

16th Multi Conference on Computer Science and Information Systems



MCCSIS

19-22 July 2022
Lisbon, Portugal

Proceedings of the International Conferences

» ICT, Society and Human Beings 2022

» Web Based Communities
and Social Media 2022

» e-Health 2022

Edited by
Piet Kommers
Mário Macedo



iadis

international association for development of the information society

**INTERNATIONAL CONFERENCES
ON**

**ICT, SOCIETY AND HUMAN
BEINGS 2022**

**WEB BASED COMMUNITIES
AND SOCIAL MEDIA 2022**

and

E-HEALTH 2022

part of the

**MULTI CONFERENCE ON COMPUTER SCIENCE AND
INFORMATION SYSTEMS 2022**

**PROCEEDINGS OF THE
INTERNATIONAL CONFERENCES
ON**

**ICT, SOCIETY AND HUMAN
BEINGS 2022**

**WEB BASED COMMUNITIES
AND SOCIAL MEDIA 2022**

and

E-HEALTH 2022

JULY 19 - 21, 2022

Organised by



international association for development of the information society

Copyright 2022

IADIS Press

All rights reserved

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Permission for use must always be obtained from IADIS Press. Please contact secretariat@iadis.org

As a member of Crossref (a non-profit membership organization for scholarly publishing working with the purpose to make content easy to find, link, cite and assess) each published paper in this book of proceedings will be allocated a DOI (Digital Object Identifier) number for its fast and easy citation and indexation.

Volume Editors:

Piet Kommers and Mário Macedo

Computer Science and Information Systems Series Editors:

Piet Kommers and Pedro Isaías

Associate Editor: Luís Rodrigues

ISBN: 978-989-8704-40-5

TABLE OF CONTENTS

FOREWORD	ix
PROGRAM COMMITTEE	xv
KEYNOTE LECTURE	xix

FULL PAPERS

ICT, SOCIETY, AND HUMAN BEINGS

UA INFORMA CONTRIBUTION TO ATTRACT PROSPECTIVE STUDENTS: AN EXPLORATORY STUDY <i>Margarida M. Marques and Lúcia Pombo</i>	3
TECHNOLOGICAL, ORGANISATIONAL AND PERSONAL FACTORS OF REMOTE WORK: AN EXPLORATORY STUDY <i>Ina Kayser and Martin Lange</i>	11
PROMOTING THE ROAD SAFETY THROUGH THE AUGMENTED REALITY: AN ITALIAN EXPERIENCE IN OCCUPATIONAL SAFETY AND HEALTH <i>Emma Pietrafesa, Nunzia Bellantonio and Agnese Martini</i>	19
EXPLORING CONSUMER ATTITUDE TOWARD SUSTAINABLE ENERGY-EFFICIENT APPLIANCE: PRELIMINARY FINDINGS FOR AUGMENTED REALITY APPLICATION <i>Gabriella Francesca Amalia Pernice, Valeria Orso and Luciano Gamberini</i>	26
THE HUMAN IN THE HOME: PRIVACY INVASION RISKS OF SMART HOME APPLIANCES AND DEVICES <i>Kalala T Nshima and Roelien Goede</i>	33
VIRTUAL REALITY APPLICATIONS IN AUTISM SPECTRUM DISORDER: A SYSTEMATIC REVIEW <i>Mohd Amran Md Ali, Mohammad Nazir Ahmad, Wan Salwina Wan Ismail and Nur Saadah Mohamad Aun</i>	43
CYBERNETIC PHILOSOPHY OF DIGITAL PUBLIC GOVERNANCE: MODELING RECURSIVE SENSORY SYSTEMS <i>Konstantin S. Kondratenko</i>	51

TECHNOLOGICAL USAGE IN DEVELOPMENTAL UNIVERSITIES: A CASE STUDY OF WALTER SISULU UNIVERSITY OF SOUTH AFRICA <i>Agyei Fosu</i>	59
COLLEGE/HIGH SCHOOL STUDENTS' CYBERSECURITY CAREER INTEREST <i>Anthony Joseph, Mary Joseph and Tega Ileleji</i>	66
LEVERAGING SOCMINT: EXTRAPOLATING CYBER THREAT INTELLIGENCE FROM RUSSIA-UKRAINE CONFLICT <i>Bipun Thapa</i>	77
EXPECTATIONS OF SOFTWARE DEVELOPMENT EDUCATION: STUDENTS VS PROFESSIONALS <i>Janet Liebenberg</i>	87
THE EMERGENCE OF LIMINAL CYBERSPACE – CHALLENGES FOR THE ONTOLOGICAL WORK IN CYBERSECURITY <i>Jukka Vuorinen and Ville Uusitupa</i>	96
BRIDGING THE DIGITAL COMPETENCE GAP: TELL US WHAT YOU NEED <i>Sandra Santos, Margarida Lucas and Pedro Bem-Haja</i>	104
VOTING TECHNOLOGIES – FROM OSTRACON TO E-VOTING <i>Elizabeta Trajanovska Srbinska, Smilka Janeska Sarkanjac and Branislav Sarkanjac</i>	112
ARTIFICIAL INTELLIGENCE AND GENDER EQUALITY: A SYSTEMATIC MAPPING STUDY <i>J. David Patón-Romero, Ricardo Vinuesa, Letizia Jaccheri and Maria Teresa Baldassarre</i>	120
 WEB BASED COMMUNITIES AND SOCIAL MEDIA	
IMPROVING PHISHING DETECTION VIA PSYCHOLOGICAL TRAIT SCORING <i>Sadat Shahriar, Arjun Mukherjee and Omprakash Gnawali</i>	131
 E-HEALTH	
CENTRALIZED OR DE-CENTRALIZED DATA AND ALGORITHMS IN THE FINNISH HEALTH CARE INFRASTRUCTURE <i>Jussi Salmi and Lisse-Lotte Hermansson</i>	140
HUMAN MOVEMENT VARIABILITY ANALYSIS IN OFFICE-WORKERS: A REVIEW <i>Maria Eduarda Oliosi, Catia Cepeda, Luís Silva, Daniel Zagalo, Phillip Probst, Ana Rita Pinheiro, João Paulo Vilas-Boas and Hugo Gamboa</i>	147
CHARACTERIZING MEDICAL ANDROID APPS <i>Raina Samuel, Iulian Neamtiu, Sydur Rahaman and James Geller</i>	155
FELIX THE DIGIBUD: UNVEILING THE DESIGN OF AN ICT-SUPPORTED INTERVENTION FOR OCCUPATIONAL STRESS MANAGEMENT <i>Manoja Weerasekara and Åsa Smedberg</i>	163
COULD MEDICAL APPS KEEP THEIR PROMISES? <i>Raina Samuel, Iulian Neamtiu and Sydur Rahaman</i>	173

SINGLE MR IMAGE SUPER-RESOLUTION USING GENERATIVE ADVERSARIAL NETWORK	181
<i>Shawkh Ibne Rashid, Elham Shakibapour and Mehran Ebrahimi</i>	
DIGITAL SUPPORT ACTIVATES YOUNG ELDERLY TO HEALTH-ENHANCING PHYSICAL ACTIVITY	189
<i>Christer Carlsson and Pirkko Walden</i>	
CLINICAL DETERIORATION PREDICTION IN BRAZILIAN HOSPITALS BASED ON ARTIFICIAL NEURAL NETWORKS AND TREE DECISION MODELS	197
<i>Hamed Yazdanpanah, Augusto C. M. Silva, Murilo Guedes, Hugo M. P. Morales, Leandro dos S. Coelho and Fernando G. Moro</i>	
FEATURE UTILIZATION BY MACHINE LEARNING MODELS FOR COLON CANCER CLASSIFICATION	205
<i>Douglas F. Redd, Qing Zeng-Treitler, Yijun Shao, Laura J. Myers, Barry C. Barker, Stuart J. Nelson and Thomas F. Imperiale</i>	
CHARACTERIZING THE CLINICAL LANGUAGE OF OPIOID USE DISORDER	212
<i>Terri Elizabeth Workman, Joel Kupersmith, Cynthia A. Brandt, Christopher J. Spevak and Qing Zeng-Treitler</i>	
A PARSIMONIOUS MACHINE LEARNING APPROACH TO DETECT INAPPROPRIATE TREATMENTS IN SPINE SURGERY ON THE BASIS OF PATIENT-REPORTED OUTCOMES	220
<i>Lorenzo Famiglini, Frida Milella, Pedro Berjano and Federico Cabitza</i>	
A HUMAN-COMPUTER INTERACTION METHOD BASED ON U-NET CONVOLUTIONAL NEURAL NETWORK FOR TARGET MOLECULE OBSERVATION	228
<i>Wenbin Yin, Xinfeng Zhang, Jinpeng Fang, Xudong Zhou and Bin Li</i>	

SHORT PAPERS

ICT, SOCIETY, AND HUMAN BEINGS

TESTING PUBLIC WARNING SYSTEM AT SCHOOL WITH USER INVOLVEMENT - CASE STUDY FROM A RURAL COMMUNITY	239
<i>Anna Maria Urbaniak-Brekke, Øyvind Heimset Larsen and Ivar Petter Grøtø</i>	
AUTONOMY AND AUTOMATION: THE CASE OF CONNECTED AND AUTOMATED VEHICLES	244
<i>Fabio Fossa</i>	
EXAMINING THE INFLUENCE OF ABILITY, TRUST, OPPORTUNITY AND MOTIVATION ON IOT SENSORS ADOPTION FOR PREVENTING FOOD WASTE	249
<i>Yanqing Duan, Ram Ramanathan, Usha Ramanathan, Lakshmi Swamy and Katarzyna Pelc</i>	

WEB BASED COMMUNITIES AND SOCIAL MEDIA

ACTIVE-PASSIVE FRAMEWORK FOR DEVELOPING COMMUNICATION STRATEGIES TO COMBAT MISINFORMATION	254
<i>Safat Siddiqui and Mary Lou Maher</i>	

PROMOTING SOCIAL ACTIVITIES IN AN ONLINE CONFERENCE 259
DURING COVID TIMES: THE CASE OF THE EHSEMI CONFERENCE
*Eliza Oliveira, Ana Margarida Almeida, Rita Oliveira, Nuno Ribeiro,
Oksana Tymoshchuk, Rita Santos, Andreia Sousa and Lersi Duran*

SOCIAL MEDIA PRESENCE OF PUBLIC ADMINISTRATION AS A TOOL 263
TO EDUCATE TAXPAYERS
Tereza Zichová

INVESTIGATING USE AND IMPACT OF SOCIAL MEDIA ON STUDENT 268
ACADEMIC PERFORMANCE: CASE OF A UNIVERSITY IN SOUTH
AFRICA
Ruth Wario

E-HEALTH

MINDSETPLUS: THE ‘MANAGEMENT AND INFORMATION DECISION 274
SUPPORT EPILEPSY TOOL’ TO PROMOTE ASSESSMENT, GOAL-BASED
SKILLS TRAINING, AND SERVICE LINKAGE FOR PEOPLE WITH
EPILEPSY
*Ross Shegog, Refugio Sepulveda, Katarzyna Czerniak, Rosalia Guerrero,
Alejandra Garcia-Quintana, Robert Addy, Kimberly Martin, Latasha Jackson
and David Labiner*

REFLECTION PAPERS

ICT, SOCIETY, AND HUMAN BEINGS

FEMINIST THEMATIC DISCOURSE ANALYSIS IN CS 281
Alice Ashcroft

E-HEALTH

AN INCENTIVE MODEL FOR PATIENT ADHERENCE TO A HEALTH APP 285
Cândida Sofia Machado and Cláudia Cardoso

AUTHOR INDEX

VOTING TECHNOLOGIES – FROM OSTRACON TO E-VOTING

Elizabeta Trajanovska Srbinska¹, Smilka Janeska Sarkanjac² and Branislav Sarkanjac³

¹*Assembly of the Republic of Macedonia, 11 Oktomvri 10, Skopje, Macedonia*

²*Ss Cyril and Methodius University in Skopje, Faculty of Computer Science and Engineering, Rugjer Boskovic 16, Skopje, Macedonia*

³*Ss Cyril and Methodius University in Skopje, Faculty of Philosophy, Goce Delcev 9a, Skopje, Macedonia*

ABSTRACT

One of the allocation methods of scarce resources, especially in the public sector, is based on majority rule. Modern societies use majority rule to elect representative governments that make some of the biggest decisions. Voting is a main vehicle of majority rule. There are four main factors that influence and are affected by voting – technology, law, politics and society. This paper provides an insight into the relationship of the voting technology and the level of development of democracy in a given state.

Voting technologies developed from ostracon in ancient Greece, to Australian paper ballot, to telephone, fax, various forms of electronic voting, internet voting, mobile voting, blockchain and AI supported voting.

E-voting could be considered as a form of display of the level of development of democracy in a given state. From ostracon to e-voting the main question is the same: how to have good life in a good state with good laws. From the answers offered by the Pythagoreans and Plato to today advocates of modern governance it has always been about how to organise a state so that we can live together the best way we can.

KEYWORDS

Voting Technology, Internet, Blockchain, AI voting, Governance

1. INTRODUCTION

Democracy is about choosing government that will make decisions that relate to wellbeing or prosperity of citizens. In most cases it is about determining the priorities of development. And that has to do with allocation of the state budget. One of the allocation methods of scarce resources (besides market price, command, contest, first-come, first-served etc. as in Parkin, 2012), especially in the public sector, is based on majority rule. This method allocates resources in the way that a majority of elected members of governing bodies in a state chooses. Being elected by citizens they indirectly choose what (majority) voters would choose. In general, modern societies use majority rule to elect representative governments that make some of the biggest decisions.

Majority rule is a decision rule that selects alternatives which have a majority, that is, more than half the votes. It is the binary decision rule used most often in influential decision-making bodies, including all the legislatures of democratic nations.

Voting is a main vehicle of majority rule- It is a formal expression of opinion or choice, either positive or negative, made by an individual or a group of individuals.

In modern societies, in a conventional paper voting system, voters visit the nearest polling station to cast their ballots. After the polling deadline, all ballots are counted manually by some trusted entity, such as the nation's electoral commission. Eventually, the casted ballots and voting results are securely stored and managed in some archival venue for a predetermined period of time.

More than thirty years ago, when WWW was invented and became a platform of mass media over the years, numerous and often far-reaching claims about the new media's transformative potential were made. Many authors enthusiastically argued that the Internet will fundamentally change democracy and politics by providing easy and universal access to information, undermining established structures of political power,

democratizing the processes of agenda-setting, increasing the rates of political participation, improving the quality of deliberation and making plebiscitary forms of decision-making feasible (Lindner and Jennen, 2016; Weare, 2002; Anderson and Rainie, 2020).

Today, due to a large number of practical experiences, the debates on the Internet's effects on democracy are considerably less enthusiastic.

However, e-voting is indispensable in modern governance. There are many discussions on relationship of e-voting and e-governance. We would like to stress the importance of the wider context of e-voting that is governance. Here we refer to the framework given by socio-political governance of Jan Kooimann (1993). The theory of socio-political governance focuses on the plurality and interactions of social and political actors in a social-political systems that are characterized by complexity, dynamics and diversity.

It is needless to say that governance includes democracy. If governance includes as many as possible political actors that means that democratic organized society is a prerequisite for good governance. Sophisticated, well thought out voting (electoral) system defines developed democracy (Evan, 2004; Robertson, 2006).

We argue that e-voting could be regarded as a "reality testing" of the progress of democracy in a state. Well organized e-voting is a demonstration of many accomplishments which are necessary for advancement of a democratic state, especially the so-called new democracies of the former Eastern Block. We single out two extremely important goals to be achieved: mature culture of lawfulness and low corruption society.

E-voting could be considered as a form of display of the level of development of democracy in a given state. If e-voting provides significantly more transparent process of election it certainly contributes to development of democracy. If this is the case, by accepting e-voting, the practice of buying votes, intimidation, bribery and manipulation during the elections are more difficult to organize.

Generally, there are four main factors that influence and are affected by voting - technology, law, politics and society (Krimmer, 2012).

2. FROM OSTRACON TO BALLOT

Voting as a process is presumed to begin somewhere in prehistoric times, when open voting, for example, elected a tribal leader or made a decision.

In the antiquity, with the introduction of democracy, the secret ballot begins to be used for voting. For example, the use of pebbles that were secretly placed in the candidate's vessels, pebbles of a different colour for the different candidate in a vessel, or the use of broken pottery 'ostrakoni' or other print media, where the name of the candidate-option being voted for, was written (Roisman, 2011).

The secret ballot enabled the further development of the democratic voting, i.e., the voter to express his voice without fear of the public, and at the same time the possibility of the so-called vote buying – i.e., rewarding the voter for the given vote for the candidate.

Paper voting as a form of secret ballot on a prescribed voting medium was first introduced in the Roman Republic by the Law on Voting (*leges tabellariae*) in 139 BC (Yakobson, 1995). This law also started the transition from public voting to secret ballot, for all types of voting. The reason for prescribing the ballot arose from the need for greater codification of the most important democratic process - the decision-making process, in the then largest country in the Mediterranean, Europe and (one of the largest in) the world, due to difficulties in maintaining the democracy of elections in it. Namely, the prescribed ostracons and other types of voting media are subject to connection, through some marking, handwriting, violation or other type of marking that could connect the voter with his vote and thus discredit the secrecy of the ballot. The ballot was actually the Egyptian papyrus, suitable for writing, but at the same time, under the strict supervision of the state. The law was valid everywhere in the Roman state and for all Roman colonies and protectorates (Yakobson, 1995).

The Australian paper ballot, or also called a secret ballot, is the most widely used voting technology for elections in liberal democracies around the world. Victoria and South Australia were the first states to introduce secrecy of the ballot (1856), and for that reason the secret ballot is referred to as the Australian ballot. The system spread to Europe and the United States to meet the growing public and parliamentary demand for protection of voters. It is a system of voting in which voters mark their choices in controlled

privacy in public places, on uniform ballots printed and distributed by the government or designate their choices by some other secret means.

Some 150 year after the introduction of Australian paper ballot there is nothing radically new on a large scale, despite many radical changes in our lives. We can travel with the speed of sound and exchange information with the speed of light. Admittedly, there were some technological breakthroughs that were included in voting, such as telephone, fax machines, computers, to internet, but most of them were not implemented in most of the countries.

Telephone voting allows remote voting, i.e., the voter can vote from home, without going to the polling station, but due to the difficulties in achieving the security and secrecy needed to vote in state and local elections, has very limited use. Instead, it is very much used in voting for TV shows (Eurovision song contest for example).

Fax voting (or voting by fax machine) is allowed in Alaska with prior registration. It is a way of remote voting with the conveniences it brings, but the problem with the security and secrecy of the ballot is even more pronounced than in a very similar telephone voting.

Electronic voting (e-voting), is a form of computer mediation voting in which voters make their selections using a computer. The voter usually makes his choice with the help of stand-alone electronic voting machines (EVMs), or with computers connected to the Internet (Gibson *et al.*, 2016; Hao and Ryan, 2016; Kersting and Baldersheim, 2004; Katz *et al.*, 2011).

To understand e-voting, it is convenient to consider three basic steps in the election process: 1- composition of ballots, in which voters make a choice, 2- registration of ballots, in which the system records the submitted ballots; and 3-summing, in which the votes are counted. Ballot casting, recording and summarizing are routinely done with computers even in non-electronic voting systems. Electronic voting is strictly a system where the first step, the composition of the ballots (and/or the selection), is done with the help of a computer.

Electronic voting technology may include drilling cards, mechanical machines with wheels and buttons, membrane buttons, optical scanning voting machines, and specialized voting kiosks (such as touch screens) that include a direct recording electronic voting system (DRE) (Herrnson *et al.*, 2008; Herrnson *et al.*, 2009; Dill *et al.*, 2003).

Voting technology with optical scanning machines is not a direct electronic voting technology (Card and Moretti, 2007). The voter votes on a ballot paper which is then scanned to obtain an electronic record which is easily transmitted from the polling stations to the election officials. This can be done in two ways: by scanning and manual counting or by scanning and optical recognition and electronic counting. Because there is a paper ballot, the possibilities for electronic manipulation are reduced because in case of doubt, ballots can be manually reviewed and counted. The electronic part enables fast transfer of electronic data, faster summaries and publication of results. The disadvantage is that the technology consists of 2 systems - electronic and paper, which need to be organized separately and eventually integrated.

A typical DRE machine is composed of a touch screen connected to a computer. Ballots are presented to voters on the touch screen, where they make their choices and vote. The touch screen can be used to assist the voter in a variety of ways, including displaying large fonts and high contrast for the visually impaired, warning the voter to vote by choice, and preventing re-runs.

The DRE machine directly records the ballots and stores the data in its memory. Such a single machine is used for composing, voting and recording votes. The third step, writing the ballot to a memory device, is invisible to the voter (Kumar and Begum, 2012).

Introduction of new technology almost always has some shortcomings. What are the shortcomings of the use of a technology in voting?

Ensuring that voting is recorded, as voting relies on testing the hardware and software of the machine before the election, is the belief that the software running during the election is the same software as the one tested before the election. This is the subject of much controversy.

While testing hardware errors or unintentional software errors can be reliable, the same is not true for malware. Most security experts believe that an insider attack in the software development phase could reach the final product without being detected (although there is disagreement about the likelihood of such an attack). This problem is compounded by the fact that the source code is usually not available for public scrutiny (Dunn and Merkle, 2018).

Cryptographic techniques can partially solve the problem of software authentication. When software is evaluated and certified, a cryptographic hash (a short string of bits that serves as a kind of "signature" for computer code - for example, code length or code number of bits) can be calculated and stored. Just before the election, the hash is calculated. Any change in the certified software will cause the two hashes to be different. However, this technique may not prevent all attacks on the integrity of the software.

Computer viruses can infect a machine during elections. For this to happen, the machine must somehow communicate with another electronic device. Thus, connection to the Internet or wireless devices is usually not allowed. However, the voting session usually begins with the use of an activation card. An employee in the poll, after confirming the eligibility, sets the card to allow one voting session. After the session, the voter returns the card to the voting worker for reuse. At least one DRE system has been shown to be vulnerable to infection by the activation card. An infected machine can be made to register votes differently from those voted (Oo and Aung, 2014).

The threat posed by the DRE not to record votes as voters has led some individuals and organizations to argue that a paper-review report must be prepared for each ballot. DRE manufacturers have responded by adding a printer feature to their DRE. As a result, the systems produce both electronic records and paper records. However, problems with document handling and monitoring, both by voters and election officials, have led to much criticism of these hybrid systems. Many jurisdictions have already rejected them in favour of optical scanning technology (Stewart, 2011).

3. INTERNET VOTING AND MOBILE VOTING

Internet voting is remote electronic voting over the Internet where voters submit their ballots electronically to election authorities from any location. With the rapid use of the Internet, it seemed that the voting process would naturally migrate there. In this scenario, voters would choose from any computer connected to the Internet - including their home one. Beyond voting in regularly scheduled elections, many saw the emergence of these new technologies as an opportunity to transform democracy, enabling citizens to participate directly in the decision-making process. However, many countries have decided that the Internet is not secure enough for voting purposes.

As a first concern, denial-of-service attacks may block the system and to call into question the electoral process. Security experts are also concerned that many PCs are vulnerable to various types of malware. Such attacks can be used to block or replace legitimate votes, undermining the electoral process in an undisclosed manner (Jefferson et al., 2004).

The third concern about e-voting tackles the possibility of voter coercion and vote-selling when voting does not take place in a controlled environment. However, there is no consensus on the seriousness of this problem in stable democracies, as it is generally acknowledged that voting in general is less problematic in stable democracies. Taking the benefits of e-voting into account, it should be introduced more decisively in less stable democracies. Furthermore, this complaint also applies to absentee ballots, which have been widely used in the past, as well as by mail.

Electronic and online voting also provide some advanced opportunities in terms of increasing democracy (the ability to express the opinion of the individual and his influence on joint decisions), which would be very difficult to do with paper voting techniques. The first example is the open lists, i.e., the candidate lists where the parties, instead of a certain number of candidates for fixed positions, could propose extended lists and / or lists with variable order. Voters in this way have the opportunity not only to vote for a particular political party, but also to influence the order in that list, vote for people they trust and are nominated by different parties or independent lists and so on. In this case, the voting process might be preceded by a step of compiling the election-electoral list from the proposed ones, or even adding an unmentioned candidate (Tarasov and Tewari, 2017; Stewart III, 2011).

According to the survey by International IDEA from November 2020, only eight countries in the world allow their voters to cast their ballots to their national parliament elections, to the elections of the local government councils, or to the parliament of the EU online.

In countries such as France (piloting in 2003 and full access to online voting for all voters abroad in 2012), Panama or Pakistan, for example, the option to vote online is reserved for voters who live abroad. In other countries, such as Armenia, this possibility is offered only to diplomatic and military staff posted

abroad. Several States in Australia implemented internet voting for the voters with disabilities, by using their computer screen reader tools when accessing a web-based platform.

In Switzerland, 15 cantons have offered internet voting to voters abroad and to a certain number of voters within their borders.

Some countries are taking advantage of online voting at the local level, such as Canada, where municipalities in the provinces of Ontario and Nova Scotia have been using internet voting since 2003 and 2008, respectively.¹

Estonia remains the only country in the world in which any citizen can cast a remote online or mobile ballot during elections to their national parliament, to local government councils, or to the parliament of the EU – on all the election levels. Estonia became an online voting pioneer in 2005, is now a reference for the use of Internet voting technology. During the 2019, 47% of the votes to the European parliament were cast by online voters. Mainly because of denial-of-service attacks threats, Estonia maintains its traditional voting infrastructure along with the e-voting option.

4. FUTURE VOTING TECHNOLOGIES

E-voting is one of the sectors that can be advanced by blockchain technology. The idea of blockchain-enabled e-voting (BEV) is derived by analogy with the use of the digital assets like Bitcoin with which this technology was first introduced (and is the successor to the distributed P2P technologies that are used for a longer time). The BEV stipulates that every voter has a wallet - virtual access point that contains user credentials. Each voter, analogous to Bitcoin and other virtual currencies, receives one coin representing one voting opportunity (Susskind, 2017; Huang *et al.*, 2021).

The essential benefit of the introduction of the blockchain is that unlike the centralized management and verification of voting by the election authorities, voting councils or similar bodies, blockchain technology allows decentralization, i.e., the ability to check/verify from multiple places, even from each participant in the elections. With the blockchain, each participant actually has an insight into all the votes, the times when they occurred, these records cannot be changed, and everyone has access to them.

The blockchain technique used in the voting process provides increased voting security, and allows for greater immediacy: voting takes place on a perhaps more unreliable device - for example a mobile phone instead of a polling station, but with similar security.

5. AI-VOTING (ARTIFICIAL INTELLIGENCE SUPPORTED VOTING)

Voting assisted by AI-Artificial Intelligence implies 3 directions through which AI would improve the voting process:

- The first direction is to increase the security of voting through algorithms such as face recognition, voice, biometric information, handwriting for signature and the like.
- The second direction implies that in the voting process, a preliminary proposal of a vote is included, which the voter would then confirm, based on, for example, analysis of a questionnaire, analysis of programs of parties and candidates, previous voting of candidates, etc. The proposed questionnaire, for example, would guide the voter through a sequential question-based algorithm to the proposed vote. In this way, the voter is helped to cast his or her vote for the candidate who best meets his or her requirements.
- The third direction implies assistance to AI on the part of the candidates, politicians, parties, with better review and adjustment of the demands of the voters, i.e. their programs based on the proposals-analysis of the AI are adjusted, and at the same time better target the voters.

The use of AI in the voting process brings many benefits, improvements and increases the effectiveness and democracy of voting (Polonski, 2017), but in addition to the basic technological problems - ensuring secrecy and validity, which are similar to electronic and online voting, carries its own risks and ethical dilemmas, which should be further analysed and addressed.

¹ <https://medium.com/edge-elections/which-countries-use-online-voting-3f7300ce2f0>

6. WEIGHTED VOTING (W-VOTING)

Weighted voting is a concept-idea proposed by the first author of this paper, and represents an opportunity for a step forward in the voting process, supported by technology, towards greater democracy and immediacy of this process.

Weighted voting is based on advanced voting and / or voting with the help of AI. Basically, this technique will be based on electronic / internet / blockchain voting with adding weight to each group of voters, i.e., voters receive a different weight of their vote depending on the proximity to the voting topic or other criteria. In this way, for example, the citizens of the capital can vote for the development of the capital, as well as those who do not live in it, but the first should get more weight for their votes because they have a common capital with other citizens in the country, but additionally they live in it.

From the information technology side, in addition to the stated problems and solutions brought by electronic, internet and blockchain supported voting in this most advanced type of voting, the voter database should be complemented with the database of coefficients that would add or deduct weight to these votes. Coefficient databases can experience a rapid increase from 1 to thousands, similar to the growth of, for example, Google PageRank technology.

7. PUTTING E-VOTING IN WIDER CONTEXT

E-voting is considered as a tool for fostering democracy and governance. However, it alone is not sufficient. And in reality, it is far from easy to implement it, despite expertise and political will.

There is no simple recipe. Many factors should be put in play. We will briefly mention two – probably the most important.

First, it is the education. Long-term investing in education is probably the first thing to do. Finland is probably the best example in Europe for how education changes a society – it raises the living standard; it eradicates unemployment and it improves competition. Better education doesn't come automatically with buying computers for every student. The process of education is a complex engagement. For illustration, The OECD's Programme for International Assessment (PISA) evaluates both digital and print reading performance. From education in general it is much easier to go to political education.

Education is a prerequisite of democracy. As we mentioned before, corruption is linked with less stable democracies.

Second it is fighting the corruption. The fight against corruption must be accompanied with building a culture of lawfulness. E-voting without visible accomplishment in these areas is a weak factor of democracy. This implies only one thing. E-voting must be a part of a comprehensive development framework. E-voting is a concept that should be regarded as a test for digital literacy, culture of lawfulness and success in fight against corruption. The advocates of e-voting must be aware of the social and political context in a given country, triggering the discussions on corruption and lawfulness. So, even opening a discussion in a parliamentary committee, let alone a public debate, is a good sign. It is a sign of a new level of relationship of trust between state and citizens. And to put it succinctly, e-voting is all about trust.

Studies confirms that lower corruption is associated with an increase in the PISA scores across countries. Other indicators like access to education, enrolment, and schooling years show that there is significant relationship between education quality and corruption (De La Cruz Aquino, 2017). Access to education is indispensable for the implementation and sustainability of democracy (Climent, 2006).

Oelkers (2000), referring to Condorcet, argues that modern society needs active critical citizenship, citizens able to exchange arguments in the public arena of politics. The most important virtue in such society is civic courage, and this requires education.

8. CONCLUSION

The voting process is as old as civilization. It is not stationary, but a process that is constantly evolving and improving with the development of technology, social consciousness and democracy. The use of ICT technology in the voting process not only finds increasing application, but also becomes crucial and opens

many new opportunities for comprehensive development of society. The benefits it brings are obvious. So, it is necessary to avoid the potential risks, in order to come up with solutions that will enable its smooth and safe use.

Potential risks are not only malware, hacking, attacks on databases of voters and many others security flaws.

Underdevelopment in key areas of a democratic society should be considered as risk, as well.

To put it in other words, e-voting enables voting in controlled privacy in private places. That means that you vote in privacy of your home on your personal computer. You are voting in privacy and you are not threatened or pressurized by another person. Control means that you cannot cast multiple votes, you cannot doodle on the e-paper, you cannot vote for another person etc. E-voting must provide software and security systems to prevent misuse or abuse of privacy. In our opinion that is only one side of the story. Control is not only surveillance and arresting evildoers. There are many democratic risks of vertical, bureaucratic, non-transparent and non-accountable state. E-voting works better in horizontal state with mature culture of lawfulness. Culture of lawfulness together with rule of law provide personal freedom (condition that guards a person from threats and coercion).

E-voting should be a test for advanced culture of lawfulness and measure of the success of fight against corruption. This claim is backed up with knowledge that countries that apply e-voting have lesser level of corruption. As lawfulness is indispensable in fighting corruption, it is indispensable in e-voting systems.

The main thesis in this study is that there is no e-voting in high corrupt states. And that there is a connection between low corruption and developed culture of lawfulness.

From ostracon to e-voting the main question is the same: how to have good life in a good state with good laws. From the answers offered by the Pythagoreans and Plato to today advocates of modern governance it has always been about how to organise a state so that we can live together the best way we can.

ACKNOWLEDGEMENT

This work was partially financed by the Faculty of Computer Science and Engineering at the Ss. Cyril and Methodius University in Skopje.

REFERENCES

- Anderson, J. and Rainie, L., 2020. Many experts say digital disruption will hurt democracy. *Pew Research Center*. Online: <https://www.pewresearch.org/internet/2020/02/21/many-tech-experts-say-digital-disruption-will-hurt-democracy>.
- Card, D. and Moretti, E., 2007. Does voting technology affect election outcomes? Touch-screen voting and the 2004 presidential election. *The Review of Economics and Statistics*, 89(4), pp. 660-673.
- Climent, A.C., 2006. *On the Distribution of Education and Democracy* (No. 0602).
- De La Cruz Aquino, N., 2017. Correlation Between Corruption and Education in Developing Countries.
- Dill, D.L., Schneier, B. and Simons, B., 2003. Voting and technology: Who gets to count your vote?. *Communications of the ACM*, 46(8), pp. 29-31.
- Dunn, M. and Merkle, L., 2018, March. Overview of Software Security Issues in Direct-Recording Electronic Voting Machines. In *Proceedings of the ICCWS 2018 13th International Conference on Cyber Warfare and Security, Washington, DC, USA* (pp. 8-9).
- Evan, W.M., 2004. Voting technology, political institutions, legal institutions and civil society: a study of the hypothesis of cultural lag in reverse. *History and technology*, 20(2), pp.165-183.
- Gibson, J.P., Krimmer, R., Teague, V. and Pomares, J., 2016. A review of e-voting: the past, present and future. *Annals of Telecommunications*, 71(7), pp.279-286.
- Hao, F. and Ryan, P.Y. eds., 2016. *Real-world electronic voting: Design, analysis and deployment*. CRC Press.
- Herrnson, P.S., Niemi, R.G., Hanmer, M.J., Bederson, B.B., Conrad, F.G. and Traugott, M.W., 2009. *Voting technology: The not-so-simple act of casting a ballot*. Brookings Institution Press.

- Herrnson, P.S., Niemi, R.G., Hanmer, M.J., Francia, P.L., Bederson, B.B., Conrad, F.G. and Traugott, M.W., 2008. Voters' evaluations of electronic voting systems: Results from a usability field study. *American Politics Research*, 36(4), pp. 580-611.
- Huang, J., He, D., Obaidat, M.S., Vijayakumar, P., Luo, M. and Choo, K.K.R., 2021. The application of the blockchain technology in voting systems: A review. *ACM Computing Surveys (CSUR)*, 54(3), pp.1-28.
- Jefferson, D., Rubin, A.D., Simons, B. and Wagner, D., 2004. Analyzing internet voting security. *Communications of the ACM*, 47(10), pp. 59-64.
- Katz, G., Alvarez, R.M., Calvo, E., Escolar, M. and Pomares, J., 2011. Assessing the impact of alternative voting technologies on multi-party elections: Design features, heuristic processing and voter choice. *Political Behavior*, 33(2), pp. 247-270.
- Kersting, N. and Baldersheim, H. eds., 2004. *Electronic voting and democracy: a comparative analysis*. Springer.
- Kooiman, J. ed., 1993. *Modern governance: new government-society interactions*. Sage.
- Krimmer, R., 2012. The evolution of e-voting: why voting technology is used and how it affects democracy. *Tallinn University of Technology Doctoral Theses Series I: Social Sciences*, 19.
- Krimmer, R., 2019. A structure for new voting technologies: what they are, how they are used and why. In *The Art of Structuring* (pp. 421-426). Springer, Cham.
- Kumar, D.A. and Begum, T.U.S., 2012, March. Electronic voting machine—a review. In *International Conference on Pattern Recognition, Informatics and Medical Engineering (PRIME-2012)* (pp. 41-48). IEEE.
- Lindner, R., Aichholzer, G. and Jennen, L., 2016. Electronic democracy in Europe. *Prospects and challenges of e-publics, e-participation and e-voting*. Cham: Springer.
- Oelkers, J., 2000. Demokratie und Bildung: über die Zukunft eines Problems. *Zeitschrift für Pädagogik*, 46(3), pp. 333-347.
- Oo, H.N. and Aung, A.M., 2014. A survey of different electronic voting systems. *International Journal of Scientific Engineering and Technology Research*, 3(16), pp.3460-3464.
- Polonski, V., 2017. The Good, the Bad and the Ugly Uses of Machine Learning in Election Campaigns. *Centre for Public Impact*.
- Parkin, M., 2008. *Microeconomics*. Pearson Education.
- Robertson, L., 2006. One Man One Vote: Trust between the Electorate, the Establishment, and Voting Technology. *Journal of Technology Studies*, 32(2), pp.85-89.
- Roisman, J., 2011. *Ancient Greece from Homer to Alexander: the evidence* (Vol. 10). John Wiley & Sons.
- Stewart III, C., 2011. Voting technologies. *Annual Review of Political Science*, 14, pp. 353-378.
- Susskind, J., 2017. Decrypting democracy: Incentivizing blockchain voting technology for an improved election system. *San Diego L. Rev.*, 54, p.785.
- Tarasov, P. and Tewari, H., 2017. The future of e-voting. *IADIS International Journal on Computer Science & Information Systems*, 12(2).
- Weare, C., 2002. The Internet and democracy: The causal links between technology and politics. *International Journal of Public Administration*, 25(5), pp. 659-691.
- Yakobson, A., 1995. Secret ballot and its effects in the late Roman Republic. *Hermes*, 123(H. 4), pp.426-442.