

Perceptions of the use of the Internet of Things in Banking: The Perspective of Students in Poland

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Abstract: The main objective of the article was to identify the perception of the use of Internet of Things technology in banking from the perspective of young people. The survey was conducted in 2025 using the CAWI method at the Faculty of Management of the University of Warsaw and covered 205 students. The survey form was divided into two parts. The first part examined the general perception of IoT technology. The second part focused on examining the perception of this technology in banking applications. The key conclusions include: respondents are concerned about the security of their data and, in the case of banking applications, financial losses as a result of data leaks and loss of privacy to government agencies. Data analysis aimed at improving the personalization of products and services are the main areas of IoT use in banking. They perceive the usefulness of speeding up the payment process as important. In addition, it can be concluded that there is a high level of knowledge about IoT technology. Theoretical implications include recognizing the use of Internet of Things technology in banking among young people in Poland and outlining how to study this phenomenon. Practical implications will be important for banks and financial institutions that use or plan to use IoT in their products and services. The limitation of the study was that the survey was conducted only among the academic community. Further research should focus on expanding the scope of the study to include a larger number of academic centres and deepening the understanding of the determinants of the use of Internet of Things technologies in banking in the context of knowledge management.

Keywords: Internet of Things (IoT), CAWI, Electronic banking, Technology acceptance, Perceived risk, Knowledge management

1. Introduction

Modern financial institutions, including banks, are increasingly using innovative technological solutions to enhance the efficiency of their services. The implementation of innovations is also becoming a key factor in building a competitive advantage. The development of information technologies used by both banks and their customers enables the collection of large amounts of data. It is important to note that data collection is increasingly taking place in real time. This data can be used to better understand changing needs and identify the behaviour of bank customers. By utilizing data obtained through solutions based on Internet of Things (IoT) technology, it is possible, for example, to create more personalized financial offers. IoT-based solutions can also support the automation of many operational processes in banking. Automation contributes to increasing the efficiency of financial institutions and reducing operating costs. Another important aspect of IoT technology is the ability to improve customer service quality through the use of modern analytical tools. This technology can also support the development of new communication channels between the bank and the customer. Another aspect of IoT technology in banking is the security of financial services. Systems that utilize IoT can help detect irregularities and potential financial fraud. The collection of large amounts of data is an integral part of using IoT technology. Banks are aware of the need to implement solutions related to the protection of this data. A concern related to the collection of customer data is customers' apprehension about the purpose for which this data is used. This issue is addressed in a number of academic articles on the application of IoT technology. Research on the application of IoT allows for a better understanding of both the benefits and the risks associated with its implementation. An analysis of this issue can support strategic decision-making in financial institutions. Research findings can be helpful in planning investments in modern technologies. It is also important to examine the impact of IoT technology on the evolution of existing business models or the development of new ones in banking. This technology can contribute to the creation of innovative financial services. Research on the use of IoT also allows for the identification of potential directions for the future development of banking. Consequently, analysis of this area is important both from a scientific perspective and for the practical functioning of the financial sector.

Although banking and finance are traditionally associated with digital data, risk analysis, and capital management, the integration of IoT introduces a whole new dimension—physical data sources are becoming an integral part of the processes of generating, processing, and applying knowledge. As a result, financial institutions are transforming into knowledge-based organizations in an even more dynamic, contextual, and predictive manner (Atzori et al., 2010) (Porter & Heppelmann, n.d.). The basis of this phenomenon is data generation by IoT devices. In a financial context, this may include data on customer behaviour, their location, how they use products, or even their lifestyle (Vermesan et al., n.d.). The next stage of data utilization involves

processing, which consists of filtering, integration, and analysis. Financial institutions use advanced analytical tools, including artificial intelligence and machine learning, to transform raw data into useful knowledge (Chen et al., 2014). The organizational knowledge generated in this way should be applied in business practice. In the broader picture, it is evident that financial institutions use knowledge derived from the IoT to make operational and strategic decisions and to personalize services (Dong & McIntyre, 2014). It is also worth noting the organizational aspect. The use of IoT in knowledge management processes requires a cultural shift within the organization

These considerations led to the formulation of the following research question: How does the younger generation in Poland perceive the widespread use of Internet of Things (IoT) technology in banking? The primary research objective of this article is to examine awareness of the use of IoT technology in banking among young people in Poland.

The article is divided into five main sections: introduction, literature review, research methodology, discussion of results, and conclusion. The introduction describes the research problem, presents key aspects of the Internet of Things, formulates the research question and the purpose of the study, and outlines its structure. The literature review section includes a discussion of previous research on the perception of Internet of Things technologies, with particular emphasis on the banking sector. The methodology section presents the research procedure, describes the survey questionnaire used, and characterizes the research sample. The fourth section presents and discusses the research findings, comparing them with results obtained by other authors. The summary covers the most important conclusions drawn from the analysis, describes the limitations of the study, and indicates possibilities for the practical and theoretical application of the results. Finally, suggestions for further research directions are presented.

This article contributes to the existing literature on the implementation of IoT in banking. Furthermore, it is part of the author's long-term research on the perception of information technologies, which examines changes in the preferences of current or future users. These include, among others: the general perception of the quality of banking services available through electronic channels(Zborowski & Chmielarz, 2023) and security(Zborowski, 2025c), electronic payments(Chmielarz et al., 2021) and the recognition of cryptocurrencies(Zborowski, 2025b).

2. Literature Review

The primary objective of this article is to examine how young people perceive the use of Internet of Things (IoT) technologies in banking; therefore, it is important to review the current state of research on this topic.

In their article, Yilmaz et al.(Hazar & Yilmaz, 2019) present a study conducted among students majoring in accounting and finance. The study showed that perceptions of ease of use and usefulness have a positive impact on the intention to use a given technology. In their research conducted on customers of Indian banks, Almugari et al.(Almugari et al., 2020) analysed the factors influencing the adoption of IoT. The authors considered factors such as: awareness; privacy and security; cost; convenience; social influence; and habits. They demonstrated that: convenience, social influence, privacy and security, and awareness had a significant positive impact on IoT adoption in banks, while cost and habits were not significant. Singh et al.(Singh & Msibi, 2021) in their survey research conducted with students, sought to identify factors influencing the adoption of IoT devices and/or applications for individual use. Their study considered factors such as: education, work, security, and health. The study's results indicate that attitudes toward usability, ease of use, and user satisfaction positively influence the intention to use IoT and the actual adoption of these solutions, while affordability, basic knowledge of the technology, security concerns, and Internet access also influence the behaviour of users and non-users of these solutions. In their study involving students from a Malaysian university, Amy et al.(Amy et al., 2020) used a self-developed questionnaire to investigate intentions to adopt IoT technology. Their research focused on factors such as perceived benefits, digital mindset, technological motivation, barriers to technology adoption, attitude, and trust. The study found that attitude, technological motivation, and digital mindset have a significant impact on the intention to adopt IoT. Lonescu-Feleaga et al.(Lonescu-Feleaga et al., 2021), in their study involving economics students from four Romanian universities, examined the factors influencing the acceptance of IoT technology. The results of the study showed that students are willing to accept IoT technology and implement it in their future professional work. Additionally, the study found that individuals trained in the use of IoT technology tend to perceive products utilizing it as useful and easy to use. Tin(Tin et al., 2025), in his study involving students in Malaysia on IoT technology acceptance, utilized a set of core factors from the TAM model. He also included factors such as perceived usefulness, perceived ease of use, perceived security awareness, and perceived satisfaction. The results demonstrate the key role of perceived usefulness, ease of use, satisfaction, and security awareness in influencing user behaviour and their intentions toward IoT devices. Sim et al.(Liew et

al., 2017) used a similar research group in their study. They demonstrated that the dimension of perceived usefulness is the factor with the greatest influence on the acceptance of IoT technology. In their study conducted in Pakistan, Muhammad et al. (Muhammad et al., 2025) examined the level of acceptance of IoT technology among students. The results highlight the need to improve IoT infrastructure, incorporate IoT courses into the academic curriculum, and create an environment conducive to the successful implementation of the technology. Negm's (Negm, 2022) research on students' perceptions of IoT technology showed that an individual's level of technological optimism, discomfort, and uncertainty influences their intention to adopt IoT products and services for online learning. The psychological motivator, namely innovation, is irrelevant. Paško et al. (Paško et al., 2022) in their study, they focused on surveying students who assessed their own knowledge and skills in the areas of IoT, artificial intelligence, and e-commerce. The results obtained revealed the students' level of knowledge regarding these solutions, which can serve as a source of knowledge for industry. Khalifa et al. (Khalifa et al., 2024) emphasized the importance of knowledge management in modern organizations in their research. They highlighted the role of the Internet of Things (IoT) in streamlining knowledge management processes, such as creating, organizing, sharing, and utilizing knowledge, which leads to improved quality of services provided by these institutions. The study's results show that information institutions effectively use IoT applications to track physical and intangible assets on their premises. Chen ("The Teaching Model of Integrating Professional, Entrepreneurial, and Smart Education in Accounting," 2025) analysed accounting programs at applied universities. He examined the internal implications and elements of digital intelligence associated with integrating education in innovation and entrepreneurship with vocational training. He proposed a teaching model characterized by "collaboration between the university and the business, triple helix integration, and synergy between competition and training": through collaboration with businesses to create a smart training platform in finance. Jasmani et al. (Jasmani et al., 2024) in their survey involving 121 respondents, assessed these students' perceptions of various factors influencing the integration of IoT with accounting practices. The study provided insight into how the implementation of IoT among future accountants can help transform the accounting industry. Key findings indicated that perceived usefulness has a significant and positive impact on the behavioural intentions of future accountants, suggesting that they are more likely to adopt IoT if they perceive it as useful.

The cited literature shows that there are many studies on the acceptance of IoT technology among students. Most of them focus on identifying factors that may make students more likely to start using this technology. Unfortunately, there are few studies describing young people's perceptions of the use of IoT technology in banking. Furthermore, there are few studies in the literature conducted among business administration students. This group is of interest due to the nature of the work they will perform in the future. These are the individuals who will assume managerial positions. They will influence the implementation of various technologies, including IoT, both within organizations and externally as products incorporating this technology. This article fills that research gap.

The literature review indicates that understanding young people's perceptions of the use of Internet of Things (IoT) technology in banking is a broad phenomenon that requires a focus on various factors. Based on the literature review and the author's experience in researching perceptions of various information technologies (Sołtysik-Piorunkiewicz et al., 2025), the scope of the study was formulated. The study should examine: the sources from which respondents obtain knowledge about the technology in question, the financial risks to customers arising from the use of technology in banking, the areas where the technology is used in banking, the limitations, the benefits for the bank, and the drawbacks and risks associated with the use of IoT technology.

3. Research Procedure

Drawing on previous studies on the perception of information technology (Zborowski, 2025a), (Zborowski, 2025b) use, the research procedure adopted consisted of the following sequential stages:

- a literature review of the latest sources on the perception of new technologies, particularly the Internet of Things,
- development of a pilot version of the survey questionnaire to verify the accuracy and clarity of the questions,
- development and refinement of the survey questionnaire prototype based on the above assessment, followed by the creation of the final version of the questionnaire,
- conducting the survey using the CAWI (Computer-Assisted Web Interview) method,
- analysing and discussing the results of the calculations and their statistics,

- drawing conclusions, identifying limitations, and outlining future research directions.

An analysis of online and academic materials, supported by expert opinions, enabled us to define the requirements for a survey on the perception of Internet of Things (IoT) technology in the context of young users' expectations. It was assumed that the survey, in addition to assessing perceptions of the topic, should also serve as a source of substantive knowledge for respondents. The survey form included questions regarding: sources of knowledge about Internet of Things (IoT) technology, known examples of technology applications, definitions, and the elements that best characterize the technology. The survey also included questions about: the properties, limitations, challenges, benefits, and risks associated with the use of devices operating on IoT technology.

The survey was conducted from March 28 to April 11, 2025. For this purpose, the dedicated LimeSurvey platform, hosted on the Faculty of Management's own servers at the University of Warsaw, was used. After verifying the received survey results, 205 responses were included in the analysis. The collected results were averaged. MS Excel and MS Power BI software were used to analyse the results. Based on the results obtained, they were interpreted and conclusions were drawn.

4. Characteristics of the Research Sample

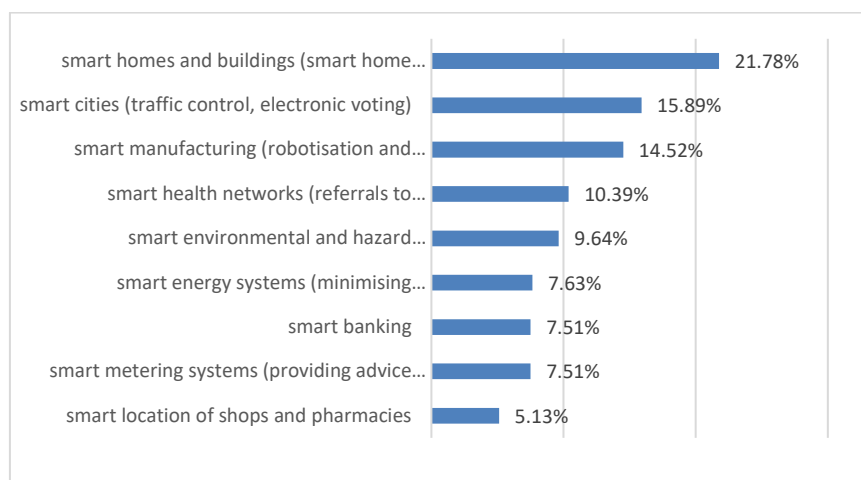
The research sample included 205 students from the Faculty of Management at the University of Warsaw. Women accounted for a significant proportion of the total respondents (63%), while men accounted for only 37%. Virtually all respondents (99%) were young people aged 19–24, 88% of whom had completed a bachelor's degree. Slightly more than half of the respondents, i.e., nearly 55%, came from large cities with over 200,000 residents. 25% came from rural areas, and the remaining 20% from cities with populations ranging from 21,000 to 200,000. Well over half (58%) of the survey participants described their financial situation as good, and 23% as very good. Those describing their situation as average or poor accounted for a combined 18%. The distribution of the respondents' employment status showed that over half (52%) were solely students, while nearly 36% had part-time or full-time jobs.

The study sample consisted of students. It should be noted that this group is not representative of the entire population of young people in Poland, but these individuals are highly active online and are the most open to innovation, particularly technological innovation.

5. Presentation of the Research Results

The first part of the survey examined general perceptions of Internet of Things (IoT) technology. Questions regarding the use of this technology in banking were included in the second part of the survey. The breakdown of responses to the questions in both groups is presented below.

Regarding awareness of IoT technology, respondents were asked about the areas where the Internet of Things concept is most commonly observed today. The distribution of responses to this question is shown in Figure 1. For this question, respondents could select multiple answers.

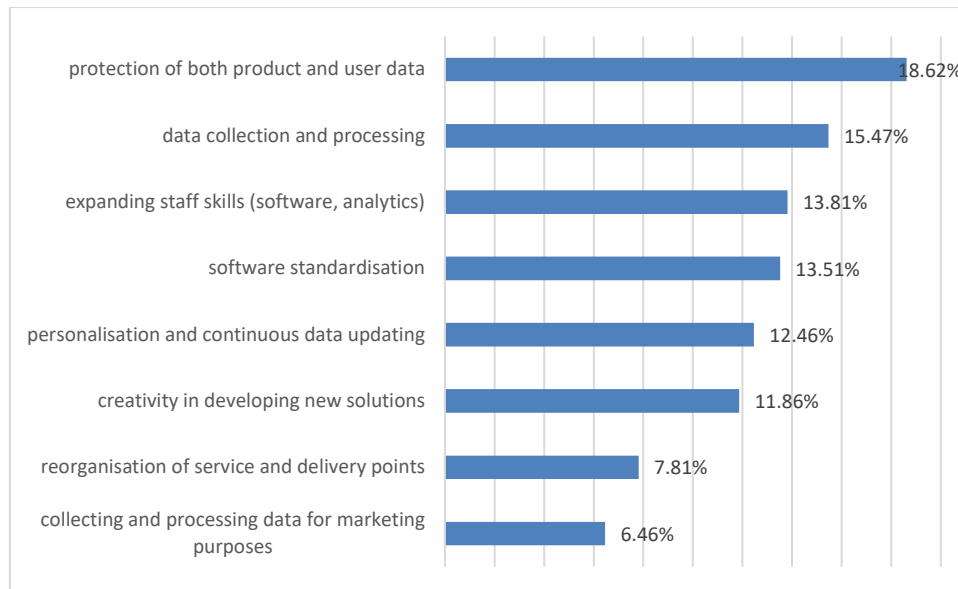


Source: Own work based on questionnaire

Figure 1: Areas of application for Internet of Things technology, according to respondents

Referring to Figure 1, it can be seen that the most frequently selected response (21,78%) is “*smart homes and buildings (smart home energy and security systems)*”, followed by “*smart cities (traffic control, electronic voting)*” at 15,89%. The least frequently selected answer was “*smart location of stores and pharmacies*” (5,13%). It is worth noting that “*smart banking*” accounted for only 7,51%.

Among the challenges facing the widespread adoption of the Internet of Things concept, respondents primarily pointed to security. Respondents could select multiple answers, the distribution of which is presented in Figure 2.

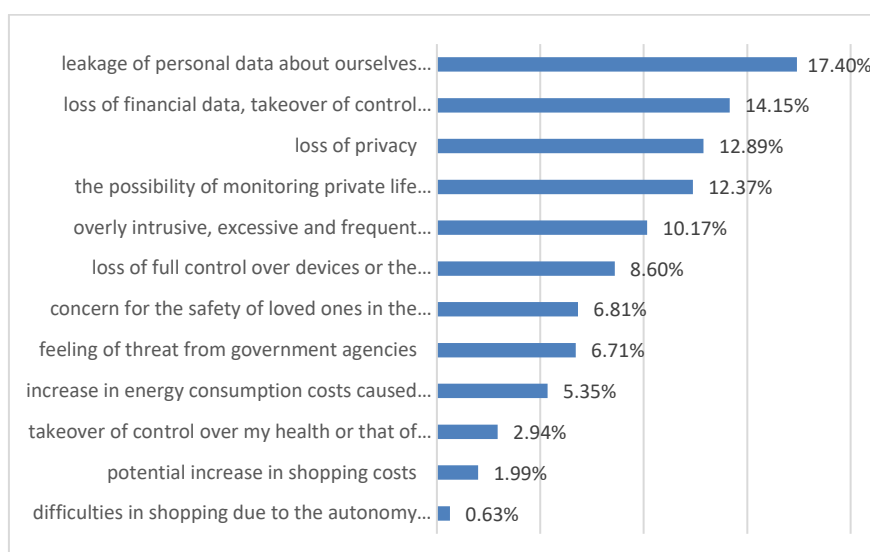


Source: Own work based on questionnaire

Figure 2: The significance of the challenges facing the widespread adoption of the Internet of Things

With reference to Figure 2, it should be noted that respondents identified “*protecting data related to both the product and the user*” (18,62%) as the greatest challenge to popularizing the concept of the Internet of Things. The least significant challenge was “*collecting and processing data for marketing*” (6,46%).

In the question regarding risks associated with the use of the Internet of Things, respondents highlighted security-related risks. Respondents could select multiple answers, the distribution of which is presented in Figure 3.

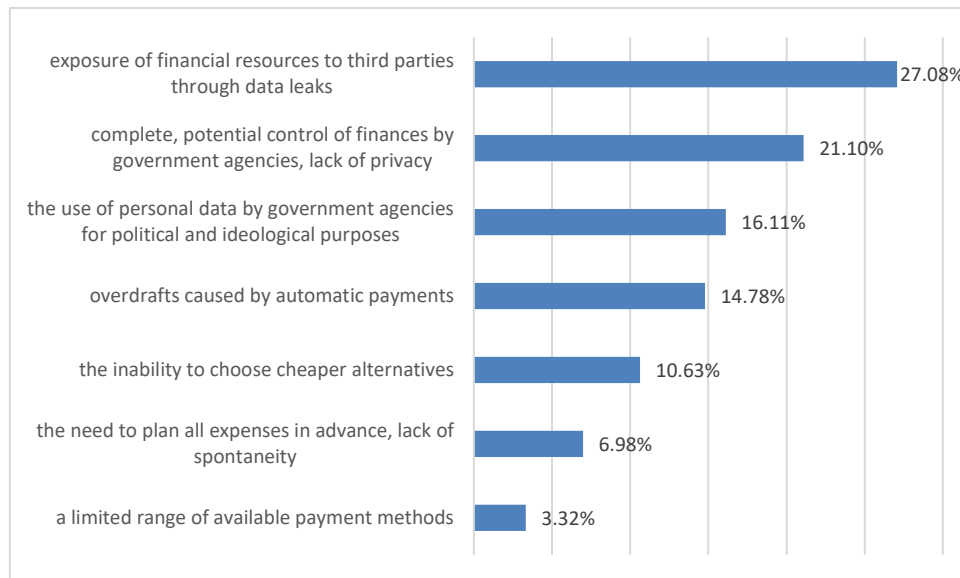


Source: Own work based on questionnaire

Figure 3: Risks associated with the widespread use of the Internet of Things, according to respondents

Referring to the data presented in Figure 3, it can be seen that the most frequently selected response was *“leakage of personal data about oneself and loved ones”* (17.40%). The next two most frequently selected responses were: *“loss of financial data, others taking control of our finances”* (14.15%) and *“loss of privacy”* (12.89%). The threat that respondents consider least significant is *“difficulties with online shopping due to the autonomy of software that places orders online”* (0.63%).

The next question examined the financial risks respondents fear regarding the use of IoT in banks. Respondents could select multiple answers, the distribution of which is presented in Figure 4.

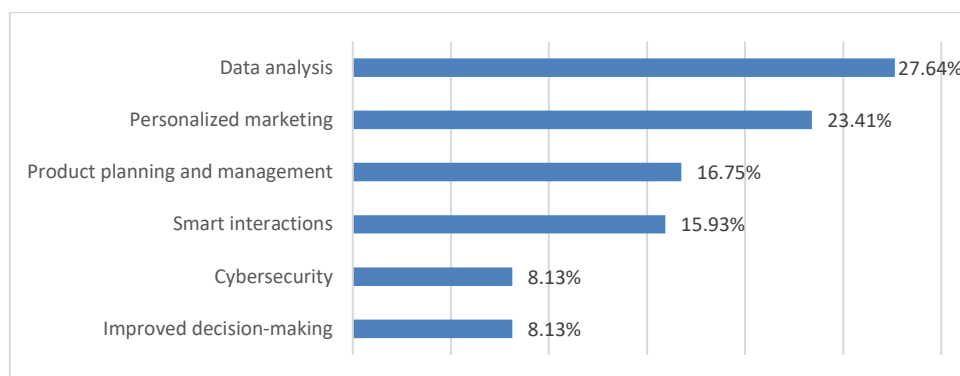


Source: Own work based on questionnaire

Figure 4: Financial risks associated with the use of IoT in banks, according to respondents

Referring to the data presented in Figure 4, it can be seen that the majority of respondents (27.08%) fear that their financial resources could be exposed to third parties through data breaches, as well as the potential for government agencies to gain complete control over their finances and a lack of privacy (21.10%). The third-largest concern is the use of personal data by government agencies for political and ideological purposes (16.11%).

Next, the study examined in which areas of the bank's operations the Internet of Things will be used most extensively. Respondents could select three answer options, the distribution of which is presented in Figure 5.



Source: Own work based on questionnaire

Figure 5: Areas of the bank's operations where the Internet of Things will be used most extensively

Based on the data presented in Figure 5, it can be seen that there are three groups of responses. The areas of the bank's operations where, according to respondents, IoT technology will see the strongest growth are: *Data Analysis* (27.64%) and *Personalized Marketing* (23.41%). Less significant were: *Product planning and management* and *Smart interactions*, at around 16.75% each. The least significant were: *Improved decision-making* and *Cybersecurity*, at exactly 8.13% each.

The next question concerned identifying areas where Internet of Things solutions could be applied in a bank. Respondents could select three answer options, the breakdown of which is presented in Table 1.

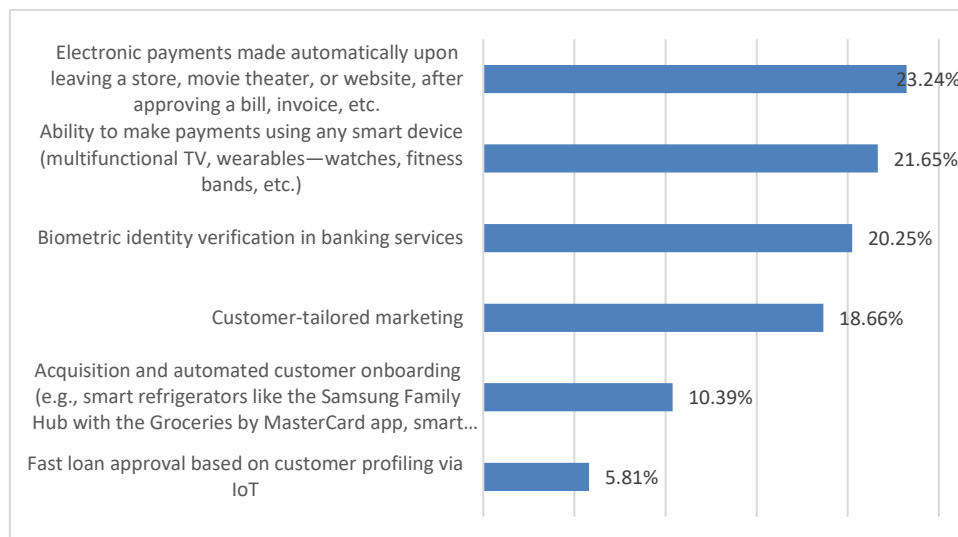
Table 1: Areas where the Internet of Things can be applied in a bank

Answers	Percentage
Data analysis helps understand customers and modify existing products	14,59%
The Internet of Things can help banks and financial institutions collect real-time customer data and analyze it	14,03%
Personalizing services and products helps attract and retain bank customers	12,06%
Collecting customer data helps banks and financial institutions identify customer needs and concerns	11,78%
Financial organizations can use smart interactive solutions, such as chatbots or apps—for example, in online banking—to assist customers anytime, anywhere	9,40%
Cybersecurity—by leveraging the Internet of Things, financial institutions can ensure safer and easier user identity verification	9,26%
Data analysis helps understand the value chain, from distributors and suppliers to retailers, which can enable banks to introduce new services	8,98%
With data from the Internet of Things, banks can develop robust strategies for managing their products	7,01%
By analysing customer data from the Internet of Things, banks can gain more of the information needed to shape organizational strategy	5,61%
With data from the Internet of Things, banks can increase product profitability	5,19%
With data from the Internet of Things, banks can protect organizational data	2,10%

Source: Own work based on questionnaire

The data presented in Table 1 suggest that, according to respondents, the IoT will enable data analysis that helps understand customers and modify existing products (14.59%) and will help banks and financial institutions collect real-time customer data and analyse it (14.03%). Slightly less important was the use of IoT to personalize services and products, which helps attract and retain bank customers (12.06%). The least important, according to respondents, would be the use of this technology to protect data held by the organization (2.10%).

Next, survey participants were asked about the benefits for individual customers of using IoT in online banking. Respondents could select multiple answers, the distribution of which is shown in Figure 6.



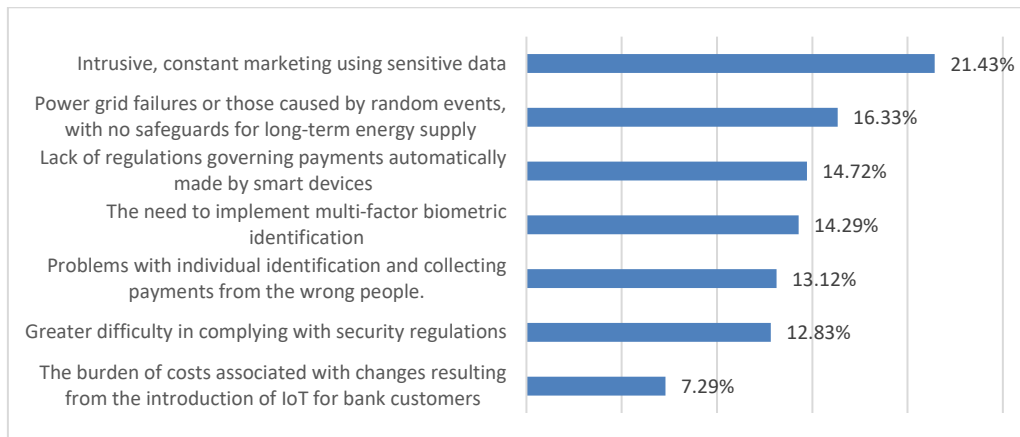
Source: Own work based on questionnaire

Figure 6: Benefits for individual customers of IoT applications in online banking

With regard to the data presented in Figure 6, respondents believe that the most important benefits of using IoT technology in online banking include: electronic payments made automatically upon leaving a store, movie theatre, or website, after approving a bill, invoice, etc. (23.24%), the ability to make payments using any smart device (smart TV, wearables—watches, wristbands, etc.) 21.65%, and biometric identity verification in banking

services 20.25%. The least significant benefit was the rapid granting of loans based on customer profiling via IoT 5.81%.

In the next question, respondents were asked to identify the disadvantages of using IoT in online banking. Respondents could select multiple answers, the distribution of which is presented in Figure 7.

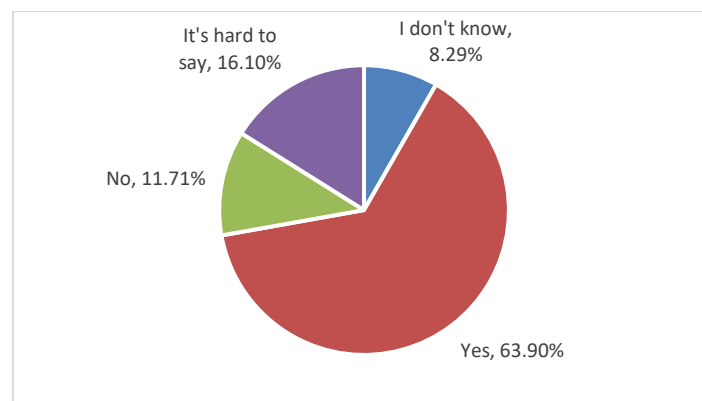


Source: Own work based on questionnaire

Figure 7: The drawbacks of IoT applications in online banking from the perspective of individual customers

Referring to the data presented in Figure 7, the response structure clearly shows that the dominant response was “Intrusive, constant marketing using sensitive data” (21.43%). The next two were: power grid failures or those caused by random events, with a lack of safeguards in the long-term energy supply (16.33%), and the lack of regulations governing payments automatically made by smart devices (14.72%). The least significant drawback was the cost burden associated with changes related to the introduction of IoT for bank customers (7.29%).

The next question concerned the projected increase in banks’ spending on the implementation of Internet of Things technology. The distribution of responses is presented in Figure 8.

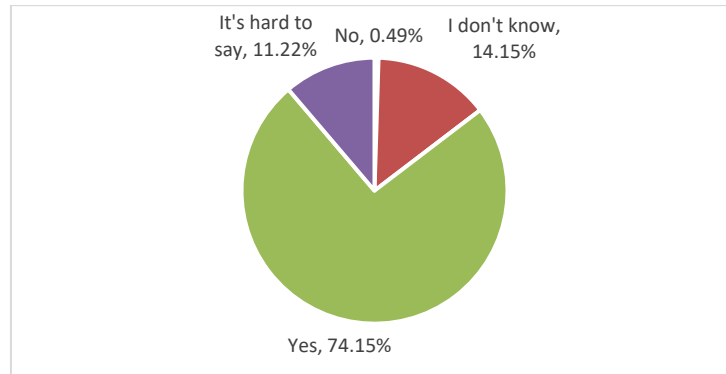


Source: Own work based on questionnaire

Figure 8: Projected increase in banks' spending on Internet of Things technology investments

Referring to the data presented in Figure 8, it is clear that more than half (63.90%) of the respondents indicated that these expenses will increase. Only 11.71% stated that this will not be the case.

Next, respondents were asked about the potential of the Internet of Things in banking as an incubator for new solutions. The distribution of responses is shown in Figure 9.



Source: Own work based on questionnaire

Figure 9: The use of Internet of Things solutions in banking can serve as an incubator for new solutions

Based on the data presented in Figure 9, it can be said that the positive attitude toward the use of IoT is even more pronounced than in response to the previous question. In this case, as many as 74.15% of respondents expressed a positive view, while only 0.49% expressed a negative one.

6. Discussion of Results

Respondents indicated that IoT technology is primarily used in smart home solutions, particularly for energy management and security support. This response aligned with another related to the challenges facing this technology, where the most frequently selected answer was the protection of data concerning both the product and the user. In the area of risks, the security aspect, including data security, was also dominant. Respondents indicated that they fear the leakage of personal data about themselves and their loved ones. The results obtained are consistent with a series of studies conducted in various countries on the acceptance of IoT technology, indicating that ensuring user data does not leak is crucial.

Research on perceptions of the use of Internet of Things (IoT) technology in banking has revealed the following picture. At the same time, it is difficult to relate these findings to the existing literature, as such literature is practically non-existent. Regarding financial risks associated with the use of IoT in banking, according to respondents: the disclosure of financial resources to third parties through data breaches, the potential for government agencies to gain complete control over finances, and the lack of privacy are the greatest threats. The responses indicate that when using IoT technology in banking solutions, respondents still fear financial losses resulting from data leaks and the loss of privacy to government agencies. It is worth noting that even the banking system's reputation as a guarantor of the highest levels of cybersecurity and protection of its customers' interests did not alleviate respondents' concerns. Nor did it shift their concerns toward, for example, the lack of cheaper alternatives.

When asked about the areas in which banks will utilize Internet of Things (IoT) solutions, respondents correctly identified data analytics-particularly those that help understand customers and modify existing products. These findings align with the limited research on IoT applications in banking, which points to improvements in both service quality and better alignment of products with customer needs.

Regarding the benefits that the application of IoT technology in banking can bring to individual customers, respondents cited the following: electronic payments made automatically upon leaving a store, movie theatre, or website after approving a bill or invoice, and the ability to make payments using any smart device (such as a smart TV, wearables-watches, wristbands, etc.). From the responses provided, it can be concluded that the benefits respondents can achieve through the use of IoT technology in banking solutions are important to them. These responses align with general research on the acceptance of this technology, where measurable benefits are crucial for technology adoption.

When asked about the drawbacks of using IoT in banking, respondents cited the following: intrusive, constant marketing that exploits sensitive data; and power grid failures or outages caused by random events, coupled with a lack of long-term security in the energy supply. The responses indicate that respondents have a good understanding of how data collected via their IoT-enabled devices might be used. The response regarding power grid failures confirms that respondents have a solid grasp of the technical aspects of this technology. The responses align with general research on technology acceptance, including IoT, which indicates that acceptance of technology increases as knowledge about it grows.

7. Conclusion

The primary objective of this article was to examine young people's perceptions of the use of Internet of Things (IoT) technology in banking. Key findings indicate that, as with general studies on the acceptance of IoT technology, respondents are concerned about the security of their data in the event of financial losses in banking resulting from data breaches and the loss of privacy to government agencies. When it comes to the application of IoT in banking, respondents see its use in data analysis aimed at improving the personalization of products and services. The research confirmed that respondents are well aware of examples of IoT technology applications in the form of accelerating the payment process, and this is an important factor for them. Regarding the drawbacks of using the technology in question in banking, respondents indicated that they are well-acquainted with both the potential ways banks could utilize IoT and the technical aspects of how the technology operates.

The theoretical implications include identifying the use of Internet of Things (IoT) technology in banking among young people in Poland and outlining a methodology for studying this phenomenon. The practical implications will be significant for banks and other financial institutions that use or are considering the use of IoT technology in their products.

The limitations of the research described in this article include the fact that it was conducted in the academic environment of a single research centre in Poland. Additionally, the study was limited to management students, which may make it difficult to generalize the results. Further research should aim to expand the scope of the study to include a larger number of academic centres and conduct a more in-depth examination of the determinants of the widespread adoption of Internet of Things (IoT) technology in banking solutions.

Ethics Declaration: Ethical clearance was not required for the research.

AI Declaration: AI tools were not used in the creation of this paper.

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