

Czech University of Life Sciences  
Faculty of Economics and Management

## BACHELOR THESIS



# E-voting application for local elections in Bosnia and Herzegovina

by Bojan Glavan

Department of Information Engineering

Supervisor of the bachelor thesis: doc. Ing. Vojtěch Merunka, Ph.D.

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*Bojan Glavan*

I hereby declare that I carried out this submitted diploma thesis **E-voting application for local elections in Bosnia and Herzegovina** independently, and only sources listed in the Bibliography were used.

In Prague, 15<sup>th</sup> of March, 2021

Bojan Glavan

# Abstract

Electronic elections are nothing new in today's society, but they are still very underrepresented around the world. Acceptance and usage of technologies needed for e-voting in elections remains a problem regardless of where they are implemented. The political situation in Bosnia and Herzegovina is considered as one of the most complicated in the world. The result of such a system is a poor economic situation, a high unemployment rate, a large number of politicians, an exodus of the population, and so on. The consequence of all this is the lack of trust of citizens towards politicians and the fairness of the electoral system. Citizens feel that their vote has no weight. This paper analyzes already existing models of online voting, with the aim of their modification and implementation. We investigate the online election processes that took place in Estonia and Switzerland, and following the example of the way they were held, we present a model that can be implemented in Bosnia and Herzegovina in local elections in the municipality of Novi Grad Sarajevo. The current situation in Bosnia and Herzegovina leads to a drop in turnout, which ultimately results in stagnation or worse, the collapse of the state. The problem is also the organization of elections that will be fair, secure and efficient. We conducted a survey that shows the interest of citizens in the idea of implementing e-elections, and this can be considered a "favorable ground" for the continuation of dialogue on this topic. We believe that the implementation of online elections represents a potential solution in breaking the distrust of citizens in the election process. By implementing them, the electoral process can be made simpler, faster and more efficient, and in the future it could set an example that could be followed by other municipalities in Bosnia and Herzegovina.

**Keywords:** Electronic elections, Elections, Politics, Bosnia and Herzegovina

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# Chapter 1

## Introduction

The voting process today is one of the most important elements and pillars of a democratic society with the aim of making decisions. (Frik, 2011) From the perspective of democratic elections, participation in elections (by voting) whenever possible is crucial in the functioning of democracy. By voting for parties and candidates, citizens can express their political views, and in this way can influence political decisions. (Petitpas, Jaquet, and Sciarini, 2020)

According to the model of participation in democracy, it is desirable to achieve the maximum level of citizen participation in decision-making that ultimately affects their lives. (Pateman, 1970) Turnout alone is not the biggest problem, what is more important is equality in participation. (Jan Teorell, 2006; J. Teorell, Torcal, and Montero, 2007)

The term online is appearing more and more every day in all spheres of our lives. Online services are represented at every step, when buying food or clothes, booking tickets for a cinema or a sporting event, paying bills, working from home, and nowadays also attending school. Accordingly, adjusting the online election platform seems only a matter of time. It seems that people generally appreciate the ease of using online services, along with their availability and flexibility. In the beginning, online services were mostly used for the purpose of marketing, but over time, online networks and the way of communication became the shortest and fastest way to reach a single person. Using online services is a matter of today and the future, and many governments today use these platforms to expand their services. These services are very easily adaptable to new technologies, but some like holding online elections are a much bigger challenge. In the vast majority of countries, elections are still held in the traditional way through paper ballots.

Voters appear at the polling stations, show documentation proving their identity, and fill out a ballot in the voting booth. After that, they fold the ballot and they put it in the ballot box.

The implementation of online elections will speed up the counting process, and at the same time reduce the number of people needed to maintain them, and ultimately reduce the cost of elections. Many states have tried to implement online elections, but only a few have succeeded. The main stumbling block was the so-called "black box", which is term used to explain the lack of transparency where from voters is required to trust to electronic voting system, even without seeing their vote. (Frik, 2011)

## 1.1 Objectives

The purpose of this paper is to explain online voting in general and the ultimate goal is to examine the possibility of implementing online local elections in Bosnia and Herzegovina, in the municipality of Novi Grad Sarajevo. By implementing e-elections, the process of voting can be made simpler, faster and more efficient.

This way of voting can affect the turnout of voters, given that there are a number of people who because of many reasons can not go to the polls, despite the fact that they would go out and vote.

This study focuses on several important issues. Some of them are:

- What technology stands behind electronic voting?
- What led to a certain electronic election process succeeding or failing in one area?
- What are the benefits and what are the challenges of this process?
- And what is it that affects the outcome of such a process?

Currently, voting in Bosnia and Herzegovina is held in traditional way, but this study intends to break through the framework of traditional voting and try to present a model that could be used for the purpose of online voting in the municipality of Novi Grad Sarajevo. And if it were considered acceptable, it would be desirable if other municipalities followed the same example. We believe



that a huge problem is the distrust of citizens, but it is up to us to gain that trust.

## 1.2 Methodology

The thesis is divided into several chapters. The second chapter deals with the analysis of electronic elections in general, it explains the important concepts related to them, and the principle of electronic elections. In order to get an idea of possible implementation, we researched the e-election models used in Estonia and Switzerland, and we conclude the chapter with a number of benefits and obstacles that need to be considered for successful implementation. The third chapter presents some general and important information about the state of Bosnia and Herzegovina. The history of Bosnia and Herzegovina is very thorny, but a series of events in the past, results in the situation in Bosnia and Herzegovina as it is today. Which brings us to the fourth chapter, that explains in more detail the current political system and the current situation in Bosnia and Herzegovina. We conclude the chapter with a description of the current elections in the municipality of Novi Grad in Sarajevo.

We conducted a survey in order to examine the interest in electronic elections, which is represented among citizens. We were interested in how open citizens are to the option of electronic voting and how much this idea would make sense to implement in this area. Following the important steps that are responsible for the adequate maintenance of electronic elections, we will present a model that could be implemented.

# Chapter 2

## E-elections

### 2.1 Introduction to E-elections

The use of new technologies in nature contributes to the quality of the elections themselves. In the case of e-elections, the technology behind them relies on a system where election data is monitored, saved and processed as part of digital information. One of the biggest benefits of this way of voting is the economic aspect. It can also be said that e-elections enable an increase in the quality of work, reduce the complexity of tasks, speed up the counting process, allow easier data transfer, etc. (Saini, Verma, and Sharma, 2017) The possibility of remote voting is, along with the economic aspect, the biggest benefit of e-elections, and entails the possibility of higher turnout. (Adeshina and Ojo, 2020)

Electronic voting unites several types of voting and electronic counting of votes. The very concept of electronic voting can mean voting via electronic machines, punched cards, voting over the phone or over the Internet.

#### 2.1.1 Process of the electronic voting

The electronic voting process can be divided into 5 stages: registration, setup, authentication, voting and vote counting.

- **Registration.** During registration the voter must register and attach his/her identification data required to participate in the election.
- **Setup.** The process of setup is crucial because it generates the key needed to encrypt and “sign” the ballot. In the further process, this step ensures

the privacy of the voters, and gives confirmation that the voter is the one for whom he/she represents himself/herself.

- **Authentication.** The purpose of authentication is to review whether the registered user meets all the conditions for voting by comparing the entered data with the data that already exist about the given user.
- **Voting.** The voting phase provides the equivalent of the options that exist on paper ballots, and provides security on several levels. The first is to ensure that the voter votes, the second is not to allow early results (for example in many online polls we can see results immediately after voting, in the case of electronic elections this should not be the case as this could affect the further course of elections). Security is achieved through encryption and the already mentioned "signing".
- **Vote counting.** This stage denotes the final stage of the election process. Invalid ballots, i.e. invalid votes, are checked and removed. The correct or valid ballots are counted and the election results are published. (Saini, Verma, and Sharma, 2017)

When it comes to maintaining the e-election process, there are few things that must be accomplished for voting to be possible. Such as:

- *Accuracy.* The results will be correct.
- *Democracy.* The possibility to vote is given only to those who fulfill their rights to it, and these voters are allowed to vote only once.
- *Privacy.* Neither the authorities nor anyone else can link the ballot to the voter.
- *Verification.* Confirmation that all votes were counted correctly, as well the confirmation to voter that his vote has been placed in virtual ballot box.
- *Robustness.* The fact that everyone can access the elections, from all computers or servers, opens the possibility of attacking the election process. This causes a great need for resilience to external factors that may jeopardize the electoral process.
- *Availability.* The system allows all voters to vote from beginning to the end of the poll.

- *Pause/resume during voting.* The system allows all voters to stop the voting process or to restart it as long as the elections last. Saini, Verma, and Sharma, 2017

### 2.1.2 Type of voters

Studies show that there are three groups of voters: *regular voters*, *occasional voters* and *abstainers*. (Sciarini and Goldberg, 2016; Goldberg, Lanz, and Sciarini, 2019)

According to research conducted in Switzerland by (Goldberg, Lanz, and Sciarini, 2019), political campaigns have the greatest impact on the *occasional* voters. In order to get a bigger turnout, voters will be reminded that the elections will be held soon, and they would be able to get information in time. *Regular* voters are less "affected" by campaigns and they will vote through one of the channels, so it doesn't matter too much to them whether that channel will be a post office, a polling station or the internet. If they use the internet as a way to vote, it will not be a reason but just a replacement for the voting method. In the group of *abstainers*, a positive effect of the introduction of online voting can be expected. The lack of interest in voting mainly stems from a lack of interest in politics, political alienation, or a lack of faith in the political structures. Enabling internet voting would not solve the problem of abstinence, but there is a possibility that with a strong political campaign, a certain percentage of abstainers will decide to vote.

According to (Goodman, 2014), internet voting can encourage some non-voters and (fewer) occasional voters to participate.

## 2.2 Usage

In this section we will delve into usage of electronic elections. As examples we took two countries, Estonia and Switzerland. First one is great example how e-elections became "thing of national pride", while the other is telling us how implementation of e-voting affected voter turnout.

### 2.2.1 Estonia

Of the countries that have managed to implement online elections, Estonia is the first in line. The possibility of voting online first appeared in the 2005 local elections, where online elections were an alternative to traditional elections and paper voting. Voter turnout was very low, with a final score of 9,317 people voting that way. Since this attempt was considered a failure, the logical question was "does it worth it?". In the next parliamentary elections held in 2007, 30,275 people voted online, while in the 2009 local elections the number of 100,000 people was exceeded, when 104,415 people voted online, or 9.5 % of voters. These data indicate that online voting has tripled with each subsequent election. (Springall et al., 2014)

However, according to data from 234 municipalities in Estonia, it was concluded that e-voting did not ultimately lead to higher turnout. The number of people who chose to vote online increased, but overall turnout remained almost unchanged. (Bochsler, 2010)

#### Election analysis in Estonia

The 2013 local elections were held on October 20, while voters were able to vote online from October 10-16. From total electorate 21.2% people decided to vote online, or in numbers 133,808 voters. During the 2013 elections, a team of experts from America attended and monitored the election process in Estonia. They made a detailed analysis and in their work they presented some of the problems that they consider to be potential omissions and weaknesses. According to data from 2014, the percentage of voters who voted online exceeds 30%. (Committee, 2014a) Given that they are the only ones in the world to use online voting at the presidential and local election level, many Estonians experience online elections as part of their national pride. On the other hand, one of the major political parties sharply criticized the online elections and advocated their abolition. (Broadcasting, 2014) Estonia's Internet Voting Committee believes that online elections are as safe as traditional elections. (Committee, 2014b) Despite the fact that many Internet voting schemes suggest the use of cryptography to achieve end-to-end verification in Estonia, they have opted for a simpler design.

**National ID cards** represent smart cards that have the ability to perform cryptography. Using this card, Estonians perform the authentication process by

passing the card through a reader connected to the computer from which they will vote. Authentication is performed through the Transport Layer Security (TLS) client, which allows digital signature. Each of these cards contains two pairs of Rivest–Shamir–Adleman (RSA) keys, one for authentication, the other for signing. Confirmation of the connection between the "public key" and the identity of the cardholder is stored on the card and in the public Lightweight Directory Access Protocol (LDAP) database. (Authority, 2012)

In addition to voting via computer, it is also possible to vote via mobile phone where a special SIM card is used for authentication and login, while the voting process is done via the Mobile-ID mobile application. (Springall et al., 2014)

### **Test and opinion**

Most of the e-voting server code was published on the GitHub repository a few weeks before the election. The rest was recreated by the team of scientists in order to complete testing. The feasibility of an attack on the online voting system was tested. In an experiment where the Estonian e-voting system was reproduced, experts represented hackers who aimed to attack during the election. Scientists point out that they have successfully developed client-side attacks that were able to "quietly" steal votes from voter-owned computers, successfully bypassing "safeguards" such as the National ID smartcard and smartphone verification application. In addition, they were able to demonstrate server-side attacks on the counting server. Estonia relies on a complicated set of procedural controls, which are unable to provide complete security and transparency, according to US scientists. Experts warn of the shortcomings of this system, nothing that cyber warfare has advanced significantly since the time this voting system was designed.

### **E-voting infrastructure**

Infrastructure is made out of 4 machines:

- **Vote forwarding server (VFS)** - represents a server that accepts HTTPS connections from the client's software, sees if it is competent to vote, and forwards the vote to the vote storage server.
- **Vote storage server (VSS)** - is a backend server that stores signed, encrypted, votes collected during the period provided for online voting. The Vote storage server cannot be accessed online.

- **Log server** - is a server used for internal storage of logs and monitoring of a platform that collects "events" and statistics caused by *Vote storage servers* and *Vote forwarding servers*. Only members of the election administration can access the log server.
- **Vote counting server (VCS)** - it is used only in the final stage of election and it is never connected to the network. Authorized persons use a DVD to which they copy encrypted voices (without their signatures) from the *Vote storage server*. The Vote counting server is connected to a hardware security model that contains optional private keys. The HSM (Hardware Security Module) is used to decrypt the votes, count them and issue the final results.

### **Voting process**

The E-voting system uses *public key cryptography*. This provides protection in the analog world known as the "double envelope" commonly used in cases of absentee voting. The outer envelope represents the digital signature (voter identity), while the inner envelope protects the secrecy of the ballot (public key encryption). Once the eligibility of voters to vote is determined, the digital signature is detached from the ballot. The ballots are then forwarded to another, physically separated machine (HSM) where they are decrypted and counted.

At the beginning of the election, the authorities publish a set of client applications for Windows, Linux and Mac OS, which can be downloaded from <https://www.valimised.ee/>. To defend against forced voting, a solution has been implemented in which voters are allowed to vote an unlimited number of times during the online election period. Of all the votes, the last one entered counts. Also, a voter can cancel his online vote by voting at the polling station via a paper ballot. In the event that some fraud occurs during or after the election, i.e. the online election is attacked by hackers, Estonian law allows the annulment of online elections. In that case, all online votes would be considered annulled, and voters would have to resort to the traditional way of voting.

### **2.2.2 Switzerland**

One of the most detailed studies aimed at analyzing the impact of e-voting on turnout is done in Switzerland. In their work, (Petitpas, Jaquet, and Sciarini,

2020) address the questions of whether the use of e-voting increases turnout, and how the possibility of online voting affects the population divided by age groups. Online voting was introduced in 2004 in Switzerland as a pilot project.

### Election analysis in Switzerland

The reason for the introduction of e-elections, the Swiss authorities found in the reaction of voters to the introduction of voting by mail, which was implemented in the 90s. According to analyzes done by (Luechinger, Rosinger, and Stutzer, 2011), mail voting increased turnout by between 3 and 4 percent.

The data taken within this analysis refer to 30 direct democratic votes in the period 2008-2016. The canton of Geneva was taken as an example, where online voting was possible in all municipalities. No registration is required to vote in Switzerland, every citizen who turns 18 thus acquires the right to vote. Such a practice was also applied in the context of electronic elections, it was not necessary to register further in order to be able to vote.

Age	Abstainers (0/5)	Occasional(2/5)	Frequent(4/5)
1990 +	0.02%	0.13%	0.07%
1930-1949	0.06%	0.036%	-0.11%

Table 2.1: Probability of increasing voter turnout by introducing online voting in Geneve canton, 2008-2016

The results of the analysis show an interesting fact in the context of younger voters. The study compared the possibility of increased voter turnout for people born in 1990 and after, with a group of people born between 1930 and 1949. The probability that persons born after 1990 will go to the polls without going to the polls in the previous 5 elections has been increased by 0.02 % by being able to vote online. The probability that the turnout increased in the birth population between 1930-1949 increased by 0.06 %.

For *occasional voters*, the results were also unexpected, calling into question the hypothesis that the younger population would be “attracted” by online voting.

Ultimately, the effect of being able to vote online is almost imperceptible to voters who belong to the group of *regular voters*. In a sample of people born between 1950-1959, the impact of online voting opportunities has a negative impact on turnout (-0.011). The analysis showed that the effect of being able to vote online is positive and credible. In the case of abstainers, where the profile of a



person was taken as an example: male, unmarried, born between 1960 and 1969, registered in Geneva and did not participate in any of the last 5 elections, the possibility to vote online had a positive effect on the chances of participates in the next elections.

## **2.3 Advantages and challenges of electronic voting**

The complexity of maintaining and how elections are held online is not an easy thing to explain to voters, candidates, political parties and observers. On the other hand, election management bodies around the world are aware that elections must meet all criteria and ensure absolute security. (Goldsmith, 2011)

### **2.3.1 Advantages**

#### **Cost and logistical advantages**

In the traditional conduct of elections, it is necessary for the organizations holding the elections to solve the problems of designing, printing, distributing, securing, storing and counting ballots. Electronic voting can reduce or eliminate the logistical parts of this problem. Of course, we should not forget the part of logistics that electronic elections require, as the configuration and preparation of all necessary technologies. Also a suitable place where all the associated hardware can be stored and secured between elections. Cost would be as well reduced if we consider less staff would be needed to observe, maintain and count elections. By doing that even the percentage of human error would be decreased. (Goldsmith, 2011)

#### **Voter Identification Possibilities**

Whether the voter is in the voting booth or voting remotely, the use of technology can improve the mechanisms needed to identify voters. Some of the technologies that can be used are biometric recognition systems such as fingerprint recognition systems. Also, the use of smart cards and a personal identification number can be considered as an option. The use of these technologies significantly reduces the chance of fraud and ensures that the voter is also within the

voter register. (Goldsmith, 2011; Saini, Verma, and Sharma, 2017)

### **Accessibility and increase of voter turnout**

In the case of the use of electronic voting, there is an increase in accessibility to the electoral process. Ultimately, electronic voting can encourage groups of people who use various forms of modern technology on a daily basis to vote (example: young people). In addition to young people, the very possibility that the persons who are not able to physically appear at the polling station, i.e. persons with disabilities, vote is the wind in the sails of this idea. Next to people with disabilities, it could be especially useful for voters who vote outside their country (for example: soldiers, diplomacy, business workers, people on holiday, etc.), and all those who are not able to appear physically at the polling station on election day. At last group of people who could benefit from online elections are certainly people living abroad, and instead of the usual voting process at the embassy they would be able to vote via a website or an application. Even though research from Geneva Canton (see. Switzerland) tell us that implementing of online elections did not increase the vote turnout, the possibility of increasing the turnout by introducing internet elections cannot be ruled out. (Goldsmith, 2011)

### **Fast and trustworthy results**

In a scenario where technology is properly designed, and where citizens are sufficiently educated about the e-voting process, e-voting could lead to a faster electoral process. In that case, voters do not have contact with the ballots, they do not have to fill them, fold them and put them in the ballot boxes, and above all, they do not have to be at the polling station at all. They don't have to spend time going to the location, nor do they have to wait at the polling station. Not only that voters will need less time to vote, but the counting of votes will be much shorter process. The use of technology for this purpose makes a big difference. Votes are counted electronically, and the results are ready immediately after the election process is completed. In addition to that, the results would be saved in electronic form and submitted to the election organization for tabulation. The chances of an error in calculating the data during tabulation are significantly reduced. (Goldsmith, 2011)

### **Dealing with election complexity**

Elections are by themselves a very complex process. The use of technology can make it much easier to make choices. In the end, it even allows multiple elections to be held at the same time, which would be a revolutionary change over time, given that in most countries, presidential and local elections are held alternately. (Goldsmith, 2011)

### **Late changes to ballot**

This benefit has already been mentioned. In practice, voting near the end of the election period is something that is being avoided. Last-minute voting can significantly affect election results, but it can also lead to irregularities that can result in unfair or dubious elections. There were cases when bags full of votes arrived at the polls just before the end of the election period, and the use of these technologies could reduce the chances of such a thing. A ballot that would arrive at the "last" minute via internet voting would be inserted into a virtual "ballot box" for a period of a few seconds. (Goldsmith, 2011)

### **Elimination of invalid ballots**

In most countries, a certain number of voters cancel their ballots for various reasons, both intentional and accidental. The process of detecting them takes a lot of time, and the ability to vote online would allow the use of software that would be designed in such a way that these ballots are not stored in the same place where those who are properly filled. This benefit could be even greater if the focus is on those voters who would unknowingly incorrectly vote on paper. In the case of online voting, they can be notified that their ballot is incorrectly filled in, they can change it and thus directly influence the election results. (Goldsmith, 2011)

### **Fraud prevention**

Electronic voting can reduce the possibility of fraud, but it is not able, like the traditional way of voting, to completely eliminate the possibility of fraud. (Goldsmith, 2011)

## **Impartiality**

Any type of electronic voting and counting of votes follows pre-defined rules and is immune from human influence, and is thus impartial. (Goldsmith, 2011)

### **2.3.2 Challenges in electronic voting**

#### **Lack of transparency and confidence**

The lack of transparency is a big stumbling block if we take into account that transparency is the key to developing trust in electronic elections. Voters can be assured that their votes ended up in the ballot box, making traditional paper elections very transparent. Electronic voting, on the other hand, requires voters to trust that without seeing their vote, they trust the system to be fair. In case of having online elections pressure is on the election authorities to develop and maintain confidence in the process. There is no room for error here, because in the event that the trust of citizens is lost one there is a very small chance to regain it. (Goldsmith, 2011) This phenomenon is often called "black box". (Frik, 2011)

#### **Audit of results**

Reviewing the results is very important for any type of elections. The advantage of traditional elections, held by paper ballots is that in case of lack of confidence ballots could always be counted again. This possibility is very important for proving the fairness and correctness of the election process. One of the possible ways to overcome this challenge is by implementing a machine called the Voter Verified Paper Audit Trail (VVPAT), which makes paper copies of electronic votes, where they are verified by voters. (Goldsmith, 2011)

#### **Confusion and education**

The procedures necessary to hold electronic/online elections can be too complicated to understand for those who are responsible for the elections. The likelihood that the competent authorities are not familiar with all procedures must be kept to a minimum. From the other side, the election committees will not be the only ones which will have to learn and adopt to new system. Electronic voting, and the electronic election process for people who use technology in ev-

eryday life can be a very simple thing to understand. On the other hand, for a certain population who do not have experience with the use of technology, or for a people that do belong to the group of uneducated population, the process of electronic/online elections can be a big problem. A significant number of voters must be educated to use electronic/online voting. They need to be familiar with the tools they will use, and the whole election process need to be explained to them. Educating citizens on this topic can be expensive. (Goldsmith, 2011)

### **Integrity and Accuracy of source code and IT skills**

Electronic voting relies on software. The software is a set of instructions that "explain" to electronic voting or the counting of votes how it works. Errors, although not so real, can creep into defining a set of instructions and thus compromise the entire code. In this case, an examination by a professional is necessary, which must be neutral and independent. Maintenance and repair of hardware/software used for electronic/online voting requires special IT skills. These skills are required in the time period before, during and after the election. There is a possibility that staff specializing in this area is not available at an affordable price. Providing these skills can be a very expensive process if one considers that there are no staff providing such services in the desired area, and that same staff must be "imported" from abroad. (Goldsmith, 2011)

### **Power considerations**

Electronic voting requires a large amount of electricity. Lack of electricity and short circuits are potential problems that could ultimately have devastating consequences for the elections. For this reason, it is necessary that in addition to the main machines at the polling stations, there be an alternative to the main source of energy. (Goldsmith, 2011)

### **Security**

Security is the biggest issue, and probably the most difficult task in making electronic elections, is to make them immune to error and resistant to any kind of attack. The main goal is to implement secure e-elections that will guarantee the privacy of voters and the accuracy of voting. A system that ensures secure elections must meet the following requirements:

- *Eligibility.* Only legitimate voters count.
- *Uniqueness.* Each voter has the right to one vote.
- *Anonymous.* Every voter is anonymous.
- *Accuracy.* Voting results cannot be changed. It is not possible to add or subtract votes after the polls close.
- *Fairness.* Voting process must be fair and correct.
- *One-off.* After filling in the ballot, the voter has no further obligations until the end of the election.
- *Public verification.* Provide the voter with a way to check the correctness of the entire election process.

**DOS (Denial of Service)** This problem probably has the best chance of happening. DOS, as its name suggests, represents the inability of voters to access the service, in this case online elections. This problem can happen spontaneously, in case the voter is not able to log in to the network or server where the elections are held for some reason. On the other hand, there are well-founded suspicions that DOS can be “challenged” by hackers, and DOS can “attack” any election participant. There is also a well-founded fear that administrators could find themselves under attack by DOS attacks. With today’s technology, it seems that this type of attack cannot be guaranteed to be prevented. **Solution:** This problem can be solved by enabling online voting for a period of a few weeks, as in the case of Estonia (see Estonia). In this way, even in the event of an attack, voters will have time to go to the polls again, change the ”tool” of voting and ultimately be alerted to potential attacks.(Saini, Verma, and Sharma, 2017)

**Fake Servers** This type of attack is possible and not negligible. In this scenario, hackers aim to create a server very similar (identical) to the one implemented for voting. The server would mimic the layout and procedure of an election server with the aim of collecting data from voters, data necessary for authorization and verification during voting. **Solution:** For this problem solution is the education of citizens, especially those who are not technologically educated. That could be done thru set of commercials and educating materials which would

be published during pre-election campaigns.(Saini, Verma, and Sharma, 2017)

**Malicious software** This type of attack is most known from all above. It is less likely, which still exists and should not be overlooked, that a virus or worm will appear on the server hosting the election. On the other hand, the possibility of a virus appearing on the device through which the voter is voting is significantly higher. The problem is even bigger because in most cases the user is not even aware that the virus is on his device. Such a virus can be a big problem because it is able to change an already given vote, or to make it invalid and thus damage the voter and his choice. **Solution:** A potential solution to this problem could be to implement procedures to verify and verify the voting software. In that case, there would be a possibility to detect and remove the "infected" ballot, and to inform the voter. What is a fact, and can always cause a "worm of doubt", is that the technology, hardware and software from which voters are voting will always be out of the hands of administrators (i.e. those who hold the elections). Accordingly, the technology of holding elections must not depend on the devices that voters will use, but must be one step ahead of the problem. (Saini, Verma, and Sharma, 2017)

## Secrecy

Voter secrecy is one of the main tasks of all types of elections. Secrecy is a very common problem to solve, and is probably the biggest obstacle to holding online voting. *Family voting* is an example of a situation where it is very difficult to ensure absolute secrecy. In case one family member persuades or directly influences the decision of another family member, the problem cannot be solved by using internet voting. In traditional elections, this problem is solved by absolute isolation during voting (voters vote in the booths), while in a situation where voting would take place from home, this problem could pose a greater danger to the objectivity and correctness of the election. In the context of online voting, virus attacks by hackers would be the biggest problem for the secrecy of voters, their identification data that could potentially be misused. *Selling votes* is also a serious problem, but it cannot be solved in traditional elections either, and in that case we rely on the moral ethics of the voter himself. (Frik, 2011)

## **Digital Divide**

The digital divide represents the consequences of using technology (computers) within society. In the online voting scenario, the computer distinguishes between those who own it and those who do not, with those who do not own it being obviously at a disadvantage. Even in a scenario where voting would take place in booths, people who have no experience with computers would be difficult “material” to convince to vote that way. (Saini, Verma, and Sharma, 2017)

By including the Digital Divide, electronic voting will favor citizens who are familiar with the Internet and already vote, while discriminating against the less educated and the elderly. (Gainous and Wagner, 2007; Oostveen and Van Den Besselaar, 2004; Pippa, 2001)



# Chapter 3

## About Bosnia and Herzegovina

### 3.1 Geography

Bosnia and Herzegovina is a country located in Southeastern Europe. Roots of the name “Bosna” were never completely elucidated, but it is known that it was first documented in the X century in the work of the Byzantine Emperor Constantine VII Porphyrogenitus “De Administrando Imperio”. Although different in age, historical hierarchy and size, Bosnia in the north and Herzegovina in the south today represent two equal regions in the name of the state. Bosnia and Herzegovina is surrounded by three countries - Republic of Croatia in the north, south and west. Republic of Serbia in the east and Republic of Montenegro on southeast. Although small in area (51,129 km<sup>2</sup>), Bosnia and Herzegovina is rich in mountains and rivers. One of many specific things about Bosnia and Herzegovina is its 24 km long exit to the Adriatic Sea, which is one of the shortest coasts in the world where Bosnia and Herzegovina has one city called Neum.

The capital is Sarajevo, which is home to just over 300,000 inhabitants. In addition to Sarajevo, the larger cities include Banja Luka (unofficial capital of Republika Srpska), Tuzla, Mostar (unofficial capital of Herzegovina) and Zenica.

### 3.2 History

Bosnia and Herzegovina has a long and very interesting history. Many events that have taken place in the past have left questions to which no answers have been found up to this day.

### **Ottoman empire (1463 - 1878)**

In 1463, due to the expansion of the Ottoman Empire, Bosnia and Herzegovina fell under the rule of the Ottoman Empire. Before the arrival of the Ottomans in Bosnia and Herzegovina, there were two religions: Catholicism and Orthodoxy. With the arrival of the Ottomans in the territories of Bosnia and Herzegovina, Islam appeared and spread. Even then, Bosnia and Herzegovina became a country inhabited by people of three religions. (Malcolm, 1996; Boras, 2013; Beširević, 2008)

### **Under Austro-Hungarian monarchy (1878 - 1914)**

With the weakening of the Ottoman Empire, and the growth and strengthening of the Austro-Hungarian monarchy in 1878, Bosnia and Herzegovina stops to be part of the Ottoman Empire, and after the Berlin Agreement became part of the Austrian monarchy. This period was accompanied by many reforms, construction of roads, introduction of compulsory schooling, construction of railways. (Malcolm, 1996)

One of the most important people from the Austro-Hungarian monarchy for Bosnia and Herzegovina was Benjamin Kalaj, who had the idea to introduce the term Bosniak, a term that would unite Serbs, Croats and Muslims living in the same country. He believed that, unlike the Orthodox and Catholics, Muslims do not have their home country outside the borders of Bosnia and Herzegovina, and that it would be easiest to implement this idea with them. However, this idea, which had a future in theory but not in practice, did not live long due to the great influence of the already mentioned Croatia and Serbia.

### **From the World War I until the World War II (1914 - 1939)**

With the fall of the Austrian monarchy, and the growth of a new ideology, "Yugoslavism", the southern Slavs were united. This officially happened in 1918, when the Kingdom of Serbs, Croats and Slovenes was born (Montenegro and Bosnia and Herzegovina also belonged there). Ten years later, the country changed its name and Bosnia and Herzegovina entered the World War II as part of the Kingdom of Yugoslavia. (Malcolm, 1996)

## **World War II (1939 - 1945)**

The Kingdom of Yugoslavia quickly fell under German and Italian rule, and the Independent State of Croatia (Bos. Nezavisna Država Hrvatska - NDH) was quickly established, to which Bosnia and Herzegovina was annexed. Only 6 days after the establishment of the Independent State of Croatia, Sarajevo was occupied.

Bosnia and Herzegovina was the place where the foundations of the state that would be created after the end of the war, Yugoslavia, were laid. On the wave of communism, the state was built by Josip Broz Tito. It is important to emphasize that during the World War II, there were fights between all three nations, and that all three nations also cooperated, despite the enormous crimes committed during the period 1941-1945. (Malcolm, 1996)

## **Under Tito's Yugoslavia (1945 - 1990)**

After the World War II, the Kingdom of Yugoslavia became the Socialist-Federal Republic of Yugoslavia, in which Bosnia and Herzegovina itself had the status of a republic. From the beginning, as it has been the case throughout history, Bosnia and Herzegovina has lagged behind in every segment, both industrial and economic. This is often blamed on the "eternal" problem of lack of national identity. Since politics was communist, the influence of religion was minimized, which was most felt by Muslims.

This was the case until the early 1960s, when there was a rise in Muslim consciousness that overlapped with the period in which Tito began his non-aligned movement. An important change is seen in the fact that in the first census in Yugoslavia, in Bosnia and Herzegovina, there were three options: Serbs, Croats and non-nationals (Muslims could declare themselves as Serbs or Croats of the Muslim religion). The vast majority of Muslims then declared themselves nationally undecided. In 1971, the option "Muslim" was introduced on the census as an ethnic affiliation, where it no longer represented only religious affiliation but also nationality. This period is remembered as a period of great progress and the birth of a form of national identity in Bosnia and Herzegovina. It is accompanied by growth in the economy and construction of infrastructure. Special mention should be made of the 1984 Winter Olympics, which took place in 1984 in Sarajevo and the surrounding mountains. (Malcolm, 1996)

### **Collapse of Yugoslavia and War in Bosnia (1990 - 1996)**

After the death of Josip Broz Tito in 1980, nationalist currents within Yugoslavia began to circulate again. They were especially expressed in Serbia and Croatia, and these events also affected Bosnia and Herzegovina. In 1990, the first multi-party elections were held. Slobodan Milošević came to power in Serbia, Franjo Tuđman in Croatia, while Alija Izetbegović established himself as the leader of the Muslim population in Bosnia and Herzegovina.

Slovenia was the first to leave the composition of the still formally functional Yugoslavia in 1991, and its example was followed by Croatia for several months, which ended in the war between Croatia and Serbia. This event resulted in the war on the territory of Bosnia and Herzegovina which lasted from 1992 to 1995.

At the very beginning of the war, Bosnia and Herzegovina was divided into two parts, the part where the majority was Orthodox (Serb population), and the part where the majority were Muslims and Catholics (Croats). As in the war with Croatia, Serbia wanted a part of the territory inhabited by Serbs, even though it was at odds with historical borders. During the war in Bosnia and Herzegovina, over 100,000 people died and over 2 million people were displaced, all of which were accompanied by horrific and inhumane crimes. The war ended with the signing of the Dayton Agreement on December 14, 1995 in Paris, and the warring parties signed the agreement with Slobodan Milošević as the leader of Serbia, Franjo Tuđman as the leader of Croatia and Alija Izebegović as the leader of the Muslims. The Dayton Agreement was envisaged as a temporary solution that would end the war, but it is still in force today and shapes a very complicated political system in Bosnia and Herzegovina. (Malcolm, 1996)

# Chapter 4

## Political system of Bosnia and Herzegovina

### 4.1 Political background

#### 4.1.1 Dayton agreement

The political system of Bosnia and Herzegovina is one of the most complicated in the world. Beside ending the war, the Dayton agreement was used in order to establish a political structure within the country that would satisfy all three signatory countries. All three sides had their own idea of what Bosnia and Herzegovina should look like. Serbia had a vision where a large part of Bosnia and Herzegovina with a majority Serb population would join it, while Croatia was in favor of Bosnia and Herzegovina remaining within the original borders, but also the creation of a "Croatian" entity in Bosnia and Herzegovina, which is inhabited by the majority of Croatian population. The idea of Alija Izebegović, i.e. the Muslim member of the presidency was to keep Bosnia and Herzegovina within its borders and not to divide, but to be a state of both Serbs and Croats and Muslims, as it had been centuries before. By the agreement, it was decided that Bosnia and Herzegovina would continue its legal existence under international law as a state, with a modified internal structure as envisaged here and within its international borders. (Izetbegović, 2021; Interior of Canton Sarajevo, n.d.)

The annex on the "Agreement on the Inter-Entity Boundary Line and Accompanying Issues" agreed that Bosnia and Herzegovina would consist of two

entities, the Federation of Bosnia and Herzegovina and the Republic of Srpska. Later, the Brčko District was established, which is a separate unit and does not belong to either of the two entities in order not to violate the Dayton Agreement, on the basis of which it was agreed that 49% of the territory would belong to the Republic of Srpska, while the remaining 51% would belong to the Federation. (Interior of Canton Sarajevo, [n.d.](#); Prnjavorac, [n.d.](#))

#### **4.1.2 Political structure**

Both entities have the right to make international agreements but with the consent of the parliament of Bosnia and Herzegovina. Power is divided into executive, judicial and legislative. The Presidency of Bosnia and Herzegovina consists of three members: one Bosniak, one Croat, elected directly from the territory of the Federation, and one Serb, elected directly from the territory of the Republic of Srpska. (Hercegovine, [2002](#))

#### **Federacija Bosne i Hercegovine**

The Federation of Bosnia and Herzegovina (hereinafter FBiH) is one of the two entities created by the signing of the Dayton Agreement. Power in the FBiH is exercised at 5 levels: municipality, district, city, canton and federal level. (Miličević, [1998](#))

According to the 2013 census, there are 2,219,220 inhabitants in the FBiH. 70.4% are Bosniaks, 22.4% are Croats, 2.5% are Serbs and 4.6% are "Others". (Statistika.ba, [2013](#))

#### **The Republic of Srpska**

The Republic of Srpska (hereinafter RS) is smaller than two entities. It is inhabited by a majority Serb population with a share of over 80%, while there are traces of the Muslim and Croat population. Power in the Republic of Srpska is exercised at two levels: the municipal level and the Republic of Srpska level. (Miličević, [1998](#))

According to the last census from 2013, there are 1,228,423 inhabitants in RS. The absolute majority are Serbs, who make up 81.5% of the population, Bosniaks have 14%, Croats 2.4% and 2.1% are "Others". The largest city and

also a cultural, administrative and political center is Banja Luka, where over 200 thousand people live. (Statistika.ba, 2013)

### **District Brčko**

Brčko District is an administrative unit within Bosnia and Herzegovina. It is the result of a compromise between the RS and the FBiH. It was officially established in 2000, and with its area it occupies only 1% of the total area of Bosnia and Herzegovina. The Brčko District has a very important geostrategic position because it lies in the north of the country, on the border with Croatia in the north, while in the east and the west it is surrounded by the Republic of Srpska, and on the south by the Federation of BiH. (Paragraf, 2010)

With the information we have from the last official census from 2013, there are 83,516 inhabitants in the Brčko District. The majority are Bosniaks with 42.4%, 34.6% of the population declares themselves as Serbs, 20.7% as Croats, while "Others" have 2.4%. (Statistika.ba, 2013)

## **4.2 Current situation**

The current political situation in Bosnia and Herzegovina is worrying to say the least. In addition to the very complex political system in which the entire country is located, there are a number of socio-economic characteristics that further complicate the lives of the citizens of Bosnia and Herzegovina. A very complex political system results in a large number of politicians per capita. Political parties with a pronounced national sign are the ones with biggest power and have the largest number of voters. All three constituent peoples have such examples, with the Bosniak part of the population being the Party of Democratic Action (Bos. Stranka Demokratske Akcije - SDA) founded by Alija Izetbegović in 1991. From the Croatian part of the population, the party with the greatest influence is the Croatian extension of the Croatian Democratic Union (Bos. Hrvatska Demokratska Zajednica - HDZ), while among the Serbian part of the population, the political party with the strongest electorate is the Alliance of Independent Social Democrats (Bos. Savez Nezavisnih Socijaldemokrata - SNSD).

### **4.2.1 A large number of politicians**

The number of politicians, i.e. candidates on the lists, is growing from year to year. In the 2012 local elections, 84 political parties, 29 coalitions and a total of 383 political entities could be found on the lists. If we compare this with the number of inhabitants from the census held in 2013, according to which there are 3,531,159 inhabitants in Bosnia and Herzegovina, we come to the figure that we have one political party for every 42,000 people. (Bosnia and Herzegovina, 2015)

In the local elections 4 years later, in 2016, 30,027 people ran for the municipal council, which brings us to the data that for every 117 inhabitants of Bosnia and Herzegovina there is a candidate for a member of the municipal council. (Bosnia and Herzegovina, 2016)

In Bosnia and Herzegovina, voting is done through paper ballots. Every citizen over the age of 18 who is registered to vote has the right to go to the polls. (Paragraf, n.d.)

## **4.3 Elections**

Elections in Bosnia and Herzegovina are divided into two levels, the presidential and local elections. They are held every 4 years, while the time period between the presidential and local elections is two years. The first presidential elections were held in 1996, while the first local elections were held in 1997.

### **4.3.1 Presidential elections**

Presidential elections are elections where citizens have the opportunity to elect a leader (president) from their group of people, in simple words, those residing in the Republic of Srpska entity have the opportunity to elect a member of the presidency from the Serb people, although this situation constitutionally discriminates against ethnic minorities, in this case Croats, Bosniaks and Others, which together make up 18.5% of the population of that entity. A very similar situation is present in the Federation of Bosnia and Herzegovina, where all its inhabitants have the right to vote for a Bosniak or Croat member of the presidency, thus discriminating against Serbs and Others, who make up 7.1% of the total population. Presidential elections take place every 4 years, that is also a duration of mandates of the elected candidates. A curiosity related to the general elections



in Bosnia and Herzegovina is the election of three presidents. Once elected, they (Serb, Croat and Bosniak) rotate every 8 months in the position of "Chairman of the Presidency". For every important state decision, all three members must agree.

### 4.3.2 Local elections

In addition to the presidential elections, local elections are held in Bosnia and Herzegovina, during which citizens have the right to elect their representatives at the level of local self-government, in other words municipalities. In these elections, voters elect members of the municipal council, and elect the mayor of the municipality in which they are registered.

### 4.3.3 Voter turnout

The participation of the citizens of Bosnia and Herzegovina in voting system is not satisfactory, which is best seen in the turnout. (Puhalo and Perišić, 2013)

The first local elections were held in 1997. Since then, local elections have been held a total of seven times. The highest turnout was achieved in the first elections held in 1997. The *Table 4.1* shows the turnout in the elections from the first to the last elections.

No.	Year	Voter turnout
1.	1997	87%
2.	2000	65.4%
3.	2004	46.8%
4.	2008	55.28%
5.	2012	56.51%
6.	2016	54.69%
7.	2020	48.97%

Table 4.1: Voter turnout on local elections in Bosnia and Herzegovina since 1997

In the *Table 4.1*, we can see that voter turnout is declining from year to year. The first elections in 1997 brought a large and so far the highest turnout, mostly because they were the first since the independence of Bosnia and Herzegovina, and residents felt greater responsibility and need to vote, which can be directly related to the unfortunate events of 1992- 1997. In the 2000 and 2004 election years, there was a large drop of almost 20% compared to previous elections.

This was followed by two increases in turnout, the first in the next elections in 2008 of almost 10% more than in the previous ones, while the growth trend continued in the next election year when the turnout was slightly higher than 1%. Since then, the 2016 local elections and the last elections in 2020 have declined, especially in the last elections where turnout for the second time since Bosnia and Herzegovina's independence has fallen below 50%. It should be emphasized that the COVID19 pandemic had an impact on low or low turnout in the 2020 local elections, but in addition the decline is explained in various ways: apathy, skepticism of citizens in possible progress, distrust of political parties and others. (Puhalo and Perišić, 2013)

## 4.4 Municipality Novi Grad

The municipality of Novi Grad Sarajevo was established in 1978. by territorial distribution of Sarajevo. In accordance with the expansion of the city and the increase in population, intensive construction of this municipality began. One of the main reasons for building this municipality was the 1984 Winter Olympics.

During the 1992-1995 war, the Municipality of Novi Grad was on the line of demarcation between the RS and FBiH, so during that time it suffered enormous material damage. (Sarajevo, 2016)

The municipality of Novi Grad Sarajevo is the most populous municipality in Sarajevo, according to the last official census from 2013, there are 118,553 inhabitants. (Statistika.ba, 2013)

### 4.4.1 Local elections in municipality Novi Grad Sarajevo

As already mentioned, the municipality of Novi Grad Sarajevo is the most populous municipality in Sarajevo. Thus, control over it makes it a very attractive political prey.

According to the election results from the local elections in 2016, 111,982 voters were registered in the municipality of Novi Grad Sarajevo, while 49,144 turned out, which is a turnout of 43.88%.

No.	Year	Registered voters	Have voted	Voter turnout
1.	2008	103133	38691	37.51%
2.	2012	107906	50371	46.68%
3.	2016	111982	49144	43.88%
4.	2020	115193	46892	40.70%

Table 4.2: Voter turnout on local elections in municipality Novi Grad Sarajevo since 2008

The data for *Table 4.2* were taken from the Central Election Commission, the competent body for the conduct and maintenance of elections in Bosnia and Herzegovina. It should also be noted that data for the 2004, 2000 and 1997 election years were not available. It was possible to reach the number of people who voted, but not the total turnout, so accordingly, those election years were omitted.

# Chapter 5

## Case Study

### 5.1 Objectives and methodology

#### 5.1.1 Objectives

In order to investigate whether the implementation of online elections would make sense at all in the area of the municipality Novi Grad Sarajevo, we conducted a survey. The purposes of the survey are, beside to examine the interest of citizens in this idea, as follows:

- To gain insight into the representation of voter types.
- To examine how satisfied people are with the current way of holding elections.
- To determine the level of citizens' trust in the fairness of the current (traditional) election process.
- To investigate the interest of citizens in online elections.
- To examine the reason for aversion to online elections.

#### 5.1.2 Methodology

The survey was open from March 6, 2021 to March 11, 2021. During this period of 5 days, residents of the municipality of Novi Grad Sarajevo had a chance to express their opinions on this idea. Given the circumstances (COVID-19 pandemic), the survey was provided to the residents in the online form through

the "Google forms" application. Group of 288 people decided to participate in the research. Respondents were not asked for personal data, and in this segment this survey relied on the trust of respondents to meet the necessary criteria to complete the survey, meaning older than 18 years and living in the municipality of Novi Grad Sarajevo.

The survey consists six questions. Five questions are required to be answered, while one question is optional. Questions were based on multiple choices from which respondents could choose only one. The questions and appropriate answers are given in *Appendix A.1*.

## 5.2 Results and discussion

### 5.2.1 Results

#### Age cohorts

Out of 288, the largest number of 126 of respondents, belong to the age cohort from 31 year to 45 years. The second in terms of the number of respondents, the group between 18 and 30 consists 86 members. In the group of those between 46 and 64 is 68 of respondents. The group to which the smallest number of respondents belongs is, as expected, the oldest group in which there were 8 respondents of the total number. The percentage display is shown in *Figure 5.1* below:

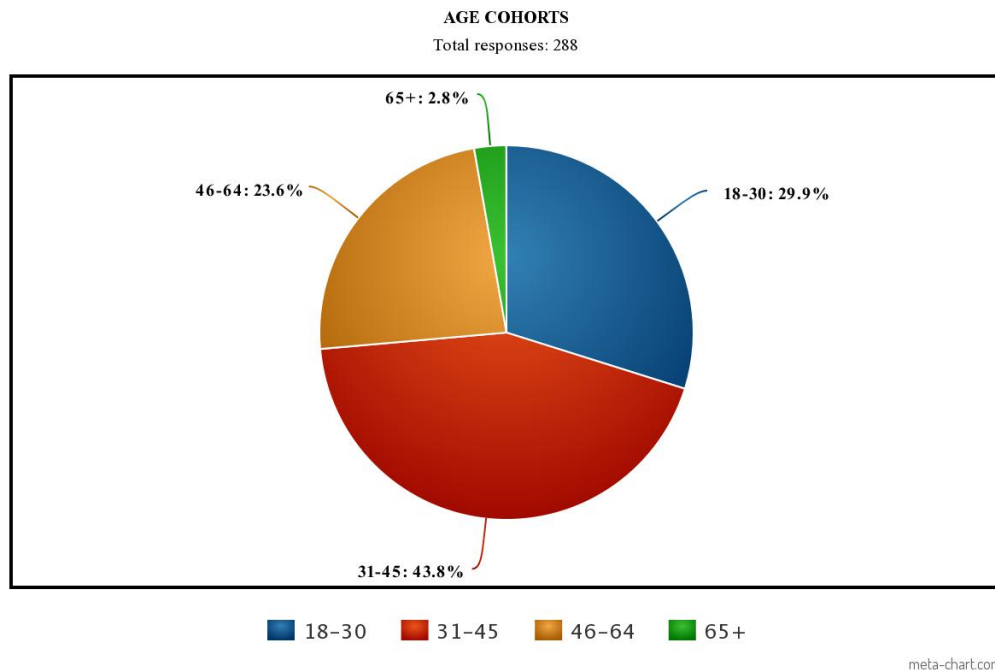


Figure 5.1: Age cohorts

#### Type of voters

From question "How often do you vote?", we were able to sort our respondents into three groups: regular voters, occasional voters and abstainers. The results tell us the following data. Most of respondents vote regularly, as many as 79.5 %, or 229 out of 288 respondents. The number of 51 respondents said that they occasionally vote, which is 17.7 %, while 8 respondents declared themselves as abstainers, more precisely 2.8 %.

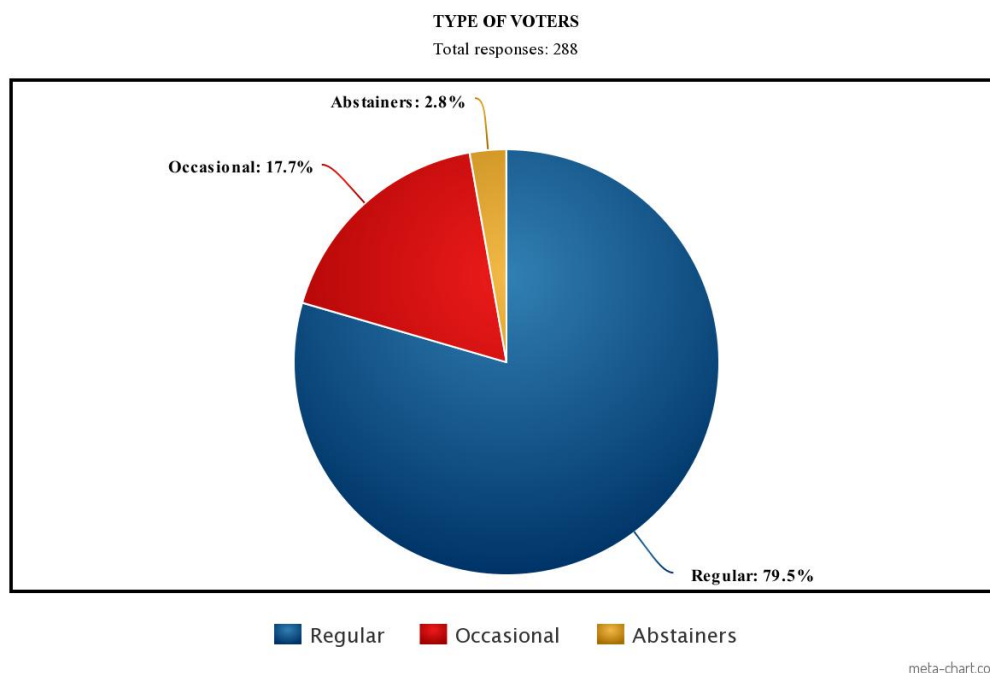


Figure 5.2: Type of voters

The *Table 5.1* shows how the types of voters are arranged according to age. Namely, in the age cohort from 31 year to 45 years, as many as 106 of respondents said that they vote regularly. The age cohort with most occasional voters is the one from 18 to 30 years, or precisely 19 out of 86. The cohorts from 18 years to 30 years and from 31 year to 45 years share the same amount of abstainers, by both having three.

No.	Age cohort.	Regular	Occasional	Abstent	Total
1.	18-30	64 (74,41%)	19 (22,09%)	3 (3,48%)	86
2.	31-45	106 (84,12%)	17 (13,49%)	3 (2,38%)	126
3.	46-64	53 (77,94%)	14 (20,58%)	2 (2,94%)	68
4.	65 +	6 (87,75%)	2 (12,5%)	0 (0%)	8

Table 5.1: Type of voters

## Election holding

Citizens of the municipality of Novi Grad Sarajevo believe that the organization of the elections itself can be significantly better, even 173 of them. The 47 participants said they were dissatisfied, while 68 of them are completely satisfied with the way the elections are currently being conducted. The chart *Figure 5.3* shows this statistic more clearly.

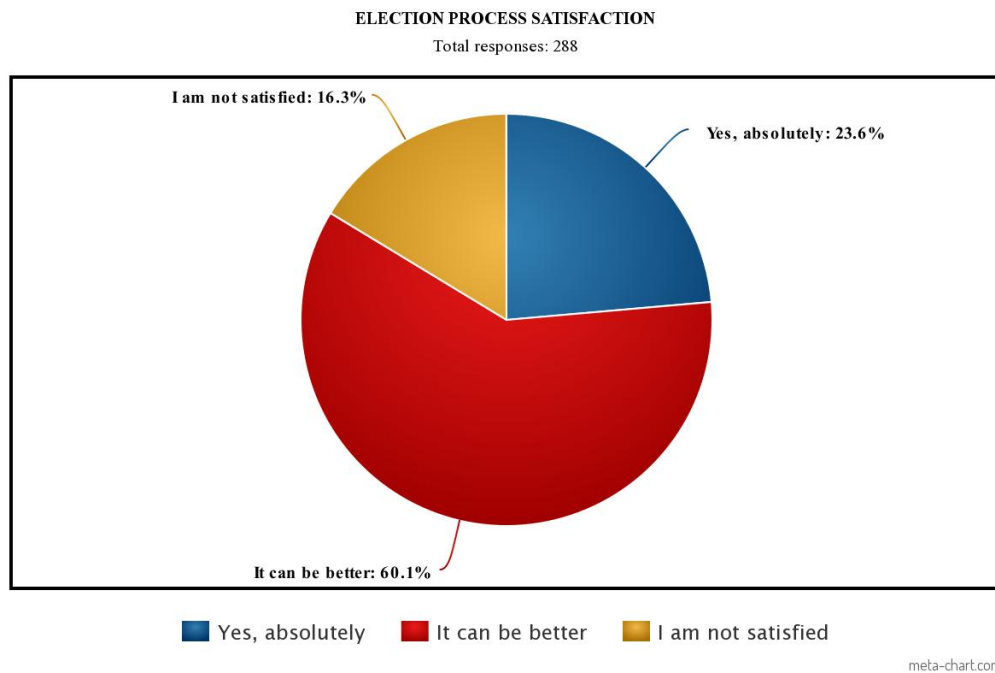


Figure 5.3: Election process satisfaction



### Election fairness

On the question "Do you believe in the fairness of elections in Bosnia and Herzegovina" 157 respondents answers that they don't have trust in election process. Only 15 out of 288 respondents replayed as they do trust in the fairness of elections, while 116 of them answered as partially.

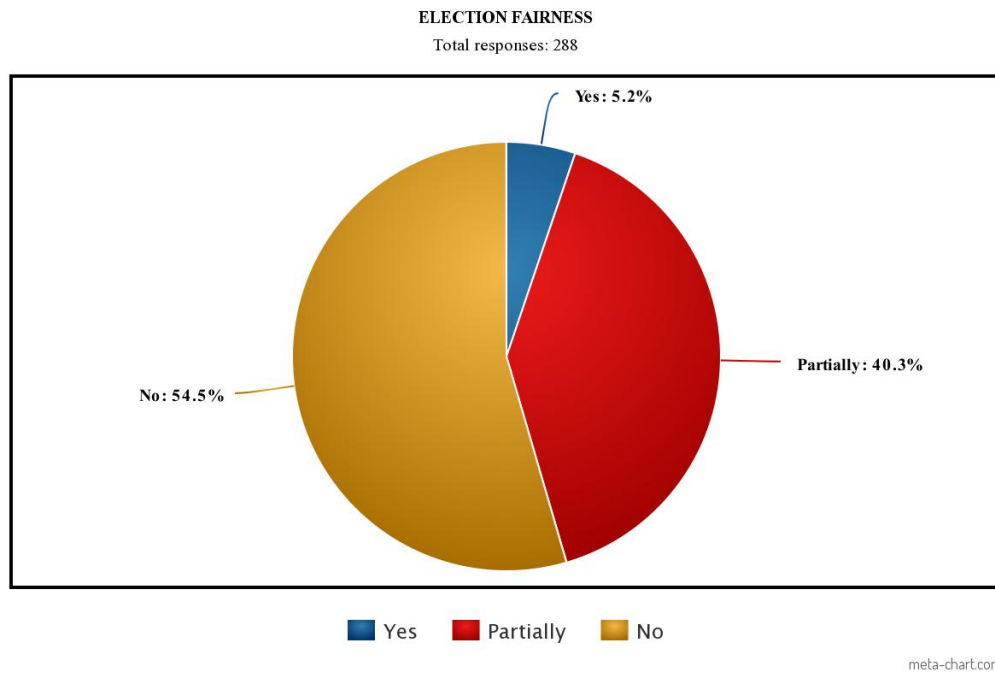


Figure 5.4: Election fairness

### Online voting

From *Table 5.5* it can be seen that 237 out of 288 participants would vote online, while 51 replied as they wouldn't. It is important to emphasize that the respondents were not familiar with the potential election process, and this answer was given purely at the expense of the idea itself.

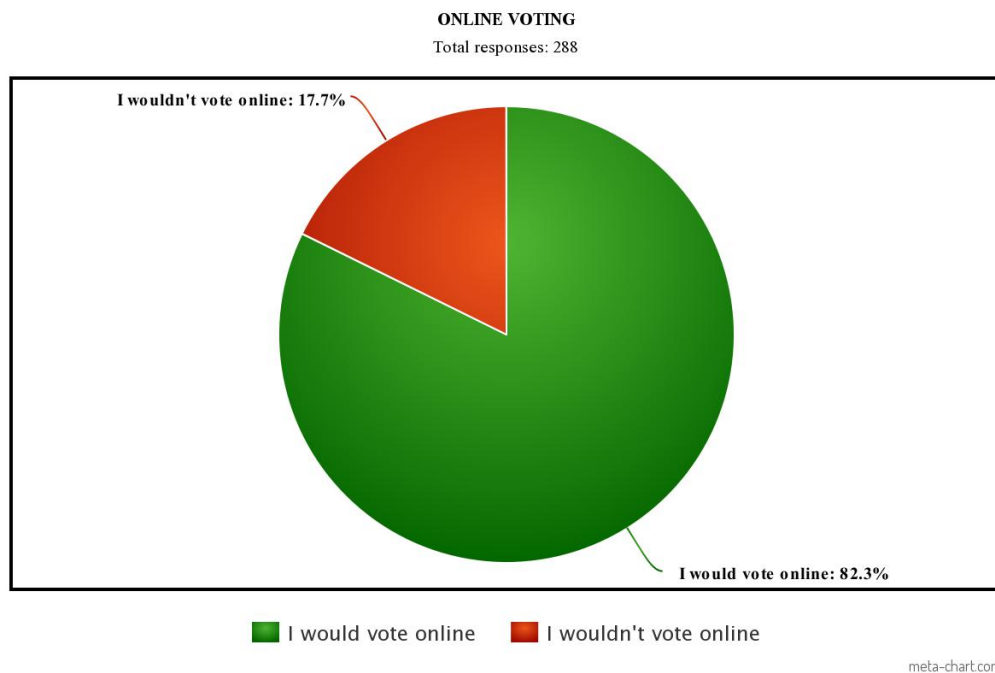


Figure 5.5: Online voting

### Why "no" to online?

In addition to previous question, respondents had an opportunity to give a reason why they do not want to vote online. The results show that 27 out of 51 respondents do not find the online elections reliable; 12 out of 51 consider that current way of voting is better and safer; 6 of them didn't not clarify the specific reason; 4 out of 51 answered as they are not familiar with the process of online voting; only 2 of them said that they do not believe in technology.

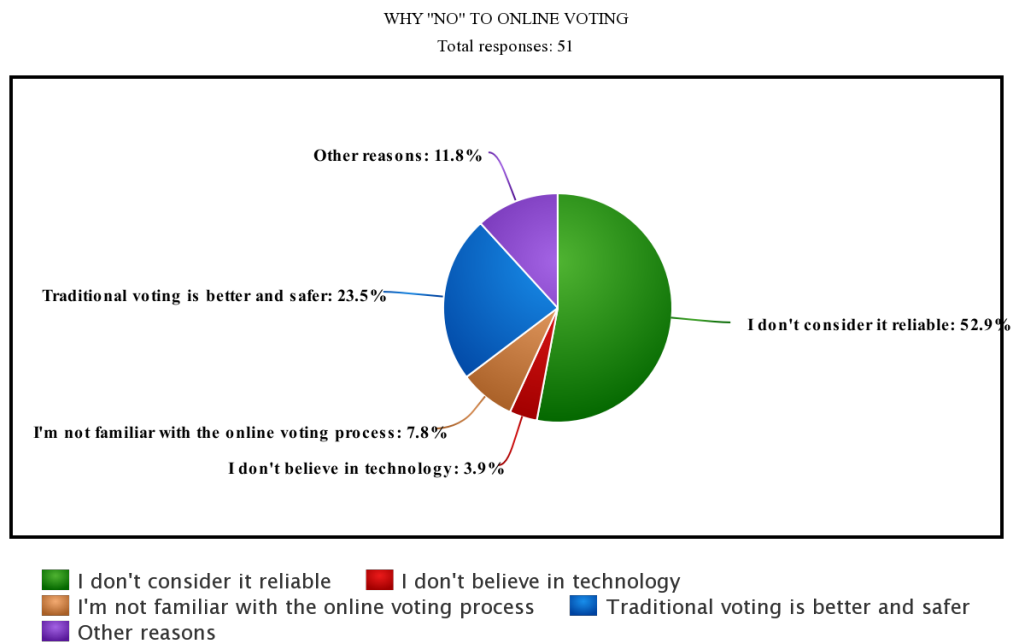


Figure 5.6: Why "no" to online voting

### 5.2.2 Discussion

As we have already mentioned, the survey itself was made with the aim of trying to give us an insight into the interest of the residents of the municipality of Novi Grad Sarajevo towards e-elections. Unfortunately, the results of the poll confirmed the hypothesis that citizens do not trust the current election process.

Since the research was conducted online, although there was no intention, certain groups of people were favored. The first are those who do not use or use very little internet. Such people could not participate in the survey and realistically they make up a certain percentage of people who would very likely be against the idea of introducing online elections, either because of their principles or because of their inability to adapt to new technologies. The thinking that older people will find it harder to adapt to new technology has been shaken by the results of this survey. Results showed that 7 out of 8 respondents over the age of 65 would vote online. If we take a look on the section Switzerland, this information may seem a little less unusual. However, we can't ignore the fact that traditional elections could present quite a challenge for the elders, especially in the environment like Bosnia and Herzegovina. Going to the polls, waiting in line and returning home can be replaced with a few clicks on your computer or mobile phone. It can be concluded that although the logic says that young people should be the driving force in introducing changes in the current electoral process, even the oldest see their benefit in this.

In general, respondents agree that the organization of elections itself must be better. Only 68 out of 288 (23.5 %) respondents believe that the current elections were organized "properly". The rest, 220 of them, believe that changes are necessary.

Probably the most shocking fact is that only 5.2% of respondents believe in the fairness of the election process in Bosnia and Herzegovina. In Bosnia and Herzegovina changes are necessary on many different levels, and elections can be the first step in doing so. Through the implementation of "healthy", safe, objective and fair elections, hope can be given to the residents that corruption is not hidden behind every corner. Exactly that thought can be a reason for implementation of online elections.

What also encourages the very idea of online elections in Bosnia and Herzegovina is the answer of the respondents to the question whether they would vote online. The vast majority of respondents supported this idea, and most young

people are open to this idea, ie 88.37 % of them. This information is something on which the belief that such elections can be held in an environment such as Bosnia and Herzegovina should be based.

From cohort of 51 respondents who would not vote online if they had opportunity for such a thing, almost half consider online elections as distrustful, and exactly that makes one of the key problems which we tried to solve in this work. How to make elections so that they are confidential? How to gain the trust of citizens? One has to understand the fact that not everyone will ever agree with the idea, just as not everyone ever votes for the same political option. According to this research, the target group should be those 4 respondents who explained as a reason for not voting online that they are not sufficiently familiar with the way it would be conducted. This problem can be solved, as mentioned earlier in the text, by a very strong campaign that would explain the process of online elections, explain why they are safe, and give instructions on how to vote correctly. see Confusion and education Online elections cannot be held easily. Their organization also requires a population that will "hold the other side", ie those who will try in every way to disprove the hypothesis that online elections are safe and confidential. Finally, we can say that the research showed that the municipality of Novi Grad Sarajevo is a fertile ground for the implementation of online elections.

### 5.2.3 Suggested model for e-voting

The proposed model for implementing e-voting consists of five different servers that are necessary for them to be held. All of them are located in the building of the Municipality of Novi Grad, in the so-called server rooms, and are strictly monitored during online elections. Strict surveillance means security guards who are there to prevent the entry of outside persons, and video surveillance is there to prevent any kind of embezzlement by those who observe elections.

The server infrastructure looks like this:

- **Client Check Server (CCS)** - It is the only server that is in direct communication with the client. In other words, all actions by the client will be carried out through CCS. CCS is in communication with *Ballot Verification Server*.
- **Ballot Verification Server (BVC)** - It is used for verification of ballots,

ie. checks that they are filled in correctly. BVC is in communication with CCS and *Voter Storage Server*. In addition to checking the ballot in order to reduce the number of invalid ballots and to ensure that the voter is voting correctly, this server also has the function of giving the voter a copy of the "ballot" as proof of voting (Verification). This server does not have access to an open network.

- **Vote Storage Server (VSS)** - A server where all the ballots previously verified by the BVC server are stored.
- **Vote Counting Server (VCS)** - The VCS server is not online, nor is it connected to any of the above servers. Server decrypt the votes, counts them and announces the final results.
- **Log Server (LS)** - It stores all events that have occurred within CCS, BVS and VSS. Only members of the election administration have access to this server.

We will divide the e-voting process into three phases: the phase of registration and authentication, the phase of voting and verification of ballots, and the phase of counting ballots and announcing the results.

### **Registration and authentication**

To register a client for a given application that is intended for e-voting, the following things are required: PIN, JMBG and RSA token.

- **PIN** - A unique combination of four digits that the client chooses when registering in the system.
- **JMBG** - Unique personal identification number (Bos. Jedinstveni Matični Broj Građanina). This is the most basic way of identification in Bosnia and Herzegovina. Every citizen has a unique JMBG. It consists of 13 digits, where the first 7 are related to the date of birth (DDMMYY), the next two numbers are related to the registration area of citizens, the next three numbers indicate a combination of gender and ordinal number for persons born on the same day, and the last digit is called control a number determined by computer mode according to the instructions of the Ministry of Civil Affairs.

- **RSA** - The RSA token is provided to all participants in the online elections through an application intended for the generation of tokens and issued by the competent election body. The token is a combination of 6 digits valid for one minute and can only be used once. At the expiration of one minute, the application generates to the user another token of the same duration.

Figure 5.7 describes first phase of voting protocol. The client connects to the website through which they will vote. To access it, the client is required to enter his name and surname, and a combination of numbers that contains: PIN, JMBG and RSA token. The combination or password looks like:

$$X X X X - D D M M Y Y Y R R S S S C - T T T T T T \quad (5.1)$$

where the first four numbers indicate the PIN, the next thirteen digits represent the JMBG, and the rest of the password indicates the RSA token.

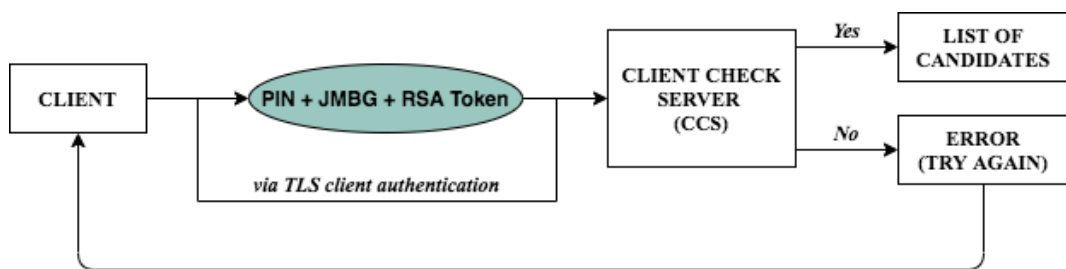


Figure 5.7: First phase of voting: Client registration and authentication

After entering its credentials and accessing the system via the TLS protocol, CCS performs a client check. The check is performed by taking the entered credentials from the user, excluding the PIN and RSA token from them, and searching for the remaining JMBG in the database. If the requested JMBG is found and if the user meets the conditions that allow him to vote, CCS gives him a list of candidates, otherwise an error is displayed on the user’s screen and returns it to the beginning of the registration process.

### Voting and verification of ballots

In Figure 5.8 the ballot verification process is explained. After it is confirmed that the user is the one he pretends to be, a list of candidates is printed in front of him, and the user himself approaches the voting process. He is given a *List of*

*candidates (L)* from which he has the right to select candidates. For example, in the case of a ballot containing three candidates, the user is shown a list containing three candidates. ie.

$$L = [a, b, c]. \tag{5.2}$$

The user selects the candidate, and completes the voting process. Logically, this process involves imagining that each user has their own list V (V as vote). The user has the right to enter one and only one vote in his list V in order for the ballot to be considered valid, e.g.  $V = [a]$ . After the user submit his vote, at that point a verification process begins which verifies that the user has filled in the form correctly. A valid ballot is considered to be a ballot on which the user has chosen one of the three candidates, ie. if the ballot has only one member as  $V.count == 1$ . In case the ballot paper is not filled in correctly, the user receives a warning and is returned to *List of candidates (L)*.

After a properly filled ballot, the user’s vote at that point is in a state called a “double envelope” where the ”outer envelope” represents his digital signature and the ”inner envelope” represents his vote.

Since the verification process was successfully carried out, the digital signature is separated from the ballots and as such goes to the VSS. At the same time, a copy of that ballot (without a digital signature) is sent to the user as a form of verification, and he can be convinced that the VSS has stored the vote he made. This is the end of voter turnout, unless the voter wants to change his decision and in that case has to go through the whole process again.

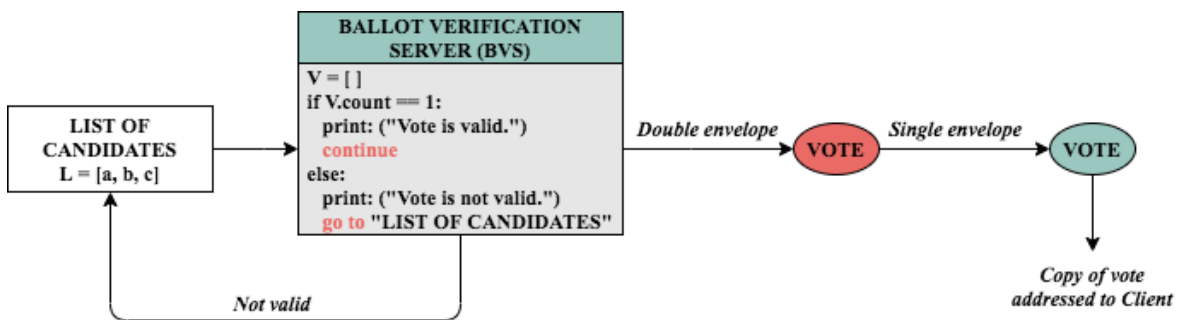


Figure 5.8: Second phase of voting: Voting process and ballot verification

### Counting ballots and announcing the results

In *Figure 5.9* the process of tabulating ballots is explained. At the moment when the vote comes to the VSS, it consists only of the ”inner” envelope, that



is, it is not known who voted, but only how, the so-called ballot secrecy. The "Inner" envelope is encrypted, and as such is stored in the VSS. After the online elections are over, the ballots are transferred to the external memory, through which all ballots are transferred from VSS to VCS. The process of transferring ballots from VSS to VCS is held under special video surveillance that includes recording the screen while the operation of transferring ballots is performed. All videos will be available as additional proof that the election was fair. VCS for the task has to remove repetitive ballots from the same client, keeping only the last one entered. VCS then decrypt the ballots and announces the final results of the online voting. These data are strictly kept, until the end of the traditional elections, when the ballots are added up with ones from traditional voting.

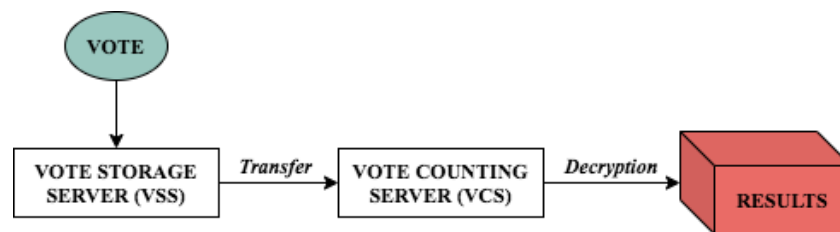


Figure 5.9: Third phase of voting: Vote counting process and declaration of results

### **Pre-election campaign**

Online elections should last 3 days before the traditional ones. If we take for example that the traditional elections are held on October 15, online voting would be possible from October 11 to 14. This would reduce the possibility of forced voting (combined with the option to vote an unlimited number of times). It is essential to have as little time as possible between online and traditional elections. The reason for this is less time during which the results of online voting can leak. Thirty days before the opening of the "online elections" it is necessary to start a strong campaign aimed at educating citizens. Also, it is necessary to convince citizens that the online voting process is safe, and the online election infrastructure itself should be adapted to all citizens so that they are able to understand it. This can be achieved through video materials broadcast on national televisions, and flyers that briefly explain the process that takes place in the background. Finally, part of the source code should be available to citizens before the elections.

# Chapter 6

## Conclusion

The aim of this work was to examine the possibility of applying electronic voting in the municipality of Novi Grad Sarajevo. The purpose of implementing online elections is to increase voter turnout in the municipality of Novi Grad Sarajevo, and to speed up and make the process more accessible. The document dealt with the analysis of already existing electronic elections where their advantages and disadvantages and their impact on the elections themselves were analyzed. We got acquainted with Bosnia and Herzegovina, its history, political situation, election process and the target municipality of Novi Grad Sarajevo. Finally, we conducted a survey on the citizens of the municipality of Novi Grad Sarajevo, where we proved that the municipality is a fertile ground for the implementation of electronic elections. By analyzing the already existing electronic elections, we understood that it is a very complex process, which must be constructed very carefully and in detail. Experiences from Switzerland have told us that online elections have not brought higher turnout, but the very potential of online elections gives us the right to hope that in the future we will be able to vote online. Experiences from Estonia on the other hand have shown us a way to implement online elections on the big stage. Although contested, the online elections in Estonia have not shown any shortcomings since their implementation, which is certainly an encouragement on the way to the implementation of the online elections in Bosnia and Herzegovina.

The conducted survey provided a more realistic insight into the society and political situation in Bosnia and Herzegovina. It was designed in such a way that its results unequivocally show the thinking of the respondents. In the survey, we found that most of those who consider themselves regular voters, which is

certainly a promising figure. Survey confirmed the thesis that citizens do not trust the fairness of elections, which in the context of online elections can be an advantage. In other words, the problem with implementing online elections is generally how to convince citizens that they are safe and fair. If citizens no longer believe in the electoral process, resistance to the introduction of online voting is likely to be lower.

Electronic elections are the future of voting, the question remains when that will become a reality. Clearly, it takes a lot of time to change of this type, but the world we live in and its speed undoubtedly tells us that it is only a matter of time. Bosnia and Herzegovina, with a very interesting history and many natural resources, suffers the results of a very complicated political system, which is slowly but inexorably destroying itself, along with its inhabitants. The large exodus of the population, huge corruption and the constant distrust of the citizens indicate that the situation will only get worse until drastic changes begin to take place. The results of the survey showed that citizens are open to such a change, which is certainly a promising indicator.

This work proved the interest of citizens in online elections, and presented a model on which it could be implemented. In the proposed model, we focused on ensuring the security of the online selection process itself. The implementation of the combination (PIN + JMBG + RSA token) guarantees a high level of security of electronic elections. On the other hand, the use of "double envelope" ensures the secrecy of voters, so that in the end it is unlikely to be traced, and to find out who voted how. In an environment like Bosnia and Herzegovina, where citizens' trust in politicians is low, it is crucial to highlight all the benefits of online voting. The model also represents a developed form of verification that gives voters an insight into how they voted, and prevents voters from voting incorrectly, which would ultimately result in fewer invalid ballots. Although a certain number of the population at each election decides to go out and cancel their ballot, this model does not allow it. The ultimate goal is to increase the turnout, but secondarily we should also think about the "quality" of votes, because if we get a higher percentage of votes that are not valid, we have not made any progress, right?

The introduction of online elections is not and cannot be completely reliable and the development of its infrastructure can be a big deal even for the most developed countries. On the other hand, even though we personally put the ballot in the ballot box, we can never be completely sure of the fairness of the

results because we are not the ones counting the votes.

# Bibliography

- Adeshina, Steve A. and Adegboyega Ojo (2020). “Factors for e-voting adoption - analysis of general elections in Nigeria”. In: *Government Information Quarterly* 37.
- Authority, Estonian Information System’s (2012). *Public key infrastructure PKI*. URL: <https://www.ria.ee/public-key-infrastructure/>.
- Beširević, Fadmir (2008). *Bosna i Hercegovina pod austrougarskom vlašću*. Munich, GRIN Verlag. ISBN: 9783656687016.
- Bochsler, D. (2010). *Can internet voting increase political participation? Remote electronic voting and turnout in the Estonian 2007 parliamentary elections*. In: Paper Presented at the Conference ‘Internet and Voting’. European University Institute, Florence.
- Boras, Pamela (2013). *Devširma (danak u krvi) i proces islamizacije Bosne*. Zagreb, Croatia: University of Zagreb.
- Bosnia, Central Election Commission of and Herzegovina (2015). *Izborni pokazatelji 2002-2014 godina*. Sarajevo, Bosnia and Herzegovina.
- (2016). *Lokalni izbori 2016*. URL: [https://www.izbori.ba/rezultati\\_izbora\\_2016/?resId=13&langId=1#/8/0/0](https://www.izbori.ba/rezultati_izbora_2016/?resId=13&langId=1#/8/0/0).
- Broadcasting, Estonian Public (2014). *Center Party petitions European human rights court over e-voting, Sept. 2013*. URL: <http://news.err.ee/v/politics/4ee0c8a2-b9c2-4d28-8ae4-061e7d9386a4>.
- Committee, Estonian Internet Voting (2014a). *Statistics about Internet voting in Estonia*. URL: <http://www.vvk.ee/voting-methods-in-estonia/engindex/statistics>.
- (2014b). *Using ID-card and mobil-ID*. URL: <https://www.valimised.ee/eng/kkk>.
- Frik, Olivier (2011). *Planning for successful elections with internet voting*. MSc Dissertation. University of Wales.

- Gainous, J. and K. Wagner (2007). “The electronic ballot box: a rational voting model for class, age, and racial bias”. In: *American Review of Politics* 28, pp. 19–35. DOI: <https://doi.org/10.15763/issn.2374-7781.2007.28.0.19-35>.
- Goldberg, Andreas C., Simon Lanz, and Pascal Sciarini (2019). “Mobilizing different types of voters: The influence of campaign intensity on turnout in direct democratic votes”. In: *Electoral Studies* 57, pp. 196–222.
- Goldsmith, Ben (2011). *Electronic Voting & Counting Technologies: A Guide to Conducting Feasibility Studies*. Washington, USA: International Foundation for Electoral Systems (IFES). ISBN: 1-931459-64-9.
- Goodman, Nicole J. (2014). *Internet Voting in a Local Election in Canada*. The Internet and Democracy in Global Perspective. Springer, Cham, pp. 7–24. ISBN: 978-3-319-04352-4.
- Hercegovine, Predsjedništvo Bosne i (2002). *Ustavne i zakonske nadležnosti Predsjedništva BiH*. URL: <http://www.predsjednistvobih.ba/nadl/default.aspx?id=10005&langTag=bs-BA>.
- Interior of Canton Sarajevo, Ministry of (n.d.). *Opći okvirni sporazum za mir u Bosni i Hercegovini*. URL: [https://mup.ks.gov.ba/sites/mup.ks.gov.ba/files/opci\\_okvirni\\_sporazum\\_za\\_mir\\_u\\_bosni\\_i\\_hercegovini.pdf](https://mup.ks.gov.ba/sites/mup.ks.gov.ba/files/opci_okvirni_sporazum_za_mir_u_bosni_i_hercegovini.pdf).
- Izetbegović, Fondacija Alija (2021). *25 godina od potpisivanja Dejtonskog sporazuma*. URL: <https://www.alijaizetbegovic.org/kratki-pregled-sadrzaja-dejtonskog-sporazuma/>.
- Luechinger, Simon, Myra Rosinger, and Alois Stutzer (2011). “The Impact of Postal Voting on Participation: Evidence for Switzerland”. In: *Swiss Political Science Review*. DOI: <https://doi.org/10.1002/j.1662-6370.2007.tb00075.x>.
- Malcolm, Noel (1996). *Bosnia: A Short History*. NYU Press. ISBN: 978-0814755617.
- Miličević, N. (1998). *Constitutional order and political structure of Bosnia and Herzegovina*.
- Oostveen, Anne-Marie and Peter Van Den Besselaar (2004). “Internet Voting Technologies and Civic Participation: The Users’ Perspective”. In: *Javnost - The Public* 11, pp. 67–78. DOI: <https://doi.org/10.1080/13183222.2004.11008847>.

- Paragraf (2010). *Statut Brčko Distrikta Bosne i Hercegovine*. URL: <https://www.paragraf.ba/propisi/brcko/statut-brcko-distrikta-bosne-i-hercegovine.html>.
- (n.d.). *Izborni zakon Bosne i Hercegovine*. URL: <https://www.paragraf.ba/propisi/bih/izborni-zakon-bosne-i-hercegovine.html>.
- Pateman, Carole (1970). *Participation and democratic theory*. Cambridge University Press. ISBN: 0-521-29004-X.
- Petitpas, Adrien, Julien M. Jaquet, and Pascal Sciarini (2020). “Does E-Voting matter for turnout, and to whom?” In: *Electoral Studies*. ISSN: 0261-3794. DOI: <https://doi.org/10.1016/j.electstud.2020.102245>.
- Pippa, Norris (2001). “Digital divide: Civic engagement, information poverty, and the Internet worldwide”. In: *Cambridge university press*.
- Prnjavorac, Advokat (n.d.). *Arbitražna odluka Brčko distrikt BiH*. URL: [https://advokat-prnjavorac.com/zakoni/Arbitrazna\\_Odluka\\_BD.pdf](https://advokat-prnjavorac.com/zakoni/Arbitrazna_Odluka_BD.pdf).
- Puhalo, Srdan and Neda Perišić (2013). *Apstinenti u Bosni i Hercegovini*. Sarajevo, Bosnia and Herzegovina: Friedrich-Ebert-Stiftung BiH. ISBN: 978-9958-884-26-9.
- Saini, Neha, Himani Verma, and Pankaj Sharma (2017). “An Analytical study of E-voting System”. In: *International Journal of Recent Research Aspects* 4, pp. 75–85. ISSN: 2349-7688.
- Sarajevo, Općina Novi Grad (2016). *O nama: Historija*. URL: <https://www.novigradsarajevo.ba/o-nama>.
- Sciarini, Pascal and Andreas C. Goldberg (2016). “Turnout Bias in Postelection Surveys: Political Involvement, Survey Participation, and Vote Overreporting”. In: *Journal of Survey Statistics and Methodology* 4, pp. 110–137. DOI: <https://doi.org/10.1093/jssam/smv039>.
- Springall, Drew et al. (2014). “Security Analysis of the Estonian Internet Voting System”. In: *CCS '14: Proceedings of the 2014 ACM SIGSAC Conference on Computer and Communications Security*, pp. 703–715. DOI: <https://doi.org/10.1145/2660267.2660315>.
- Statistika.ba (2013). *Popis 2013 u BiH*. URL: <http://www.statistika.ba/#link7>.
- Teorell, J., M. Torcal, and J.R. Montero (2007). *Political participation: mapping the terrain*. Citizenship and Involvement in European Democracies: A Comparative Perspective. Routledge, pp. 334–357. ISBN: 978-0-203-96575-7.

Teorell, Jan (2006). "Political participation and three theories of democracy: A research inventory and agenda". In: *European Journal of Political Research*. DOI: <https://doi.org/10.1111/j.1475-6765.2006.00636.x>.



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# Appendix

## A.1 Survey

- **What age cohort do you belong to:**
  - 18-30 years
  - 31-45 years
  - 46-64 years
  - 65+ years
- **How often do you vote?**
  - Regularly (I always vote)
  - Occasionally (I did not vote in all elections where I was able to)
  - I abstain (I do not vote)
- **Are you satisfied with the way local (municipal) elections are held in the municipality of Novi Grad Sarajevo? (The method of holding means: voting at the polling station, voting by mail, voting with the help of a mobile team and voting in absence.)**
  - Yes, absolutely
  - It can be better
  - I am not satisfied
- **Do you believe in the fairness of the election process in Bosnia and Herzegovina?**
  - Yes
  - Partially

- No
- **If there is a possibility to vote online (using a computer or mobile application), would you choose to do so or would you stick to the current voting method?**
  - I would vote online
  - I wouldn't vote online
- **If your answer to the previous question was negative, choose one of the reasons why you would not vote online.**
  - I don't believe in technology
  - I am not familiar with the online voting process
  - I don't consider it reliable
  - I find the current way of voting better and safer
  - Other reasons