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FUTURE ELECTORAL CHALLENGES IN POLAND: AN ANALYSIS OF PROCESSES AND VOTER TURNOUT IN 2000-2024

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Purpose: This study analyzes the evolution of electoral processes and voter turnout in Poland (2000-2024), focusing on technological innovations to improve election efficiency, transparency, and inclusiveness. It assesses voter participation trends and key challenges to provide insights for future electoral improvements.
Design/methodology/approach: The study uses mixed methods, combining voter turnout analysis, surveys of electoral commission members, and a review of materials to evaluate procedural guidelines and member preparedness.
Findings: Voter turnout increased for parliamentary and presidential elections but remained low for European Parliament elections and referendums. Challenges include inefficiencies in vote counting, protocol preparation, and technological readiness. Innovations like automated counting and biometric authentication offer promising solutions.
Practical implications: These findings underscore the need for targeted reforms in electoral training, procedural efficiency, and technological integration. These recommendations can guide policymakers and electoral authorities to design robust and citizen-friendly election systems.
Originality/value: This study offers a comprehensive assessment of electoral processes in Poland over the past two decades by combining historical data analysis with practical insights from members of the electoral commission. The inclusion of a technological perspective provides a novel perspective, highlighting the potential of digital transformation to modernize electoral systems.
Keywords: elections, electoral processes, voting, voter turnout, elections in Poland.
Category of the paper: Research paper.

1. Introduction

A person's life involves the constant need to make choices. An example of decision making in social and political life is participation in national elections. During elections, one fulfils one's civic duty by electing from among the candidates one's representative for a given position, such as the president or a member of parliament. Election time is unique because of its importance for the future functioning of the country and mass participation of citizens, which poses many organizational challenges. The work of electoral commissions is integral to the organization of elections. It is through relevant bodies and offices that the government can organize and conduct elections.

The District Electoral Commissions (DEC), which is an organizational unit of the National Election Commission (NEC), is responsible for voting and determining its results. This includes tasks such as counting and stamping ballots, verifying the identity of the voter, keeping the polling station in order, manually counting the completed ballots, completing voting records, and delivering election materials to the relevant office. Some of the processes listed above are complex and time consuming. An example is the counting of ballots, which requires manual counting of several thousand paper ballots and can take up to several hours. In the 2023 parliamentary and senate elections, some DECs were forced to work until the early morning hours by an unexpectedly high voter turnout. There was a shortage of ballot papers at some polling stations, and long and complex voter ID verification resulted in large queues outside the polling stations.

The aim of this work is to diagnose electoral processes that are problematic and in need of improvement, which will be served by feedback obtained through a survey of people with experience working in an electoral commission. The next step was to analyze and identify their weaknesses. Finally, we discuss suggestions for technological solutions that can improve electoral processes in the future.

2. Literature Review

In academic literature on electoral processes, the theoretical context plays a key role in understanding the basic concepts and mechanisms involved in the functioning of contemporary democratic systems. Understanding democracy as a system of governance, the role of national elections as a tool for its implementation, and the organizational structures responsible for voting provide the foundation for analyses related to the impact of technological change on electoral processes. This chapter provides a starting point for a more detailed analysis of electoral practices in Poland and the world.

2.1. Democracy

The term 'democracy' can be used to describe a political system in which the affairs of the government are decided by a majority vote of all citizens. Democracy dates back to the sixth century BC and originated in ancient Athens. The particle is the precursor to democracy. People have exercised their sovereign powers. The essence of Athenian democracy was the equality of citizens before the law, access to office, common unanimity, and rule of law (Cabaj et al., 2013). A modern democratic government is one where elected representatives, chosen through free elections, exercise power. It is defined by political and civil rights such as freedom of speech, the right to vote, and participation in fair and free elections. Public officials are selected through elections and held accountable to the public (Bankowicz, 2006). The Constitution, as the supreme legal act, plays a central role in a democratic government. It outlines the structure of government, the rights and duties of citizens, and procedural regulations for authorities. In a democratic state, power is divided into three branches: legislative, executive, and judicial (Bankowicz, 2006). In Poland, legislative power is exercised by the Sejm and the Senate, which enact laws and establish legal frameworks. Executive power is held by the President and the Council of Ministers, who implement the laws passed by parliament. Judicial power is vested in courts and tribunals, which uphold, rather than shape, the law in the country (Bankowicz, 2006).

2.2. The concept of national elections

According to the Polish Language Dictionary, an election appoints suitable candidates for specific functions through voting. In light of democracy, elections are a democratic tool that consists of citizens' selection through voting for representatives who exercise political power (Bankowicz, 2006).

Elections to Sejm in Poland were conducted in five rounds, as defined by the following principles (Helsinki Foundation for Human Rights, 2020):

- the principle of directness is to vote for a candidate for a specific position,
- the principle of equality, means that each voter has an equally valid vote,
- the principle of universality, a country in which every citizen with an active right to vote has the right to participate,
- proportionality principle: Each group receives a number of seats in proportion to the number of votes it receives in the election,
- the secrecy of the ballot is preserved by not signing ballot papers - no one will know for whom a citizen has voted.

2.3. Electoral bodies responsible for conducting elections

According to Article 152 of the Election Code, the permanent bodies responsible for conducting elections are the National Election Commission (NEC) and election commissioners.

The bodies appointed in connection with the organization of the elections are, in turn, district, district, territorial, and regional election commissions. The main electoral bodies functioning in Poland, according to the Election Code, are presented below:

The National Election Commission (NEC) (in polish PKW) is the highest electoral authority in Poland, which is associated with the organization of elections and referenda. The tasks include, inter alia, supervising the observance of election laws, appointing and dissolving election commissions (district and regional), announcing voting and election results, and commissioning the National Election Office to handle elections.

The National Election Office (NEO) (in polish KBW) provides services to the NEC and other bodies related to holding elections. The tasks of the NEO include, inter alia, servicing the NEC, organizing elections and referendums, providing organizational and administrative conditions, and preparing training for members of the DEC.

The district electoral commission is a commission of four members with a university degree in law. The task of the district electoral commission is, inter alia, to comply with electoral law, ensure the delivery of ballot papers to district electoral commissions, and ensure the performance of electoral tasks in cooperation with officials and relevant local government units.

The territorial election commission was appointed by the election commissioner no later than 40 days prior to the election. The territorial election commission has three components: the provincial election commission, district election commission, and municipal election commission. The duties of the territorial election commission include registering candidates for councillors, ordering the printing of election notices, dealing with complaints lodged against the activities of the district election commission, and sending the vote and election results to the election commissioner.

The District Election Commission (DEC) describes as one of the organs of the NEC, which is responsible for the practical conduct of voting and determination of voting results in elections and referendums in a given polling district in Poland. DEC is the lowest among election commmissions. The DEC is headed by a chairperson and deputy chairperson elected at the first meeting. They were responsible for managing the commission's work before and on the polling days. The tasks of the DEC include preparing the polling station for the election, serving the voter, guarding the ballot box, counting the ballots, completing voting records, and transferring election materials to the relevant office (Electoral Code).

2.4. Electoral processes

The electoral process occurs earlier than the voting day, during which the voter puts the cast vote in the ballot box. It consists of a number of other activities, such as campaigning, registering electoral committees, and counting votes. These activities are carried out only by authorized entities or electoral bodies, which operate on the basis of procedures and regulations found in the Constitution or the Electoral Code (Maksymiuk, Pastuszko, 2023). In Poland, Sejm elections are ordered by the President and announced via the Public Information Bulletin.

Election campaigning begins with the announcement and ends 24 hours before polling day. Polling districts are established a month before the election, while election committees are appointed 21 days prior, with members selected by the return officer based on population proportions. Candidate nominations close 40 days before the election, with the DEC verifying eligibility. Ballots are printed and distributed after candidate registration is complete. Preparations for election day occur the day before, including setting up polling stations and distributing materials. On election day, voting takes place from 7-21, with voters verifying their identity and casting ballots. After polls close, ballots are counted, results are recorded, and voting records are finalized. Results are validated and announced publicly, with a report sent to the President, the Speaker of the Sejm, and the Supreme Court two weeks after the NEC announces the results (Electoral Code).

3. Research methodology

This study used a mixed-methods approach that combined both quantitative and qualitative data analyses. An analysis of historical data on voter turnout and a survey of DEC members were carried out to gain insight into the practical aspects of the operation of electoral systems. In addition, a thorough analysis of the training materials received from the NEC was prepared for the training of elected mission members.

3.1. Data sources

3.1.1. Quantitative data

Data on voter turnout in Poland between 2000 and 2024 are obtained from the NEC. The data included turnouts from presidential elections, parliamentary elections, and national referendums. The dataset was analyzed to identify trends, anomalies, and the potential impact of electoral technologies on voter behavior.

3.1.2. Qualitative data

On 09.06.2024 (after the European Parliament elections), questionnaires were presented to the members of the DECs. A questionnaire survey was conducted on a group of 43 people who served as members of the DECs in these elections in various localities in the Pomeranian Voivodeship. The survey focused on examining the experiences of DEC members during elections organized by the NEC. The questionnaire consisted of thirteen questions. Two questions qualified the respondents for the survey, seven factual questions on the research problem, and four metric questions characterizing the respondents. The purpose of the survey was to understand the problems and needs of the DEC members. The questionnaire covered topics such as a member's previous experience of participating in election commissions, his or her assessment of the various stages involved in conducting elections, and suggestions

for improving the work of DEC members. Open-ended questions allowed for the identification of subjective opinions and observation of the challenges and benefits of process-driven changes in the electoral process. Additionally, training materials developed by the NEC for the training of election commission members were analyzed. These documents include guidelines on organizational procedures, the operation of technological systems, and the principles of election security. Particular emphasis was placed on the content of the sections on handling technology, such as ICT systems, that support electoral processes. Analysis of the materials made it possible to assess the preparedness of electoral commission members to perform their duties and to identify potential challenges arising from the implementation of new technologies.

3.2. Data analysis process

3.2.1. Quantitative data analysis

Attendance data were subjected to statistical trend analysis and inter-cyclical comparisons using Excel. The averages, medians, and standard deviations were calculated. Data visualization methods, such as line graphs and bar charts, were used to clearly present the results.

3.2.2. Qualitative data analysis

Survey results were coded and classified into key thematic categories. Content analysis made it possible to identify recurring patterns and differing opinions among the respondents. A detailed analysis of the training materials developed by the NEC that were used during the training of election commission members was carried out. These materials were assessed in terms of the details of the information they contained and their relevance to the needs of commission members. Particular attention was paid to electoral processes. The extent to which these materials support the effective implementation of new technologies and ensure adherence to the guidelines of the NEC was also analyzed to assess the level of preparation of commission members for their electoral duties.

3.3. Research limitations

The number of respondents to the survey, while providing valuable information, was not fully representative of all the DEC members. Survey results may also be affected by the subjectivity of the responses, which must be considered when interpreting them.

3.4. Stages of the study

This study was conducted in several stages, as follows. Turnout data were collected from the NEC resources. Next, a survey of the election commission members was conducted. The next step was the analysis of quantitative and qualitative data, which made it possible to identify the trends and significant correlations. This was followed by a thorough analysis of the NEC training materials. Finally, the results were interpreted. This methodology allows for

a multifaceted analysis of voter turnout and an assessment of electoral processes, taking into account both quantitative and qualitative perspectives.

4. Results

4.1. Analysis of voter turnout data in Poland from 2000 to 2024

Over a 24-year period (2000-2024), 37 votes (elections and referendums) were held in Poland. Table 1 summarizes the turnouts for each election. In some presidential and local government elections, there was a repeat vote in the second round; the turnout during the subsequent vote is shown in the opposite column.

Table 1.
Turnout of elections and referendums held between 2000 and 2024

Year	Elections	Voter turnout (1st round of voting) [%]	Voter turnout (2nd round of voting) [%]
2000	Presidential election	61,12%	
2001	Parliamentary election	46,29%	
2002	Municipal election	44,24%	35,02%
2003	National Referendum	58,85%	
2004	European Parliament elections	20,87%	
2005	Parliamentary election	40,57%	
2005	Presidential election	49,74%	50,99%
2006	Municipal election	45,99%	39,56%
2007	Parliamentary election	53,88%	
2009	European Parliament elections	24,53%	
2010	Presidential election	54,94%	55,31%
2010	Municipal election	47,32%	35,31%
2011	Parliamentary election	48,92%	
2014	European Parliament elections	23,83%	
2014	Municipal election	47,34%	39,97%
2015	Presidential election	48,96%	55,34%
2015	National Referendum	7,80%	
2015	Parliamentary election	50,92%	
2018	Municipal election	54,90%	48,83%
2019	European Parliament elections	45,68%	
2019	Parliamentary election	61,74%	
2020	Presidential election	64,51%	68,18%
2023	Parliamentary election	74,38%	
2023	National Referendum	40,91%	
2024	Municipal election	51,99%	44,06%
2024	European Parliament elections	40,65%	

Source: own compilation based on: https://www.pkw.gov.pl/, 16.11.2024.

When analyzing turnout in the second round of elections, a certain pattern can be observed. During presidential elections, the turnout in the second round increased, while it was lower during municipal elections.

Figure 1 presents the voter turnout from 2000 to 2024, using a bar chart. Each type of election is marked with a different color.

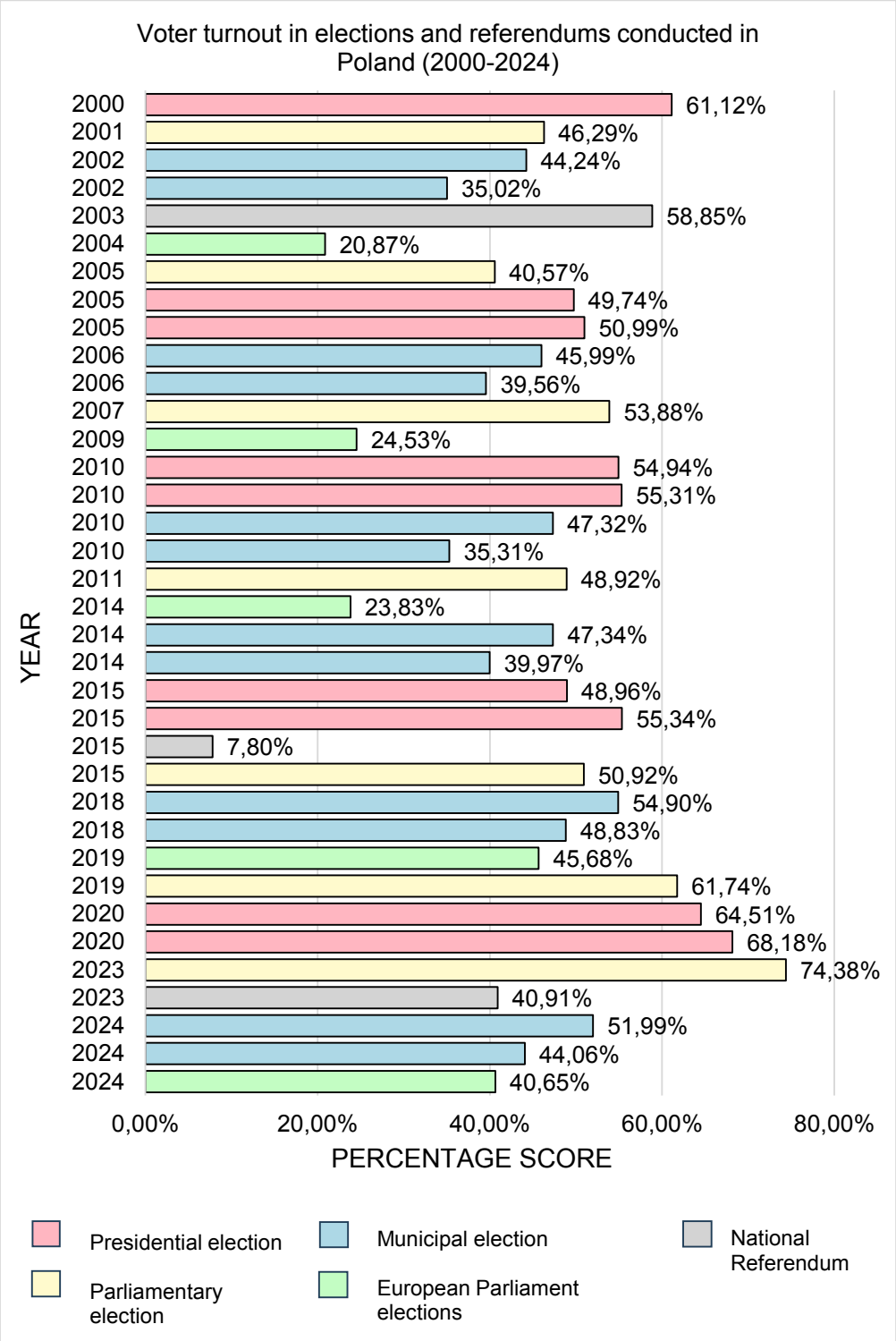

Figure 1. Turnout of elections and referendums held in the Poland between 2000 and 2024.

Source: own compilation based on: https://www.pkw.gov.pl/, 16.11.2024.

The average turnout in organized elections and referendums during the 2000-2024 election period is shown in Figure 2.

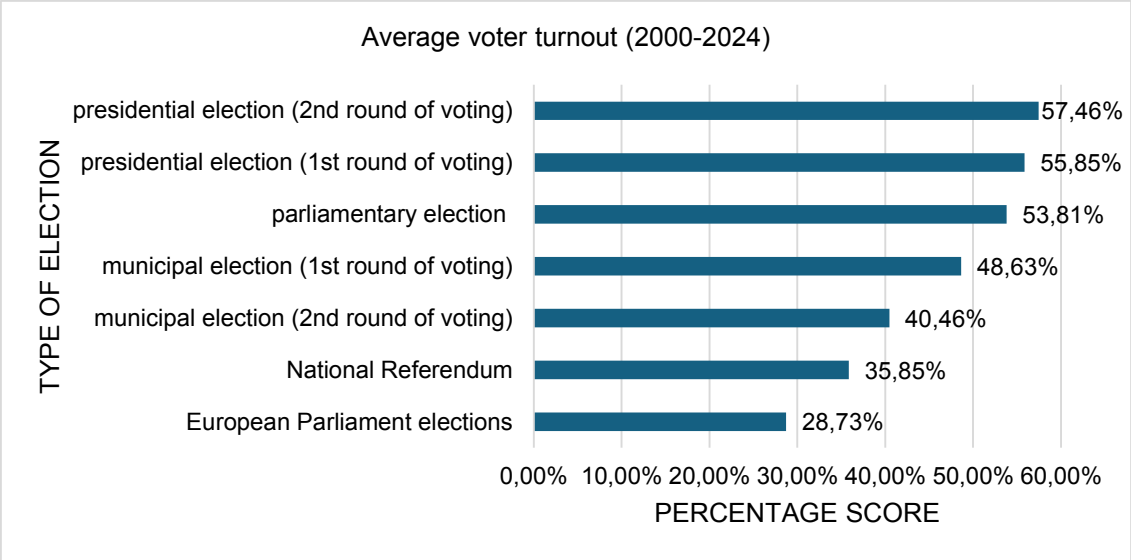

Figure 2. Average election turnout from 2000 to 2024.

Source: own elaboration.

The highest average turnout can be recorded in the second round of the election for the President of Poland, at just under 58%. This was followed by the first round of elections, with a result of almost 56%. The lowest average turnout can be seen in the European Parliament elections, as the result is below the 30% threshold.

4.1.1. Conclusions of the analysis of attendance from 2000 to 2024

In recent years, there has been a noticeable increase in interest in high-profile political elections, particularly parliamentary and presidential elections, indicating citizens' growing awareness of issues that are crucial to the functioning of the country. A particular example is the turnout recorded in 2023, which may be the result of significant socio-political events and effective mobilization efforts by political parties. The analysis also shows that the structure of voting rounds influences turnout, with the second round of presidential elections attracting more voters because of the importance of the final outcome between the main candidates. In municipal elections, on the other hand, the decrease in turnout in the second round may be due to the local nature of the voting, which limits voter mobilisation.

Challenges also arise in the context of European parliamentary elections and referendums that record the lowest turnouts. This is due to citizens' limited interest in EU issues and the specific referendum questions. This situation calls for greater promotion of the importance of these votes and raising public awareness of their impact on citizens' lives. In addition, the analysis highlights that public involvement in voting varies and depends on the nature of the elections. Votes with clear political consequences, such as presidential or parliamentary elections, involve more citizens than votes of a local or abstract nature, such as referendums with single-member constituencies.

In conclusion, elections and referendums with low turnout require the implementation of strategies to increase citizens' interests. Such measures may include voter education, more effective communication regarding the importance of voting, and the introduction of technological innovations to make voting more accessible. These findings highlight the need for further analysis and development of effective public mobilization strategies to increase citizen engagement in electoral processes.

4.2. Survey

The study involved adult women and men residing in Pomorskie Voivodeship who served as members of the DECs in elections organized by the NEC. A total of 43 individuals were surveyed.

Of the 43 DEC members participating in the survey, 29 were women and the remaining 14 were men. The age of the respondents was quite average, but the largest group was between 18 and 29 years old, being mostly students. More than 70% of the people participating in the survey lived in towns with between a dozen and 250,000 inhabitants. The remainder lived in rural areas or larger metropolitan areas. Approximately two-thirds of the respondents had a university degree and one-third had secondary or primary education.

In response to the question, "Which stage during the work at the DEC caused the most problems?" respondents rated the difficulty of three stages in organizing elections in Poland on an ordinal scale: preparing the polling station, conducting the vote, and determining the results of the vote.

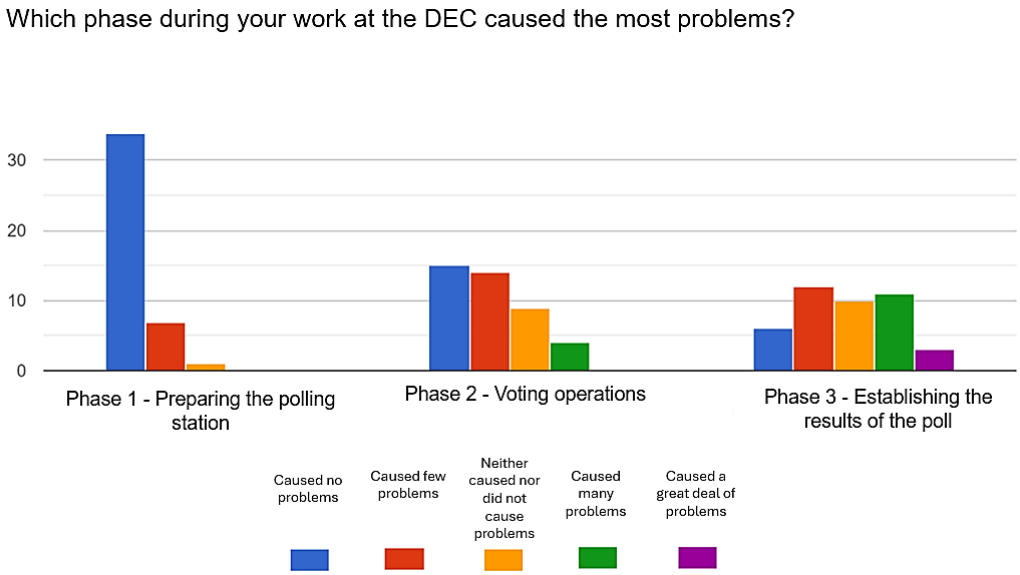

Figure 3. DEC experience survey.

Source: own elaboration.

As shown in Figure 3, a semi-open-ended question asked respondents to identify which phase during their work at the DEC caused the most problems. Over 80% indicated that the preparation of voting protocols was the most challenging process. The second most problematic

task, identified by 60% of respondents, was determining the results of the vote, specifically the process of vote counting. Other activities, such as verifying voter identities, stamping ballots, or maintaining order at the polling station, were not widely perceived as problematic. To improve DEC operations, the most popular suggestion among respondents was election digitization, supported by approximately 60%. This included automating election processes, introducing an electronic vote-counting system, and using QR technology for candidate selection. Other suggestions focused on simplifying instructions and guidelines, providing better-organized training, and offering pre-election training for DEC candidates.

Summarizing the results of the survey, members of DECs experience problems when conducting elections organized by the NEC. Approximately 90% of the respondents participated in the election as ordinary members of the DEC. The efficiency of the conduct of the last election was assessed as fairly balanced; however, almost half of the respondents assessed their last election as not very efficient in terms of organization. This was mainly reflected in the third stage of conducting elections, that is, activities related to the determination of voting results. This stage was identified as the most problematic. The processes in the previously mentioned stage that caused the most difficulties during the elections were the counting of votes and preparation of voting records. According to the respondents, these processes are too complex, resulting in lapses and mistakes made by DEC members when determining voting results. Almost 3/4 of the respondents believed that the aforementioned steps should be improved or modified. The most frequently suggested solution is the implementation and use of modern technologies for the functioning of DEC. Automation of processes, introduction of an electronic vote-counting system, and use of QR codes as a form of voting are measures that can improve the operation of the DEC and reduce the experience of problems when working in election commissions.

4.3. Analysis of electoral processes in Poland

Electoral processes play a key role in the functioning of democratic political systems by ensuring the legitimacy of power and the possibility of expressing citizens. This chapter analyze the electoral processes in Poland in detail, taking into account the process of preparing for and holding elections. Such an analysis will allow us to understand how electoral processes in Poland were shaped, and what challenges they faced in the future.

4.3.1. Process of preparing for and conducting elections

Analyzing the training materials for DEC members developed by the NEO, Figure 4 presents a process diagram containing the activities carried out during the process of preparing for and conducting elections.

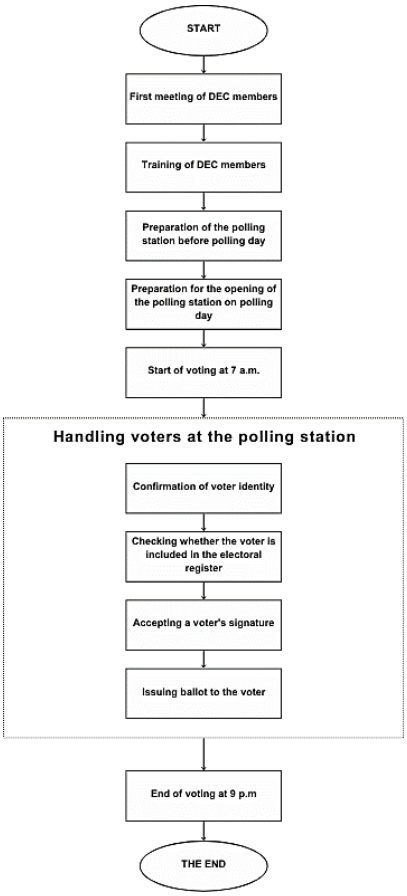

Figure 4. The process of preparing and conducting elections by DEC.

Source: own elaboration.

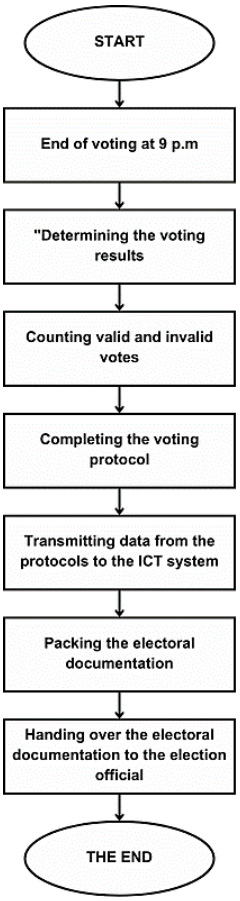

Figure 5. Process of determining the results of a ballot by DEC.

Source: own elaboration.

On polling day, before opening, the commission verifies documents, seals, recounts and stamps ballots, prepares registers and ballot papers, and ensures the station is ready. The ballot box is sealed, and all tasks must be completed by 6 a.m. Voting begins at 7 a.m., with at least half the commission present, and involves verifying voters' identity, confirming their inclusion in the register, obtaining their signature, and issuing ballot papers. Turnout data is reported at 12-17. Voting ends at 9:00 p.m. (National Election Office, 2024).

4.3.2. Process for establishing the results of votes and drawing up voting records

Analyzing the training materials for members of the DECs developed by the NEO, Fig. 9 presents a process diagram containing the activities carried out during the process of determining the voting results and drawing up voting records. Voting concluded at 9:00 p.m., marking the closure of the polling station. The ballot box was sealed, its inlet secured, and then opened to determine the results in the presence of at least two-thirds of the committee. The process included separating valid and invalid votes, counting valid votes for each candidate, and identifying reasons for invalid votes.

The committee then completed the voting protocol by counting the papers and recording the results. These results were forwarded to the IT operator for verification. After the minutes were checked, they were printed, stamped, and signed by all committee members. The finalized

protocols were uploaded to the Support for Electoral Bodies IT system, and two copies were made. One copy was posted at the polling station for public access.

Following the protocol procedures, the committee packed the election documentation. Protocols were placed in envelopes, and other documents and materials were organized into election packages. These were handed over to electoral officers. Voting records were first sent to the district electoral commission for approval. Once approved, the electoral packages were deposited with the electoral officer, who confirmed proper packing and receipt (National Election Office, 2024).

4.4. Analysis of voting patterns - Poland, Europe and the USA

Contemporary electoral processes, although rooted in democratic traditions, are subject to dynamic changes due to technological advances and cultural, legal, and organizational differences. The voting methods adopted in different regions of the world reflect the specificity of local political systems and the level of adaptation to modern challenges such as digitization, growing citizens' mobility, and the need to ensure a high level of electoral data security. This subsection presents an analysis of voting methods in Poland, Europe, and the United States. Traditional and modern voting methods, such as voting at polling stations, postal voting, electronic voting, and online voting, have been presented. This analysis will show both common trends and specific solutions that distinguish the studied regions, and identify potential inspirations for the development of electoral processes in Poland.

4.4.1. Poland

The Election Code distinguishes three ways in which one can cast a vote during elections and referendums organized by the NEC (Electoral Code): traditional voting at the premises, postal voting, and voting by proxy.

Traditional polling is the most commonly used voting method. It occurred at the polling station on the polling day between 7 a.m. and 9 p.m. It involves filling in the ballot paper given to you by a member of the polling station and dropping it into a ballot box.

Postal voting is a method of voting for voters with severe or moderate disabilities, those in quarantine, or those aged 60 years or older. Once the voter has been notified and accepted by the office of their intention to vote by post, an election packet is delivered to the voter, which contains, among other things, a return envelope, instructions with ballot papers, and a declaration of personal and secret ballots on the ballot paper. Once the voter has cast their vote and the return envelope has been properly prepared, the voter sends it back to the electoral commission, where the ballot envelope is removed from the return envelope and dropped into the ballot box.

Voting by proxy is a method of voting for voters with severe or moderate disabilities or for those aged 60 or over. After submitting an application containing the details of the person who will receive the proxy vote, the right to cast the vote is "transferred" to the designated person. On the polling day, upon arriving at the relevant electoral commission and presenting

an identity document and voting proxy certificate, the person receives ballot paper from the commission.

4.4.2. Europe

Krasnowolski (2015) distinguished additional voting methods in elections in European countries (as of 02.11.2024). Figure 6 presents the voting methods used in European countries.

	Voting methods							
	Proxy voting		Postal Voting	Electronic voting		Outside the polling station (mobile ballot box)		Others
	Based on the power of attorney	With the assistance of a third party at the polling station		In the polling station	By Internet	Mobile ballot box	Mobile polling station	
1	Albania	Croatia	Austria	Belgium	Estonia	Bosnia and Herzegovina	Austria	Austria
2	Belgium	Montenegro	Belgium	France	Switzerland	Croatia	Netherlands	Bosnia and Herzegovina
3	France	Estonia	Bosnia and Herzegovina	Moldova		Montenegro	Germany	Denmark
4	Netherlands	Spain	Estonia	Switzerland		Estonia		Lithuania
5	Poland	Lithuania	Finland			Finland		Norway
6	Sweden	Germany	France			Lithuania		Portugal
7	United Kingdom	Switzerland	Spain			Moldova		Slovenia
8			Netherlands			Norway		Sweden
9			Iceland			Russia		
10			Lithuania			Slovakia		
11			Luxembourg			Slovenia		
12			Germany			Ukraine		
13			Poland			Hungary		
14			Slovakia			Italy		
15			Slovenia					
16			Switzerland					
17			Sweden					
18			Hungary					
19			United Kingdom					
20			Italy					

Figure 6. Voting methods in European countries.

Source: Krasnowolski (2015).

The voting methods used in European countries include proxy voting, electronic voting at polling stations, electronic voting via the Internet, voting outside polling stations (mobile ballot boxes), and other voting methods.

Proxy voting with the assistance of a third party at the polling station occurs in the seven countries listed in the table, in the event that the voter is unable to cast the vote themselves there is the option to vote with the assistance of another person who is also at the polling station. To vote, this preference must be notified before the electoral commission.

Electronic voting at the polling station occurred in the four countries indicated in the table, including Belgium, where electronic voting is possible. In 2012, Venezuelan Smartmatic proposed a new electronic voting solution (Kużelewska, 2018). The voter could cast his or her vote using a touchscreen, which later allowed verification of the vote cast by printing a voting report. The printed report containing the QR code had to be scanned by the corresponding vote-counting machine and later dropped into the ballot box.

Electronic voting via the Internet is only present in two European countries: in Estonia and in Switzerland, it is possible to vote via the Internet. In Estonia, voters vote on the NEC website, and after identification, a list of candidates is displayed. A digital signature is required to confirm a vote (Czakowski, 2011).

Voting outside the polling station (mobile ballot box) occurs when a voter's health does not allow them to turn up at the polling station and cast their vote in a traditional way. The 14 countries listed in table. This involves sending two committee members to the voter's place of residence and conducting a vote outside the premises of the polling station. After verification of identity, the voter casts a vote and drops it into a ballot box, which is sealed immediately afterwards.

Some European countries have allowed early voting. Each has its own procedure and option for casting a vote. In Austria and Slovenia, it is possible to vote at an existing commission in Lithuania and Sweden at the seat of the local authority, and in Denmark, this is done through correspondence (Krasnowolski, 2015).

4.4.3. United States

The voting methods in the United States (US) are similar to those in European countries: in-person voting (in-person voting), early voting (early voting), and voting by mail (voting by mail). Figure 11 provides a summary of voting methods for US elections over the 2018-2022 period.

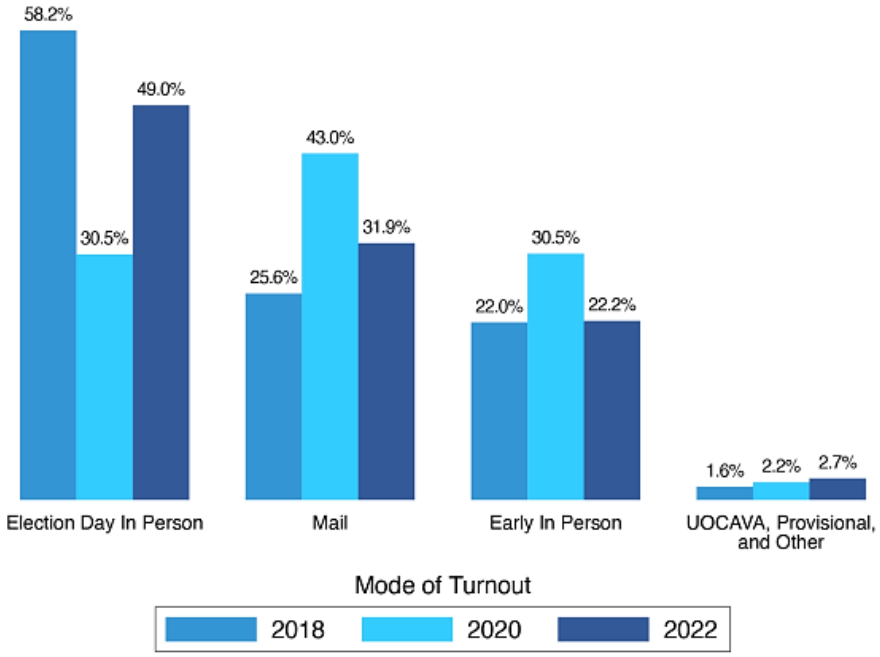

Figure 7. Preferred method of casting a ballot in the US between 2018 and 2022.

In-person voting (In-person voting) is the traditional method of voting at a polling station on an election day.

Early voting (Early voting) is an opportunity to cast a ballot before the official election day. There are two ways to cast an early vote in the US. A voter can go to a polling place or election office, obtain a ballot, cast a vote, and place the completed ballot in a ballot box or dedicated machine. In certain states, the voter can go to the polling office and take the ballot home (in some states, only the completed ballot can be taken home). Once the ballot is cast, it is sealed in an envelope and sent by a post.

Mail voting is also known as postal voting. The voter receives a postal ballot before the election, and casts a vote for a candidate at home. The final step is to send the completed ballot by mail, carrying it to the appropriate election office or, in some states, using a secure dedicated ballot box (The U.S. Election Assistance Commission, 2023).

Over the past five decades, new voting methods at polling stations have been increasingly modified and introduced in the US. With each successive election, one can see the increasing dominance of the two types of technology: scanning and Direct-Recording Electronic (DRE) (Desoi, 2018)

Figure 8 presents a list of the technology used in the United States.

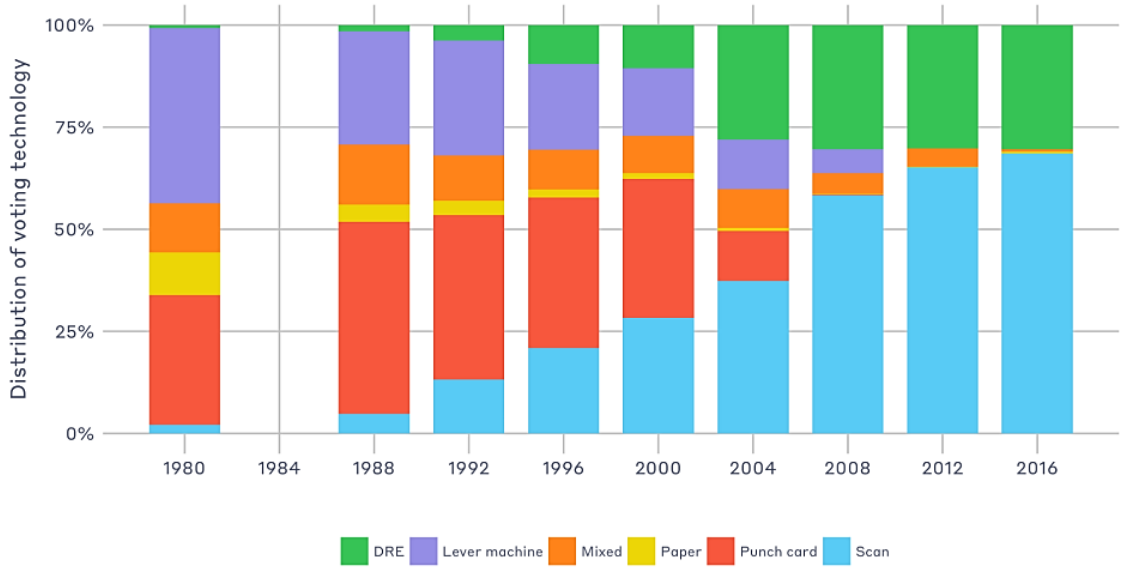

Figure 8. List of technology used in the United States between 1980 and 2016.

Source: https://electionlab.mit.edu/articles/medsl-explains-voting-technology

Currently, only a few counties use paper ballots, which are counted manually. Over the last 50 years, it is possible to see how the US has rejected the manual method of counting paper ballots in favor of technological solutions, such as Optical Scanners or DRE, which will be discussed later in this paper.

Figure 9 shows the most commonly used technologies in the US between 2020-2022.

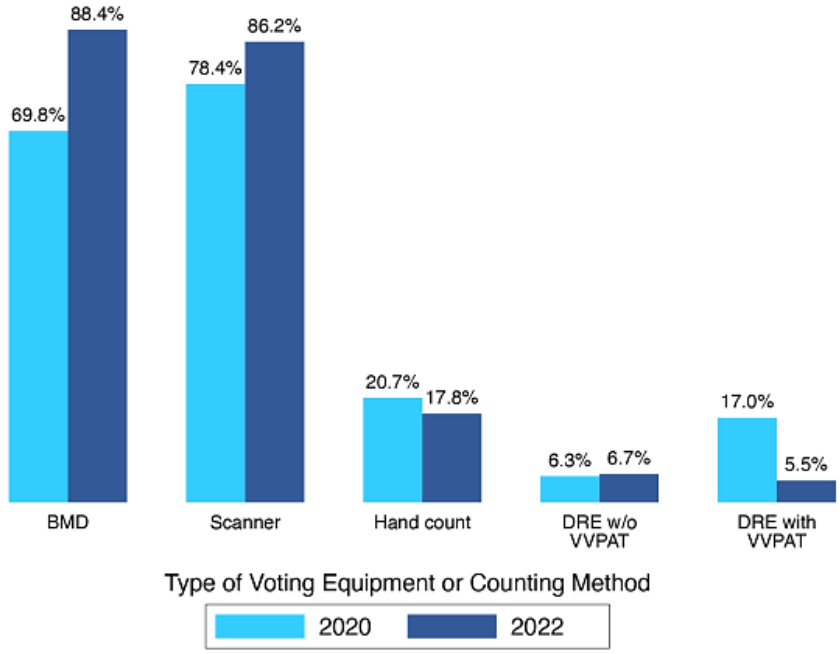

Figure 9. Technology used in the 2020-2022 US elections.

Source: https://www.eac.gov/sites/default/files/2024-11/2022_EAVS_Report_508c.pdf

The following are examples of devices currently used in the US elections (https://verifiedvoting.org/, 18.10.2024).

A Ballot Marking Device (BMD) allows voters to register their choices electronically by marking their votes without conducting automatic recounts. It displays a list of candidates on a touchscreen, where the voter selects and approves their choice. The machine then prints a paper ballot reflecting the selection.

An Optical Scanner is used to scan and automatically count votes cast on paper ballots. Voters mark their chosen candidate with a black pen and insert the ballot into the scanner, which scans it while placing it in the ballot box. At the end of voting, the scanner generates a report with the total number of votes cast.

A Direct-Recording Electronic (DRE) device, often referred to as a portable election computer, enables voters to cast votes on a touchscreen. After the vote is recorded, the system stores it in its internal memory and generates a Voter Verified Paper Audit Trail (VVPAT), allowing voters to confirm their selection via a paper receipt. This receipt is stored in a dedicated ballot box for potential audits.

In the DRE variant without VVPAT, voters also cast votes electronically, but no paper confirmation is generated. Votes are recorded and counted electronically.

4.5. The technological challenges of electoral processes

The introduction of technology into electoral processes is a key challenge in modern democratic systems. The dynamic development of technological tools and their increasingly widespread use in various aspects of social life have also affected the organization and

implementation of national elections are organized and conducted. This process, involving both technological evolution and the analysis of its impact on the functioning of electoral systems, requires a multidimensional approach that considers efficiency, cost, security, accessibility, and public trust.

As part of Kwidzinski (2024) proposes several technological solutions to the problems identified in the survey. Based on the previously performed analyses, a streamlined voting process using technology was designed for the four variants. Each of these presents the devices and their use, sequence of actions to be performed by the voter, and costs associated with designing and equipping the polling station. Kwidzinski also presented a prototype voting app that can replace the paper ballots used to date. The voting results were determined using an electronic balloon box, which could replace the current version and would be operated by the DEC chairman or his deputy. The costs associated with designing, equipping polling stations, and implementing the solution at all polling stations are included in the breakdown of all options. This section presents one such option.

4.6. Proposal for an improved electoral process using modern technology

The following is a proposal for an enhanced voting process in which the user's identity is verified using a biometric gateway and a fingerprint scanner. The vote in the election was cast via touchscreen on the voting machine, and the cast vote in the form of a digital ballot was placed and automatically calculated in the electronic balloon box.

4.6.1. Proposal of technologies to be used

- **Biometric gate** - the first stage of voter identity verification,
- **voting machine**, whereby a voter can vote in an election. This version of the device was equipped with a fingerprint scanner and digital ballot printer,
- **fingerprint scanner** - second stage of identity verification,
- **digital ballot printer** The printed digital ballot contains a unique barcode, which is a summary of the vote cast on the voting machine,
- **the electronic balloon box** acts as a traditional ballot box in which the voter inserts a previously received digital ballot. After appropriate authentication by the scanner, the electronic balloon-box confirms the vote.

4.6.2. Details of the technological solution

A storyboard depicting the sequence of actions performed during the voting process in elections organized by the NEC was designed. The storyboard presented (Figure 10) illustrates the proposal for an improved voting process according to Kwidzinski's variant A (2024).

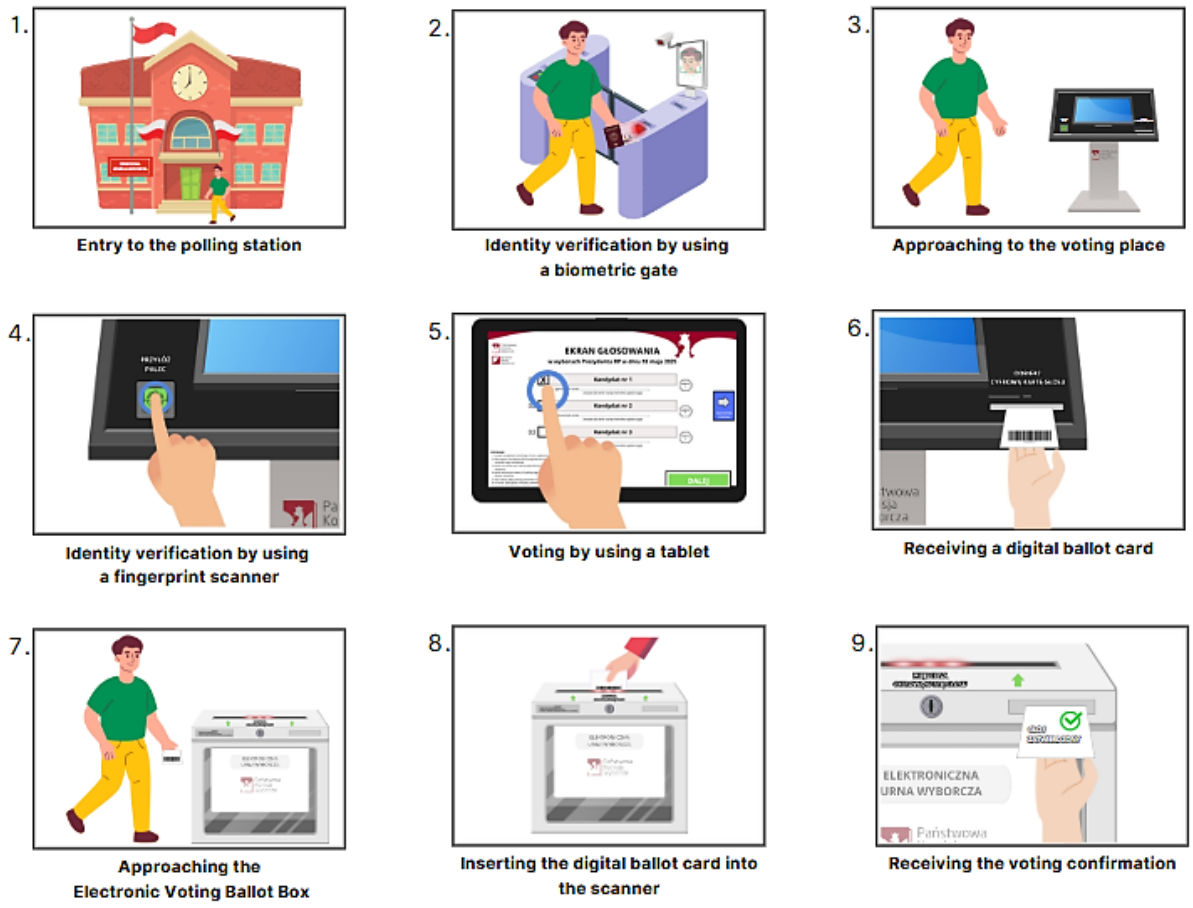

Figure 10 Improved voting process – storyboard.

Source: Kwidziński (2024).

Identity verification was performed in the proposed solution using a biometric gateway and fingerprint reader. The user then votes using a voting device and a touchscreen. After voting, the voter goes to the electronic balloon box where the voting process is completed.

4.6.3. Improved election process

Figure 11 shows a process diagram of the actions performed by voters when casting their votes at the polling station using the proposed technological solutions.

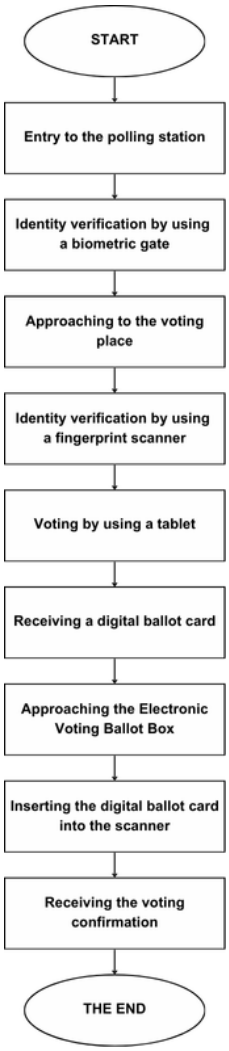

Figure 11. Improved process diagram voting

Source: own elaboration.

Upon entering the polling station, the voter prepares an identity document (e.g., e-card, passport, or QR code via the mCitizen app) and proceeds to the biometric gate. The document is scanned, and the voter's face is verified via a camera. Once matched, the gate opens, and the voter moves to the voting booth. Before accessing the voting tablet, the voter's identity is re-verified using a fingerprint reader. The tablet then activates, allowing the voter to select a candidate and confirm their choice. Afterward, a digital ballot is printed, which the voter inserts into a ballot scanner. Upon verifying the authenticity of the digital ballot, the system prints a confirmation, signaling the end and validity of the voting process.

Based on the survey, according to DEC members, the current process of tallying the results of the vote and drawing up the minutes is time-consuming. The amount of time spent tallying the results of the vote is a result of mistakes made and the incomprehensibility of the various steps in the preparation of voting records by commission members. The proposed solution reduces the scope of human intervention in favor of technology. A system operated by only one or two people - the committee chairman or deputy - is responsible for counting votes, taking minutes, and reporting results. By reducing the number of people responsible for determining

the results of the vote and entrusting the counting process to machines rather than committee members, the risk of errors is minimized. Manual counting of paper ballots, which takes several hours, will be replaced by computerized counting. Operating the machines together with downloading the voting report will take an estimated one–five minutes. In addition, to reduce the costs associated with the organization of elections, it was proposed to implement the solution not in every polling station in Poland but only in the polling stations located in the 100 most populated cities in Poland. The costs associated with implementing the solution at some polling stations were 80% lower than those associated with implementing the nationwide solution.

4.6.4. Cybersecurity of elections

Cyber security is about protecting, preventing damage to, and restoring the functioning of computers, electronic communication systems, and services, as well as wired and wireless communications, and the information they contain to ensure their confidentiality, integrity, availability, authentication, and non-repudiation (NIST, 2020).

Electronic voting (e-voting) is a method of voting in elections that uses various devices or technological solutions to register votes or the process of counting them. It can occur in two ways: stationary at the polling station or via the Internet. At the polling station, the voter votes using devices equipped with software that allows voter registration, authentication, voting, and the determination of voting results in a digital form. The objects of e-voting include mobile devices, kiosks, and computers (Taş, Tanrıöver, 2020). The second variant of e-voting is remote voting via the internet. It allows voting from anywhere (outside the polling station), and in some cases, it is possible to vote outside the country (Al-Ameen, Talab, 2013).

According to the Swiss Federal Chancellery (2024), the security of electronic voting relies on key principles such as verifiability to detect manipulation through cryptographic methods, shared responsibility by dividing the system into subsystems with limited internet access, and transparency by publishing source code for external analysis. Public scrutiny, including "bug bounty" programs, engages users to report vulnerabilities, while continuous updates and independent examinations by experts ensure systems meet current technical standards and function securely.

5. Discussion and conclusion

The analysis of electoral processes and voter turnout in Poland over the period 2000-2024 provides a number of valuable conclusions that can serve as a foundation for planning future activities in the area of improving electoral systems. The results of this research indicate the dynamic development of civic involvement in key votes, such as parliamentary and presidential elections, with the simultaneous challenge of low turnout in elections to the European

Parliament and referenda. In addition, a survey of DEC members confirmed the need to implement modern technologies for vote counting. The most problematic stages of the electoral process identified by the DEC members were activities related to determining the results of the vote and drawing up protocols. These activities are not only time-consuming, but also prone to errors, indicating the need to improve them.

One of the key challenges is the adequate preparation of election commissions. The results of the analysis of training materials indicate that, despite the availability of detailed guidelines, some procedures remain difficult to understand and require additional support, especially in the context of using new technologies.

Digital technologies that can increase the efficiency and security of elections are an important direction in the discussion of the future of electoral processes in Poland. Surveys indicate that digitization, including the automation of vote counting, the introduction of electronic systems for minutes, and the use of biometrics for voter verification, are solutions desired by both commission members and experts involved in electoral processes.

In conclusion, it is necessary to strive for further optimization of electoral processes, which requires an integrated approach that considers citizens' needs, legal requirements, and technological possibilities. The proposed innovations should be tested on a limited basis to assess their effectiveness and public acceptance before full implementation. Thus, Poland can become a leader in modern, efficient, and transparent elections, meeting the challenges of the 21st century.

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