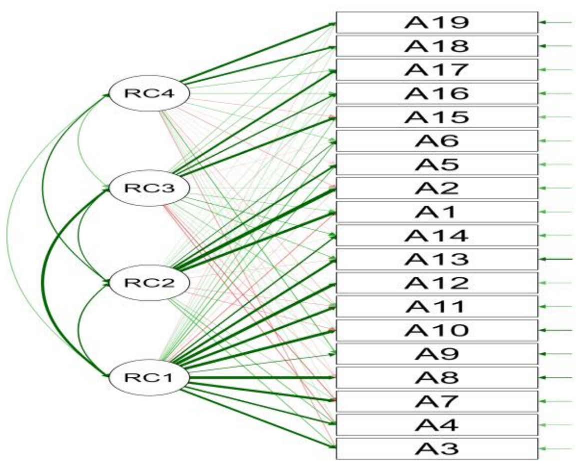
***Figure. 1.*** *Scree plot presenting the eigenvalues of the factors*




***Note:*** *analyzed data, simulated data for parallel analysis.*
***Source:*** *Own compilation in 2025.*

The Kaiser-Meyer-Olkin test confirmed the adequacy of the data for conducting exploratory factor analysis (KMO = 0.914), indicating excellent sampling adequacy (Yong and Pearce, 2013). The extracted factors were as follows: RC1 – factor 1 (digital and financial services), RC2 – factor 2 (industrial and infrastructural sector), RC3 – factor 3 (public and administrative sector), and RC4 – factor 4 (consumer and service sector) (Figure 2).

***Figure 2.*** *Path diagram of the exploratory factor analysis for the questionnaire assessing the perceived benefits of blockchain implementation across individual economic sectors (N = 202).*



***Notes:*** *Description of individual items – selected economic sectors:**
*A1: Agriculture, forestry, and fishing; A2: Mining and quarrying; A3: Manufacturing; A4: Electricity, gas, steam, and air conditioning supply; A5: Water supply, sewerage, waste management, and remediation activities; A6: Construction; A7: Wholesale and retail trade; repair of motor vehicles and motorcycles; A8: Transportation and storage; A9: Accommodation and food service activities; A10: Information and communication (IT and telecommunications sector); A11: Financial and insurance activities; A12: Real estate activities; A13: Professional, scientific, and technical activities; A14: Administrative and support service activities; A15: Public administration and defense; A16: Education; A17: Human health and social work activities; A18: Arts, entertainment, and recreation; A19: Activities of households as employers.*
***Source:*** *Own compilation in 2025.*

As shown in Table 3, the sum of squared loadings for all factors exceeded 1, indicating a strong underlying structure and suggesting that participants were able to recognize the significance of blockchain-related benefits. Given the satisfactory fit of the model identified through exploratory factor analysis (EFA), alternative models were not tested.

The first factor (RC1) accounted for approximately 31.4% of the total variance and included the following sectors: administrative and support service activities (A14); professional, scientific and technical activities (A13); real estate activities (A12); financial and insurance activities (A11); information and communication (IT and telecommunications sector) (A10); accommodation and food service activities (A9); transportation and storage (A8); wholesale and retail trade; repair of motor vehicles and motorcycles (A7); electricity, gas, steam and air conditioning supply (A4); and manufacturing (A3).

The second factor (RC2) explained approximately 13.5% of the variance and comprised the following sectors: mining and quarrying (A2); agriculture, forestry and fishing (A1); water supply; sewerage, waste management and remediation activities (A5); and construction (A6).

The third factor (RC3) represented approximately 12% of the total variance and included: public administration and national defense (A15); education (A16); and healthcare and social assistance (A17).

The fourth factor (RC4) explained about 7.8% of the variance and encompassed sectors such as culture, entertainment, and recreation (A18) as well as the activities of households as employers (A19).

## 5. Literature Review and Discussion

The existing literature predominantly explores the benefits of blockchain technology, with particular emphasis on its perceived usefulness with individual industries or sectors. However, there is a noticeable gap in comprehensive studies that examine this issue across the full spectrum of economic activities. Consequently, the findings of the present study will be contextualized through comparisons with other analyses that are likewise segmented by specific sectors.

One of the most frequently examined applications of blockchain technology is its use in the financial sector and the broader Fintech industry. In the present study, this area received one of the highest ratings for perceived usefulness, with an average score of approximately 8.3. The primary advantage identified was the high level of data privacy and security that blockchain systems can provide.

While prior research suggests that the adoption of new financial technologies may be hindered by user inertia, reliance on legacy systems (Raddatz, Nirmalee *et al.,* 2023), or limited understanding and negative associations with cryptocurrencies (Oates, Roodt and Mulaji, 2024), the overall perception of blockchain in this context remains largely positive

The perceived usefulness of blockchain technology in the public sector—particularly in public administration—was rated relatively high in the present study, with an average score of approximately 7.6. This result is consistent with findings by Kowalczyk and Napiecka (2023), who examined the views of local government employees at various administrative levels in Poland.

Previous studies have also emphasized that the implementation of blockchain in public administration may contribute to strengthening public trust in government institutions (Cagigas *et al.,* 2022). One promising application in this domain is blockchain-based electronic voting (e-voting), where favorable perceptions are linked to factors such as ease of use, perceived usefulness, technological trust, and a heightened sense of security (Mannonov and Myeong, 2024).

Respondents in the present study perceived the usefulness of blockchain technology in the education sector as comparatively lower, with an average rating of approximately 6.7. Nevertheless, existing literature highlights several potential applications of blockchain in this domain.

For instance, Shuhaimi, Awang, Al-Mashhadani, Jafar, and Mansor (2025) investigated the adoption of blockchain-based tools in the development of school-based assessment programs through a survey conducted among teachers. Although certain concerns were noted, the overall perception of blockchain in the educational context remained generally positive.

In the healthcare sector, respondents rated blockchain technology as moderately useful, with an average score of approximately 7. Similar conclusions are reflected in the literature. While physicians tend to express more optimism about the application of blockchain in medicine compared to the general public, the assessment of its usefulness in hospital settings remains mixed (Hau *et al.,* 2023).

Several barriers to implementation may contribute to this ambivalence, including limited IT competencies among staff, the absence of standardized frameworks for patient data management, a lack of defined blockchain integration strategies, and insufficient institutional support from hospital administrations (Prashar and Sunder, 2024). A noteworthy application of blockchain in this context is the management and verification of professional licenses—a need emphasized by Hasselgren *et al.* (2021) in a study involving healthcare professionals in Norway.

Respondents identified a relatively high potential for the application of blockchain technology in the logistics sector—specifically in transportation and warehousing—with an average rating of approximately 7.7. This sector is frequently cited in the literature as a key area for blockchain implementation. The considerable scope for its use is supported by empirical research; for instance, Nazet and Kuciapski (2022), based on in-depth interviews with value chain experts, emphasize the significant role blockchain can play in the development of digital supply chains.

The usefulness of blockchain technology in the hospitality and catering industry was rated moderately positively by respondents, with an average score of approximately 6.7. However, the literature presents a more nuanced view. While blockchain has the potential to improve service quality and positively affect customer satisfaction, its impact on trust, perceived security, and privacy within the industry remains ambiguous (Rodríguez Bolívar, 2024).

More broadly, within the wider service sector, the perceived usefulness of blockchain is often associated with its influence on information quality, mass customization, service quality, supply reliability, and customer relationship management (Karamchandani, Amit, Srivastava, and Srivastava, 2020).

It is also noteworthy that the perceived usefulness of blockchain technology in the agricultural sector received a relatively low assessment, with an average rating of approximately 4.9—the lowest among all examined industries. Comparable findings are reported by Balzarova, Dyer, and Falty (2022) in their study on blockchain applications within Fair Trade programs.

Although the theoretical potential for blockchain use in this context appears substantial, and its capabilities align closely with the core principles of Fair Trade, its practical applicability is evaluated as limited.

## 6. Conclusions, Proposals, Recommendations

Blockchain technology represents a transformative innovation capable of enhancing transparency, security, and efficiency within production processes across diverse economic sectors (Ajwani-Ramchandani *et al.,* 2021; Carson *et al.,* 2018; Wiśniewska, 2020; Bendarag, 2022; Müller and Seifert, 2019). The results of the exploratory factor analysis conducted in this study reveal four principal factors that characterize the perceived benefits associated with blockchain implementation, contingent upon the classification of economic activities.

The first factor, RC1, predominantly encompasses sectors such as finance, administration, information technology, and logistics. These sectors are typified by intensive document circulation, elevated risks of fraud, and a critical need for enhanced transparency. Consequently, RC1 is strongly associated with data security and protection. This factor reflects a prevailing perception of blockchain as an innovative technology, although its relevance appears confined primarily to specific sectors.

The second factor includes sectors such as mining and extraction, water supply, sewage and waste management, and construction. Within this grouping, blockchain is regarded as potentially beneficial; however, its practical adoption is perceived to necessitate substantial regulatory reforms. This is particularly pertinent as most of these sectors, except construction, operate under considerable state control.

Additionally, sector A1 (agriculture, forestry, and fishing) is characterized by a predominance of low-skilled labor and a developmental trajectory that is heavily reliant on investment in research and education, posing potential challenges for adapting to new technologies.

According to the literature review outlined in the introduction, sectors encompassed by factor RC3—namely public administration and national defense, education, and healthcare and social assistance—exhibit potential applications for blockchain technology in domains such as medical certification, patient record management, and intellectual property registries. Nevertheless, respondents generally opine that the adoption of blockchain in these sectors is unlikely to yield substantial benefits in the near term.

The fourth factor, RC4, includes sectors such as culture, entertainment and recreation, and household activities as employers. These sectors are characterized by lower levels of digitalization, with daily operations that do not necessitate blockchain integration. Consequently, blockchain adoption in these areas is expected to be gradual. Similar to factor RC3, respondents perceive blockchain as having limited utility within these sectors.

As highlighted in the literature review, economic activities that successfully implement blockchain systems benefit from network effects and operational efficiencies. Conversely, other sectors may encounter barriers to integration due to high implementation costs or the absence of standardized protocols.

This divergence risks market fragmentation, whereby different sectors and companies develop incompatible blockchain solutions. Such fragmentation poses a significant threat to the Polish economy by undermining potential synergies and marginalizing firms that do not adopt blockchain technology, thereby diminishing their competitiveness.

Respondents' assessments of blockchain's benefits in the Polish economy vary considerably. In sectors characterized by lower digital maturity (factors RC2, RC3, and RC4), blockchain is regarded as only moderately or minimally necessary. This uneven perception risks confining blockchain adoption to select economic activities, which, in the long term, may impair Poland's investment attractiveness and limit opportunities to capitalize on cutting-edge blockchain-based innovations.

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