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Insights into Internet Voting: Adoption Stages, Drivers & Barriers, and the Possible Impact of COVID-19

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ABSTRACT

This thesis investigates how global internet voting adoption occurs. Contrary to the expert expectation in the last millennium, it has not taken the world by storm. The present work investigates why that is the case and what adoption stages, drivers and barriers can be identified for internet voting. Further, it explores whether the current COVID-19 pandemic has a positive impact?

A new framework is proposed using a set of five innovation theories, Social Construction of Technology (SCOT), Gartner's Hype Cycle, the Techno-Economic Paradigm (TEP), Unified Theory of Technology Acceptance (UTAUT) and Diffusion of Innovations (DOI). The resulting framework consists of a political and individual decision-making level, five general adoption stages and four narratives to explain technology diffusion. In order to understand if this framework can provide answers for the lack of take up, 18 expert interviews and extensive complementary desk research were conducted.

The findings confirm the framework, including in which stages countries are, and identify the political level and contextual factors as bottlenecks, as well as the hopes in COVID-19, which might indeed be a turning point for internet voting adoption, which provides avenues for further research.

Keywords: *internet voting, adoption stages, drivers and barriers, COVID-19, diffusion of innovations*

List of Abbreviations

CoE	Council of Europe
CSO	Civil Society Organisation
DOI	Diffusion of Innovation
DRE	Direct-Recording Electronic Machine
EMB	Election Management Body
EU	European Union
ICT	Information and Communication Technology
IDEA	Institute for Democracy and Electoral Assistance
IFES	International Foundation for Electoral Systems
IO	International Organisation
IVS	Internet Voting System
NVT	New Voting Technologies
ODIHR	Office for Democratic Institutions and Human Rights
OSCE	Organisation for Security and Cooperation in Europe
SCOT	Social Construction of Technology
TAM	Technology Acceptance Model
TEP	Techno-Economic Paradigm
UN	United Nations
UTAUT	Unified Theory of Acceptance and Use of Technology

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"I would dream of [voting on phones] because I think that's where we live. […] We have more information on a phone about us than is in our houses. And so why not?"

Tim Cook, CEO Apple Inc.[1]

INTRODUCTION

This thesis at hand investigates the global adoption patterns of internet voting (i-voting) and the recent trends during the COVID-19 pandemic.

From Richard Buckminster Fuller (1963) in the mid 20th century over Bill Gates (1995, p. 271), who predicted in his book *The Road Ahead* that "voters will be able to cast their ballots from home or their wallet PCs" to the opening quote of this thesis by Apple's CEO, Tim Cook (2021), the idea of remote electronic voting has been envisioned by contemporary leaders since the first half of the last decade. A prediction that was increasingly made at the beginning of the early 2000s as the interest in the internet and information and communication technologies (ICT) grew bigger.

Bill Gates' quote translated into present understandings probably refers to what is nowadays called i-voting, which is a form of remote voting that is conducted in unsupervised environments such as one's home. If one compares his quote with the opening quote by Tim Cook, it does not sound very different, despite being said around 26 years earlier. In fact, the technology has been around for over two decades and has not achieved to be diffused as it was expected that it would be. During the early 2000s, a great interest in novel technology existed, and much investment occurred alongside the general developments of ICTs to enhance democratic processes. Experts and politicians back then were convinced that in the course of the following 20 years, every democratic election would be conducted via electronic voting and even using the internet (Krimmer, 2017).

[1] From an interview with Tim Cook and New York Times on 05.04.2021, accessible on: https://www.nytimes.com/2021/04/05/opinion/apples-ceo-is-making-very-different-choices-from-mark-zuckerberg.html?showTranscript=1.

However, that is not the reality and returning once more to the quote by Cook of this year; it seems that this is still a present vision for contemporary leaders. Therefore, the question can be raised why i-voting has not adopted as it had been expected and how the diffusion of i-voting actually occurs. Moreover, since recently, the interest in i-voting technology has heightened due to the global COVID-19 pandemic. Another question raises what concrete developments around i-voting adoption occurred during the pandemic and what predictions for its future diffusion can be made (Krimmer et al., 2021a).

The understanding of i-voting's diffusion seems to be common questions that have been raised in academia and yet lack a holistic overview and common first understanding, which this thesis aims to provide. Moreover, this thesis investigates the most recent trends due to the COVID-19 pandemic. This present work will solely focus on i-voting, which is a specific form of electronic voting (e-voting), but for a better understanding of research intersections between these two topics, the following section depicts previous work related to both issues.

Previous works on e-voting have investigated diffusions of e-voting (e-voting) in Europe and drivers and barriers around e-voting (Kersting & Baldersheim, 2004), on adoption factors of e-voting by young people (Schaupp & Carter, 2005), the evolution of e-voting (Krimmer, 2012), the global e-voting status (Vegas & Barrat, 2016) and to provide an e-voting framework (Risnanto et al., 2020).

On i-voting, previous studies examined the global status quo (Gibson et al., 2016; Krimmer et al., 2007), studied the origins of remote online voting (Krimmer, 2017), aimed at providing a historical overview on i-voting usage (ACE, 2020; Khutkyy, 2020) and facilitating conditions for i-voting implementation on the examples of Estonia and Switzerland (Górny, 2021). Furthermore, i-voting adoption was explicitly investigated for the Estonian case (Vassil et al., 2016), and respective adoption phases were identified for the Estonian case (Vinkel & Krimmer, 2017).

Due to the current global COVID-19, several elections that were meant to take place were postponed, and discussions about whether to implement novel, sustainable and long-term voting solutions in response to the current events have appeared (Asplund, 2021; Krimmer et al., 2020). In line with that identified research gap, this thesis poses the following research question: How is

i-voting technology adopted in the global context? Furthermore, it divides this research question into a set of sub-questions that aid to answer the overarching question:

1) Which global or respectively, regional trends and adoption stages for i-voting can be identified and why is that the case?
2) Which drivers and barriers impact the adoption process of internet voting, and why do they drive or impede adoption?
3) How are the current COVID-19 developments impacting the development of i-voting technology?

In order to answer these questions, the work at hand is structured as follows: the first chapter provides an overview of the background, history and developments of i-voting technology, the second chapter presents the methodology, and the third chapter depicts the theoretical framework that guides this research. Then, chapter four analyses the findings and five discusses the results against the research questions and the theoretical framework. Finally, chapter six comprises the conclusion and the outlook into further research.

1 BACKGROUND AND HISTORICAL DEVELOPMENT

The US played an essential role in i-voting development, as starting under Bill Clinton in 1999, they conducted their first feasibility assessments (Krimmer, 2017). In further efforts, the US began to pilot their first internet voting system (IVS) during the 2000s presidential elections in which a group of overseas militaries were granted the possibility to cast their vote online and further in two primary elections in 2000 in which voters from five US American states were able to cast their votes online (Alvarez & Hall, 2004; Leenes, 2002).

The arising issues during Florida's elections in 2000 had substantial impacts on the subsequent development of the US American electoral system as well as with regard to the issued feasibility report for i-voting technology (Krimmer, 2017; Saltman, 2006). The report concludes that IVS "pose a significant risk to the integrity of the voting process", which shows the severe implications of the events in Florida 2000's presidential election for the topic of i-voting technology in the US (Mote Jr et al., 2000, p. 2). Following the events in Florida, the US Congress passed the Help America Vote Act (HAVA) in 2002, which set out new regulations and standards for election systems. This newly passed act simultaneously opened up new possibilities, markets and avenues for e-voting developments which the Americans pursued instead. The US has maintained to pilot and offer internet voting for militaries overseas and astronauts in space according to the American UOCAVA Act (Goodman, 2017; Scytl, 2015).

The early 2000s were shaped by many trials for internet voting, such as in the UK in 2001 (Leenes, 2002), the French expatriate living in the US voting online in 2002 (Enguehard, 2007), the Canadian local remote online elections in the city of Markham in Ontario (Goodman, 2017), the Catalonian parliamentarian elections (Riera & Cervelló, 2004) and in Switzerland in 2003 in a communal referendum of Geneva (Serdult et al., 2015).

In 2004 the Council of Europe's Recommendation, also known as Rec(2004) 11 for the first time defined legal, procedural as well as technical guidelines for righteous e-voting adoption (Council of Europe, 2004). This guideline became the status quo reference for various states and a guideline to proposing e-voting regulations (Driza Maurer et al., 2014).
The Netherlands trialled early IVS for the European Parliament's election in 2004 as well as their national elections in 2006. However, this practice has stopped since 2007 due to hacking into the

system occurred (Loeber, 2014). Since then, the Netherlands have neither re-adopted i-voting nor e-voting machines into their electoral systems (Loeber, 2018).

In 2007 in Estonia, the first-ever binding and nationwide elections were held[2]. This milestone is of particular importance as Estonia, until today, remains to be the only case worldwide which with i-voting adoption on all levels of elections and for the entire electorate (Krimmer, 2017). In an issued report about the Estonian 2007's elections, observers stated that "the internet voting system […] appeare[d] to have functioned in the Estonian context on this occasion [but] the authorities should reconsider whether the internet should be widely available as a voting method or […] on a limited basis or at all" (OSCE/ODIHR, 2007, p. 2). Despite the critiques and recommendations to discontinue i-voting in elections, Estonia maintained the IVS in their elections and further introduced six years later a new generation of their IVS including features to ensure individual verifiability (Gibson et al., 2016).

With the Philippines, during the same year piloting i-voting for overseas voters, also a non-Western context started to consider the novel technology (Scytl, 2015).

A significant event impacting e-and i-voting expansion was the German Constitutional Court case in 2009 which rendered the deployment of e-voting machines in German elections unconstitutional (Bundesverfassungsgericht, 2009; Krimmer et al., 2007). This particular court case was perceived worldwide as a warning sign to reconsider the implementation of other new voting technology (NVT) into election systems and to update legal frameworks (Vegas & Barrat, 2016). A similar court judgement was announced by the Austrian Constitutional Court after the country's pilot of i-voting technology in an election of its Student Federation (Wenda, 2016).

Nevertheless, further pilots took place in Norway in 2011 (Khutkyy, 2020) and the Åland Islands in 2019 (Dueñas-Cid et al., 2020).
Norway, besides Estonia and Switzerland, might have been the case which had undertaken the most considerable diffusion efforts worldwide (Vinkel & Krimmer, 2017). After two deployments

[2] The first binding local elections were held already in 2005, but Estonia is particularly first with providing i-voting for the entire electorate in nation-wide parliamentary elections.

in 2011 and 2013, the system was discontinued due to a change of political climate in 2014 (Amundsen, 2019).

Other considerations and pilots occurred in New Zealand (Molineaux, 2018), South Africa (Fokane, 2021), Mexico (Vegas & Barrat, 2016), Armenia (Manougian, 2020), Panama (IFES, 2019a), Oman (IFES, 2019c), UAE (The UAE Government, 2020), India (Dave, 2015; Singh et al., 2017) have piloted IVS. More recently, Pakistan (Binte Haq et al., 2019) have piloted i-voting technology, and Ukraine has issued feasibility studies and set out its first timeline for introduction in October 2020 (IFES, 2019b).

Since COVID-19, a new interest for i-voting can be observed, and discussions have been resumed (Krimmer et al., 2021a). How and in what way i-voting diffusion has been affected by COVID-19 is discussed in Chapter 4.3 of this thesis. The next chapter introduces the methodological approach of the empirical study.

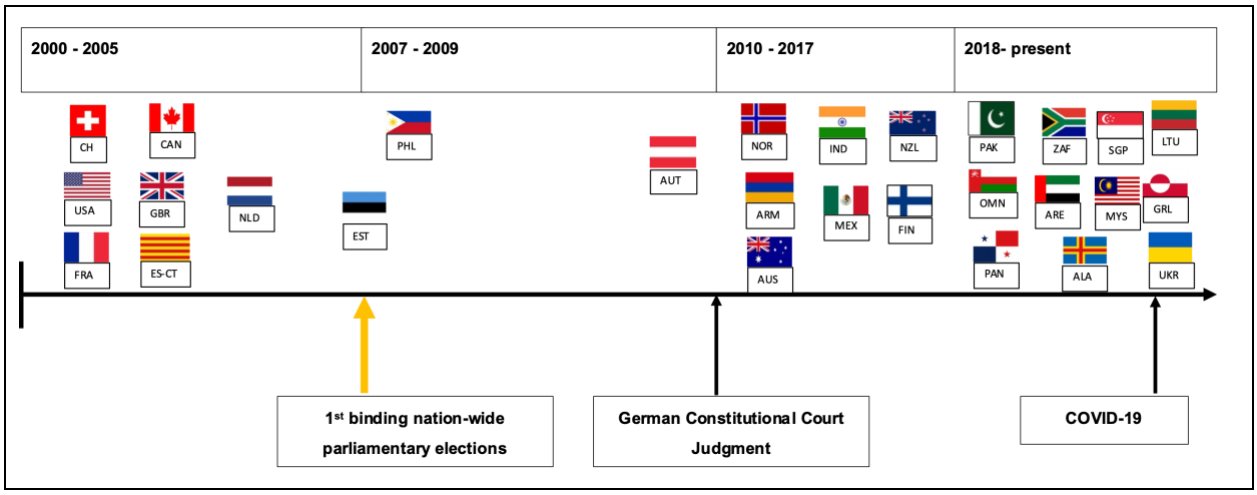

Figure 1:Historical Distribution of Cases Using i-Voting

Countries & Semi-Autonomous Territories	Adopted	Discussion	Stopped
Åland Islands			X
Australia	X		
Austria			X
Armenia	X		
Canada	X		
Catalonia			X
Estonia	X		
France	X		
Finland			X
Greenland		X	
India			X
Lithuania			X
Malaysia			X
Mexico		X	
Netherlands			X
New Zealand			X
Norway			X
Oman	X		
Pakistan	X		
Panama	X		
Philippines		X	
Singapore			X
South Africa			X
Switzerland			X
UAE	X		
Ukraine		X	
United Kingdom			X
USA		X	

Table 1: Overview on Global Internet Voting Adoption Cases

2 METHODOLOGY

The aim of this research is to understand how i-voting technology adoption occurs, to identify adoption stages, discern drivers as well as barriers and make implications for the future considering the global COVID-19 pandemic trends.

The most appropriate method to investigate these subjects is a qualitative research which enables to gather evidence to create a holistic understanding of complex social relations in pluralised contexts (Flick, 2014). Qualitative research is a method that helps to understand the opinions and perceptions of particular groups of people (Silverman, 2018). That makes it an appropriate tool to explore adoption patterns, drivers and barriers which highly rely on such social factors.

For this research project, the qualitative empirical method of a nonexperimental including expert interviews promoted by Brown & Hale (2014) is applied. Nonexperimental designs usually consist of the collection of qualitative data and are selected when it seems unpractical or too resource intense to establish a totally controlled environment for experiments with internal validity requirements (Brown & Hale, 2014). This design enables the researcher to capture subjective characteristics that are related to culture, personal perception, political views, etc. (Brown & Hale, 2014).

This research is conducted using a deductive epistemological approach to acquire knowledge. The deductive process, as opposed to the inductive method, is a technique in which hypotheses are derived from theories and later tested against collected data (Ormston et al., 2014). Furthermore, this work uses a similar approach to "systematic combining", which refers to a strategy to iterating the established theory with the empirical findings to adjust the theoretical framework on the basis of the results (Dubois & Gadde, 2002, p. 554). This thesis uses an a priori established framework against which the empirical findings will be compared and discussed (Eisenhardt, 1989). However, this present work does not foresee updating the framework constantly but in retrospect to the analysis of the findings.

The following will introduce the 2.1) data collection, including 2.1.1) sampling; 2.1.2) execution: (research tools, data validity and research forms); 2.1.3) content analysis and eventually describe the 2.2) research limitations.

2.1 Data Collection

Expert interviews. The data collection of this research is conducted via semi-structured expert interviews and complemented by desk research (Rubin & Rubin, 2012). Expert interviews are an exploratory method to attain essential information in a particular field of studies and have been increasingly gaining relevance as a qualitative research method in recent years (Bogner et al., 2014). Desk research is an effective method in which a researcher only utilises findings that others have already made via their research in order to establish a status quo in academia and to show a gap in previous research (Travis, 2016; Verschuren et al., 2010; Webster & Watson, 2002).

Desk research. This desk research was mainly conducted via the internet using the following meta-data bases: Web of Science, Scopus and by using Google Scholar. In order to avoid biases and gaining insights on the most recent research conducted that has yet to be published in journals, Google Scholar is a very effective tool. The desk research used the keywords "i-Voting", "i-Voting Technology", "History of i-Voting", "e-Voting History", "Adoption Stages of i-Voting", and "Remote Voting".

2.1.1 Sampling

According to Bogner et al. (2014), a person qualifies as an expert who is a competent and privileged person due to the ability to access information about a particular field of research. The qualitative research is conducted in the social context, provided on the basis of Krimmer's (2012) Mirabilis framework that aids identify the respective stakeholders involved in the implementation process of e-voting technology. In the context of this research, it will be limited to three stakeholders: i) Media/observer, ii) election management and iii) inventors or vendors of voting technology. More precisely, it will focus on practitioners/EMBs/policymakers, scholars and election observers, as well as vendors or inventors of i-voting technology.

Potential experts were identified via different avenues: Either as authors of academic literature or were mentioned as experts in relevant literature or were found as participants in academic conferences in this field of study. The last option of finding new experts was through the interviews itself in which other experts suggested interviewing a particular expert for that topic

Accordingly, a pool of 25 potential experts was identified. Of 25 experts, 18 agreed to participate in this research, six did not reply, and one person declined due to time constraints. Hence, 18 interviews were conducted, transcribed, confirmed and analysed. In Appendix 1, a list of all experts can be found and the respective backgrounds and affiliations that they belong to according to which they had been identified.

2.1.2 Execution

Research tools. The interviews were conducted on either MS Teams or Skype and recorded via video and audio recording devices (Quick Time/ MS Teams video recording tool). The interview duration ranged from 38:32 min up to 1:45 h. For storage, the university's One Drive cloud was used as it complies with the European data protection standards set out by the GDPR. Hence, the recording will only be stored for a period of processing the data for a reason stated in the informed consent form that each expert signed prior to the execution of the interview.

Data validity. Further, all interviews were transcribed, and the transcripts were shown to the respective expert for confirmation. Data triangulation is granted through confirming cross-checking answers against either statement of other interviewees or findings from the literature.

Relevant forms. All interviews were led in a semi-structured way guided by a questionnaire that can be found in Appendix 2. All experts were given a consent form (to be found in Appendix 3) that shall confirm that their information may be used for the purpose of enhancing this research project as well as to give the opportunity to consent for using their personal data. All experts were anonymised by default in order to achieve higher data yields, as one might expect the interviewees to speak more openly when remaining anonymous.

2.1.3 Content Analysis

For analysis of the interviews, the codification software NVivo was used. In order to effectively analyse qualitative content such as transcripts, a valuable method is to codify texts (Medelyan, 2020). The analysis in this thesis used Mayring's (2014) deductive coding method. The respective codes were deductively established in line with the research question and the theoretical framework in order to yield relevant findings. The empirical findings will be cited as in-text citations with the interview number in brackets, in the following format: e.g., single citation [1], multiple citations [1;2; 3…].

2.2 Research Limitations

This research has natural limitations with regard to its research design. Primarily, the finding of appropriate experts can limit the findings of the study to the extent that either not the most applicable experts might have been identified or that specific experts did not confirm to participate in the research (Flick, 2014). In particular, it was more challenging to achieve an even distribution among gender and geographics. Although the researcher was willing to avoid such a divide, in reality, it is difficult to find enough experts from all regions and enough female experts for the interview since the field is still dominated by Western male experts.

Also, during the interview process, issues may arise, mainly due to the lack of testing the human language, which may cause ambiguity and hence distort the originally intended meaning of words by the expert (Ochieng, 2009).
The following limitation is about qualitative research as such, as to their lack of generalizability as it would be the case in quantitative research (Ochieng, 2009).

3 THEORY

This section develops the theoretical background for the assessment of technological diffusion. As opposed to other technologies, i-voting consists of two levels of adoption processes, the political, which is a collective process and the individual adoption decision (Krimmer & Schuster, 2008). The collective adoption, which introduces the technology to a societal context, occurs at the governmental and administrative level, while the individual adoption refers to the technology acceptance by society at large and the degree of usage by the community. Since i-voting diffusion comprises of the interaction between social factors and technology, five theories were chosen that provide explanations from four different angles. These angles look from the socio-political context, the technological evolution and maturity progression, the individual usage and the adoption stages, as well as adopter categories.

On the political level, the following theories have been chosen: The Social Construction of Technology (SCOT) for the socio-political context, the Gartner Hype Cycle, which is a preferred tool by practitioners, and the more scientific profound theory called the Techno-Economic Paradigm, which is both used to assess technology maturity. On the individual level, in order to understand whether and how the technology is accepted, this thesis looks consults the Unified Theory of Technology Acceptance (UTAUT). As a bridging element between the political and individual decision-making level, the Diffusion of Innovations theory (DOI) is depicted that will aid to understand the decision stages and adopter categories.

3.1 The Social Construction of Technology (SCOT)

SCOT by Trevor Pinch and Wiebe E. Bijker is a social constructivist theory that is used in the camp of science and technology, ICT studies and technology path dependency (Fulk, 2017; Klein & Kleinman, 2002; Pinch, 2001). As opposed to techno-determinist scholars, SCOT understands that social structures in terms of norms, values, preferences or other matters shape technological development (Bijker et al., 2012). This theory argues that technology adoption is a socially-driven and collective phenomenon because technology is "a product of the social, economic, and cultural environment in which it is situated" (Humphreys, 2005, p. 231). Since election technology is a very politically and socially driven matter, SCOT provides the tools to investigate the social

aspects that impact i-voting adoption. SCOT has, further, been used in vast fields of technology adoption to study mobile banking (Bhatiasevi, 2016), ICT in health services (Kijsanayotin et al., 2009) and ICT adoption by students (Attuquayefio & Addo, 2014).

Bijker and Pinch's (1984) theory mainly consists of the following elements: 1) interpretative flexibility, 2) closure and stabilization efforts including 2a) relevant social groups and 2b) redefinition of a problem. Last, this theory deals with 3) the broader context. All of these elements are explained in the following.

The interpretative flexibility (1) refers to the subjective understanding of technology and how it ought to be used as it is designed can vary from the perception of a user that might use it in a different way than it was intended. Moreover, it can differ in its path that it is designed by various producers. Therefore, there is a difference of interpretation vis-à-vis the producer as well as the multiple users of that technology. Basically, there is neither one objective truth on how technology would be understood nor an objective truth on how that artefact ought to be designed.

The closure and stabilization (2) create the second element of this framework and refers to the point when a technology achieved to be established within society. This can either mean that debate has ceased to exist over that technology or that stabilization of that technology has been established. Stabilization hereby means that new technology achieves to solve problems for a relevant social group (2a) of people. It does not matter whether objectively a technology managed to solve or not solve a societal problem. All that is required for it to be 'stabilized' or 'closed' is that these relevant social groups perceive that the technology solves the problem.

In SCOT, there is no objective logic that would declare when technology is finally developed enough to meet society's needs. These indicators are purely subjective, perceived by the relevant social groups of society (Klein & Kleinman, 2002). Another approach to achieve closure and stabilization would be to redefine the problem (2b) so that the current technology would live up to the standard of solving a societal problem. These aspects seem relevant as i-voting may be conducted and perceived differently in respective contexts. Democratic systems differ in design, so do their election system differ from one another.

The spreading of technology is influenced by the 3) broader social and political context and their specific social groups. Since the socio-cultural and political context impacts how norms and values are shaped, this also affects how the artefact is accepted. This element, however, only plays a minor role in Pinch's and Bijker's framework (Klein & Kleinman, 2002).

SCOT was originally built upon the idea of agents and not sufficiently upon the structural formation of systems (Klein & Kleinman, 2002). The further critique was raised regarding the oversimplification of the power structure distribution within society (Winner, 1993). In order to understand these shortcomings better, this theory will consult DOI and UTAUT further, which provide explanations for that. In opposition to the socially driven theory following, two approaches that regard the diffusion process from the technology perspective are introduced.

3.2 The Gartner Hype Cycle

The Gartner Hype Cycle is a model that generically explains the development of a particular technology over time (Dedehayir & Steinert, 2016). The model provides explanations on the typical stages of technology development: 1) innovation trigger, 2) peak of inflated expectations, 3) trough of disillusionment, 4) slope of enlightenment, and 5) plateau of productivity and has prior been used to assess the current status of AI and digital government technology (Fenn & Blosch, 2018; Moore, 2019; Panetta, 2018; Stevens, 2020). For this thesis, it is purposed to provide a more practical understanding of the development of i-voting.

In the first phase, as depicted in Figure 2, which is called the innovation trigger, the new technology is introduced and through that new product or idea, the public interest is acquired, which in addition is amplified by the media and industry through large investments (Dedehayir & Steinert, 2016; Fenn & Blosch, 2018).

In the second stage, early success stories and through the media created hype, blur the vision of the true nature of technology, and decision-makers follow the trend instead of evaluating the risk carefully (Fenn & Raskino, 2008).

In the third stage, as this is yet an unmatured technology, the overinvestment cannot yield the expected return, and financiers will get disappointed (Dedehayir & Steinert, 2016; Fenn & Blosch, 2018; Fenn & Raskino, 2008).

Subsequently, stage four is marked by actors who stuck with the technology through the phase of disillusionment. In that phase, a more mature technology starts to yield net profits. Additionally, certain investment inflows begin to come back, and the technology reaches social acceptance again (Dedehayir & Steinert, 2016).

The fifth stage demonstrates real-world success stories and is being integrated by society. An increasing number of organizations, companies, governments etc., feel comfortable implementing the technology as the matured technology has proven to be less risky (Fenn & Raskino, 2008).

Internet voting technology might have experienced a similar course of maturity. In certain real cases, such as Estonia, it has been proven to be effective and internationally recognized (Goodman, 2017). In other cases, it has not and might be approaching a plateau of productivity in the near future due to the current necessity to vote remotely during COVID-19 (Krimmer et al., 2020).

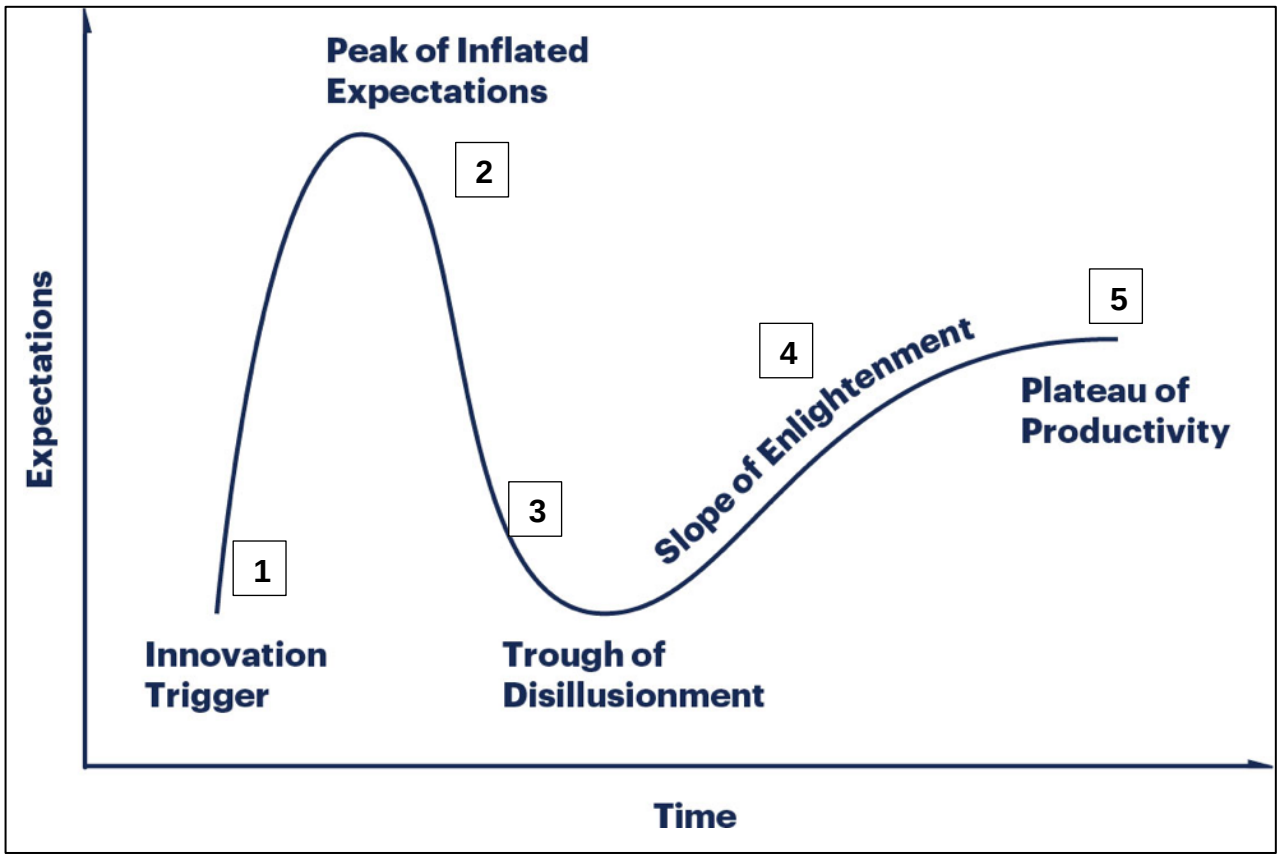

Figure 2: Gartner Hype Cycle (Source: Gartner Inc.)

3.3 The Techno-Economic Paradigm (TEP)

TEP by Carlota Perez "describe[s] the direction in which technological change and innovation are most likely to take place" (Drechsler et al., 2009, p. 3). TEP explains the course of technological revolutions and the shifts and changes that they bring across within society, the economy and inside of institutions (Perez, 2003). There are similarities between Gartner's hype cycle and TEP with regard to the maturity development of technology, but TEP is a more scientifically acknowledged theory and while the Hype Cycle is a preferred concept by practitioners. TEP recognises the phase of overinvestment as well as the 'crash'. However, TEP goes furthermore into the idea that overinvestment leads to a financial crisis among the entire society.

In TEP, an illustration of two periods exists. The first period is described as the *installation period*. The installation period consists of two phases: 1) the irruption phase and 2) the frenzy phase. During the 1) irruption phase, a new technology disrupts the pre-dominant techno-economic paradigm, which leads to high investments without backed returns and paves the way for the

second phase, the 2) financial bubble, to occur. Consequently, this will lead to the transition stage between the two periods, which is comprised of a financial crisis. In that stage, all non-economically valid actors will be cast out, and merely economically viable actors remain in the system. Subsequently, the *deployment period* appears and introduces the 3) synergy phase in which the matured technology is used for steady production and large-scale adoption throughout the entire society, as well as its institutions, takes place. The last stage of the second phase is called the 4) maturity phase, which closes the chapter on that technology, as only a few new industries, actors and technology improvements would enter the market and eventually, the time for a new paradigm shift is being prepared (Perez, 2003).

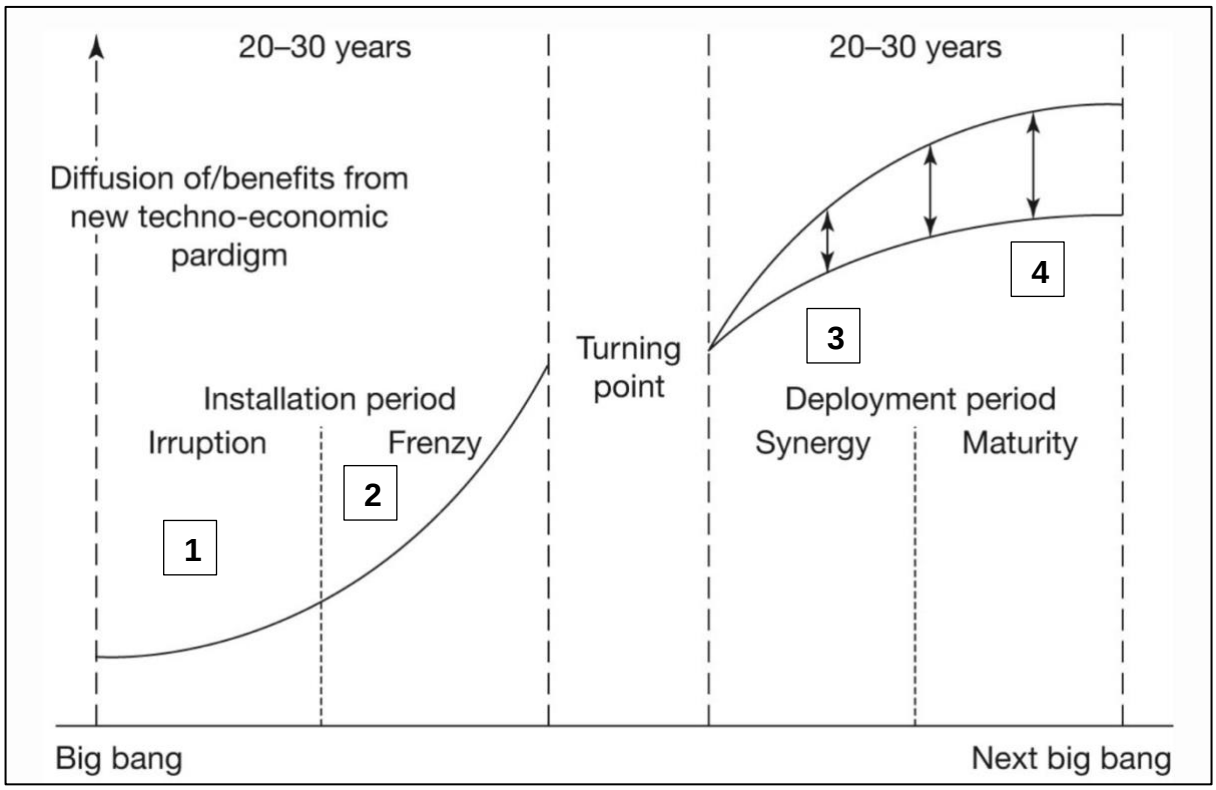

Figure 3: Four Phases of TEP (Scherrer, 2015)

Similar to the Hype Cycle, this theory is used to discern the maturity of i-voting technology and to understand whether COVID-19 might be the described turning point for the deployment period of large-scale i-voting to take place.

In the following, UTAUT will provide the tools to discern the technology acceptance patterns on the individual level.

3.4 Unified Theory of Acceptance and Use of Technology (UTAUT)

The theory by Venkatesh (2003) uses four indicators to explain the adoption of new technologies by individuals and highlights the utility and benefit-oriented assessment, which aids to understand the diffusion of i-voting on the individual level. These indicators are 1) performance expectancy, 2) effort expectancy, 3) social influence and 4) facilitating conditions.

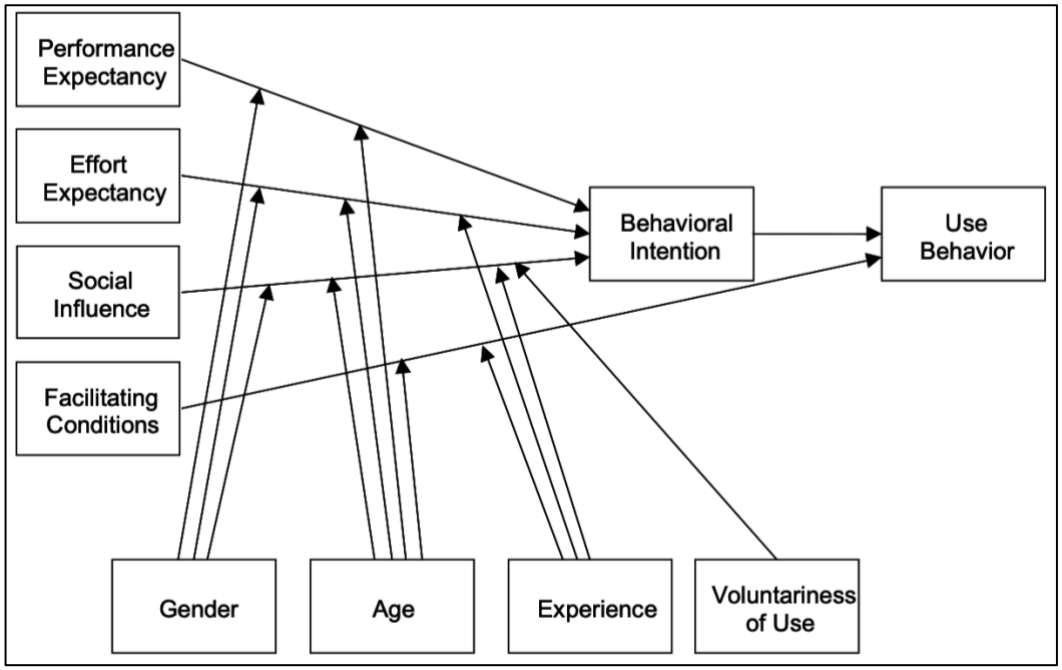

Figure 4: UTAUT Model (Source: Venkatesh et. Al., 2003)

The first three attributes are directly influencing users' intention and behaviour, whereas the last attribute, 4) facilitating conditions, is now determining users' behaviour as depicted in Figure 5. Additionally, the model provides four variables that classify the impact of the determinants according to the diversity of the users by i) gender, ii) age, iii) experience and iv) voluntariness of use.

Similar to the older Technology Acceptance Model (TAM), the most crucial key tenet of the UTAUT model is the emphasis on the subjective perception of users towards the novel solution (Davis, 1985). The 1) performance expectancy refers to the degree of perceived usefulness for better performance in specific tasks by a user. TAM highlights (Davis, 1985), and later UTAUT emphasises that adoption occurs according to users' perception of the innovation, not of the objective measurements entailed to it.

Secondly, a user might expect technology to be easy to be used or somewhat connected to much 2) effort. The perception of the effort that needs to be made strongly depends on the four variables. Age and gender, in specific contexts, might cause significant differences in the perceived effort that is required in order to utilize a technology (Khechine et al., 2014).

Social influence 3) is about the degree that users perceive that influential figures within society voice in favour of the new technology or not. The last attribute, 4) facilitating conditions, is defined by one's perceived organizational and technical infrastructure. It relates to the question of whether a technology is perceived to be supported by the general context.

This theory offers tools for the assessment of technology acceptance on the individual level. In order to categorise the individuals within society and to provide a framework that aids to determine adoption stages for i-voting, subsequently, DOI will introduce these concepts.

3.5 Diffusion of Innovations (DOI)

Everett M. Rogers' (2003) theory explains how, why and at what pace innovations spread among societies (McGrath & Zell, 2001). This thesis uses three of his dimensions that are 1) communication channels, 2) time, and 3) the social system. Besides a wide range of topics, DOI was used to study i-voting diffusion in Estonia, relevant technological deployments in different fields (MacVaugh & Schiavone, 2010) and general acceptance of e-government services (Abdel-Fattah, 2014; Vassil et al., 2016).

In order to understand the diffusion of i-voting, this theory will be used to assess the communication channels (1), utilise the adoption stages and adopter categories in the dimension of time (2) and use the elements provided in the dimension of the social context (3).

Communication channels (1) enable the sharing of new ideas and technology as well as the gathering of information on a new innovation by potential adopters. Therefore, means such as mass media and interpersonal channels such as face-to-face meetings are standard tools that are used to reach the desired effect in either promoting or demoting a technology.

The dimension of time determines in which velocity and volume and via what stages diffusion occurs. This dimension is helpful in determining the adoption stages of i-voting, which are depicted in the 1) innovation-decision process of DOI. This measurement can be displayed in five stages: 1) Knowledge/awareness stage, 2) persuasion, 3) decision, 4) implementation and 5) confirmation. These stages represent an adoption process. All stages are portrayed in more detail in Table 2.

1) Knowledge / Awareness	Decision-making entity is exposed to new innovation
2) Persuasion	Attitude is developed, which could be favouring or disfavouring.
3) Decision	Process in which the actor makes a decision to either adopt or reject the innovation
4) Implementation (only if *adopted* in stage iii)	Re-invention of the technology occurs, and altered usage exists
5) Confirmation (only if *adopted* in stage iii)	Re-affirmation of adoption by a collection of promoting evidence that the innovation was useful

Table 2: Innovation-Decision Process (Adoption Stages)

Another element in the dimension of time is the adopter categories that explain the 2) innovativeness of an individual, which are depicted and elaborated on in Table 3.

1) Knowledge / Awareness	Decision-making entity is exposed to new innovation
2) Persuasion	Attitude is developed, which could be favouring or disfavouring.
3) Decision	Process in which the actor makes a decision to either adopt or reject the innovation
4) Implementation (only if *adopted* in stage (3)	Re-invention of the technology occurs, and altered usage exists
5) Confirmation (only if *adopted* in stage (3)	Re-affirmation of adoption by a collection of promoting evidence that the innovation was useful

Table 3: Adopter Categories

These categories can be depicted as shown in Figure 5

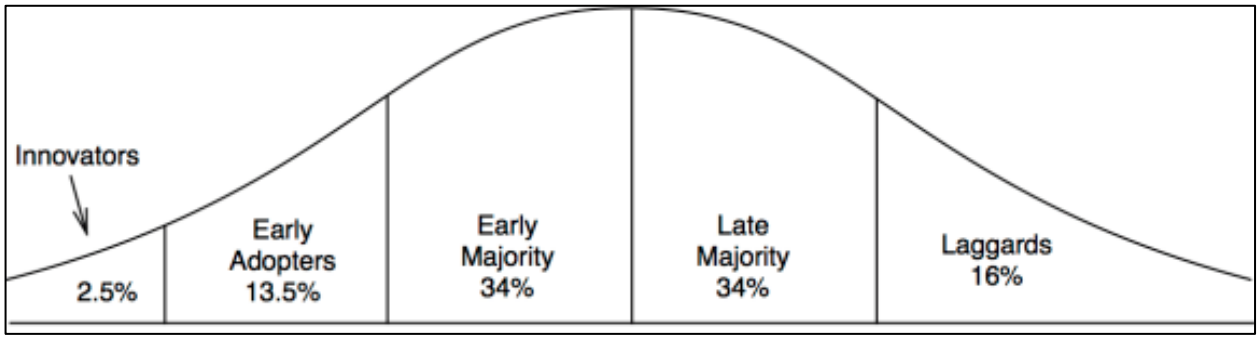

Figure 5: Bell-Curve Shaped Adoption Rates (Singer, 2013)

The social system (3) in DOI describes the influence of cultural norms and values for innovation adoption and further elaborates the opinion-making process within society by *opinion leaders* and *change agents.* Due to their technical skill, sociability and adaptation to the customs and norms of that system, they are influential in shaping DOI. Furthermore, they are seen to be the bridge between resource systems and users and able to utilise mass-communication channels to convey their messages.

DOI's properties are the adoption categories on the individual level and adoption stages on the political level, which are used to understand the adoption of i-voting worldwide. Further, it also provides the tools to assess what role public discourse delivered through change agents and opinion leaders plays in promoting or impeding i-voting diffusion on both decision levels. Subsequently, a summary of the core categories is provided, and propositions that aid the empirical research will be formulated.

3.6 Summary and Propositions

The theoretical framework is constructed upon the key ideas of the five innovation theories. Respective core elements are found in Appendix 4. The established framework concludes: Technology diffusion is a process and is incumbent upon several subjective and social factors such as society's structure, adopter characteristics and adoption stages, discourse and perception. However, no hierarchy of the five dimensions can be presented at this point. Further, it needs to be tested whether this model also captures the adoption cycle and adoption drivers as well as barriers of i-voting technology.

The framework suggests that the different dimensions are embedded into one context, in which vis an evolutionary process, under the impact of perception, adopter categories and the discourse the diffusion of internet voting technology is shaped, as depicted in Figure 6.

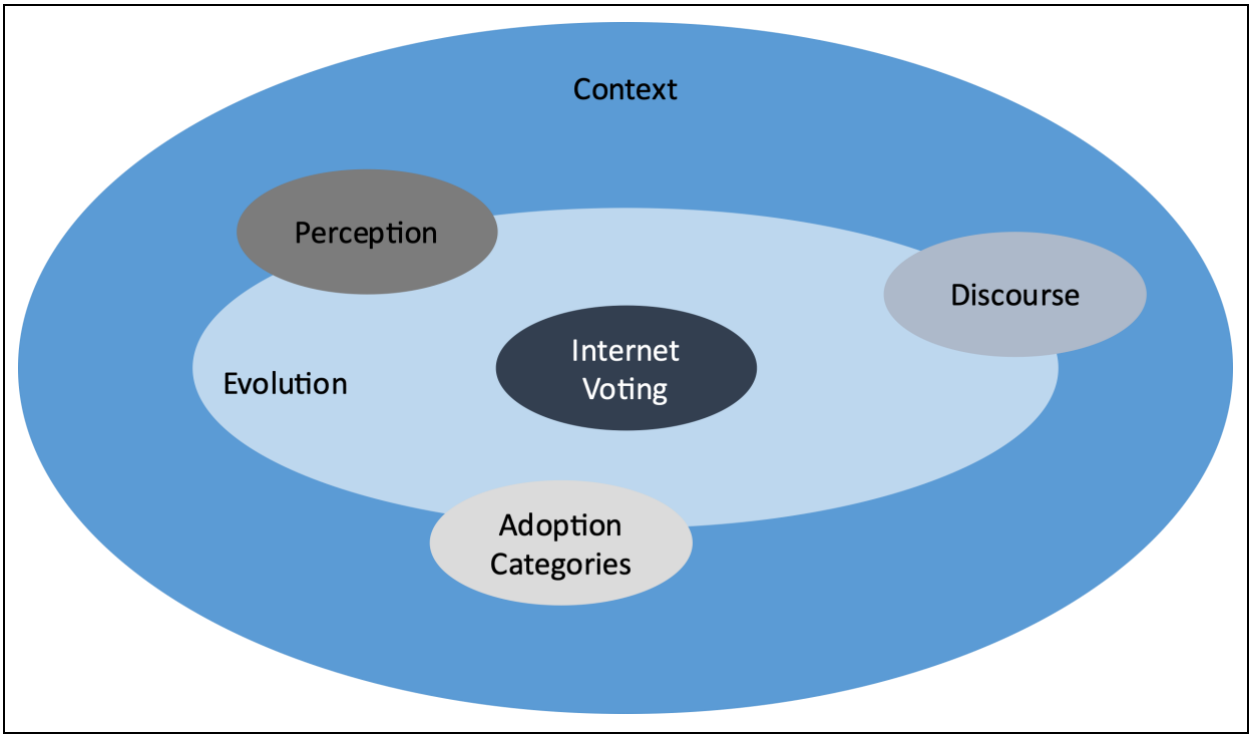

Figure 6: Framework of Internet Voting Adoption

All five theories portray the diffusion of technology from four different angles: adopter category's approach (DOI), social context (SCOT), individual & perception-based adoption and evolution and maturity-based approach (TEP/Hype Cycle). Some intersections between the theories were identified, and all provided reasonable elements for the theoretical framework of i-voting adoption. In this section, the derived categories and dimensions for the framework are depicted. These five dimensions are 1) perception, 2) evolution, 3) context, 4) adopter category and 5) discourse. Subsequently, they are elaborated on further.

The perception dimension comprises of one's subjective perception towards a technology's relative advantage/expected performance enhancement (UTAUT/DOI), the complexity/expected effort (UTAUT), observability (DOI) and the relevant social groups (SCOT). Diffusion of innovation occurs if entities believe that a given innovation would be beneficial for them.

An innovation might or might not increase effectiveness, but the objectiveness is not as decisive to adoption as is how individuals view the technology. Technology will be adopted faster if there are expected advantages towards the given status quo (UTAUT/DOI) or if it fulfils a task for a

relevant social group (SCOT). The perception towards the adoption may alter as time progresses and hence change adoption patterns (DOI/SCOT). By redefining the problem, a technology might become relevant, and a new relevant social group might be established, which drives adoption (SCOT).

The evolution dimension refers to the idea that technology follows a maturing path that is paved by failure and eventually widespread adoption. Typically, overinvestment and failure pave the way for later large-scale adoption and need to occur in order to enable the maturing process of technology (TEP/Hype Cycle). These theories consider the diffusion of technology to emerge as a system-centric process in which the individual decision is not considered.

The context dimension refers to the degree of contextual factors such as society (SCOT/DOI), the political system (DOI/SCOT), socioeconomic status (DOI) or general technical or organizational infrastructure (UTAUT) that impact the way that innovation diffusion occurs within a social system. The construction of society with either the strong presence of opinion leaders or change agents is decisive for the diffusion process (DOI). Society's norms, customs and values have a substantial impact on technology's adoption and might conflict and impede adoption if the innovation clashes with these cultural characteristics (DOI).

The political system and allocation of political and socio-economic power are strong catalysator for innovation diffusion as they might create uneven public discourse (DOI/SCOT). The technical and organizational infrastructure might either be more susceptible or less favouring of new technology, as a lack of necessary infrastructure, e.g. might impede diffusion (UTAUT).

The adoption categories deal with the categorisation of individuals within society that determine whether and how innovation diffusion takes place. Furthermore, it depicts the respective stages in which technology diffusion occurs are (shown in Figure 6): 1) awareness, 2) persuasion, 3) decision, 4) implementation, and 5) confirmation (DOI). These stages will serve as the theoretical backbone in examining the adoption stages of i-voting technology adoption. After the decision stage on the political level, the second level adoption starts to occur parallel to the first level. In this individual adoption level, the adopter categories identified by Rogers illustrate the diffusion of innovation on the personal level within society. These categories are 1) innovators, 2) early

adopters, 3) early majority, 4) late majority, and 5) laggards. Individual technology acceptance can be examined via the factors of utility and effort provided in UTAUT.

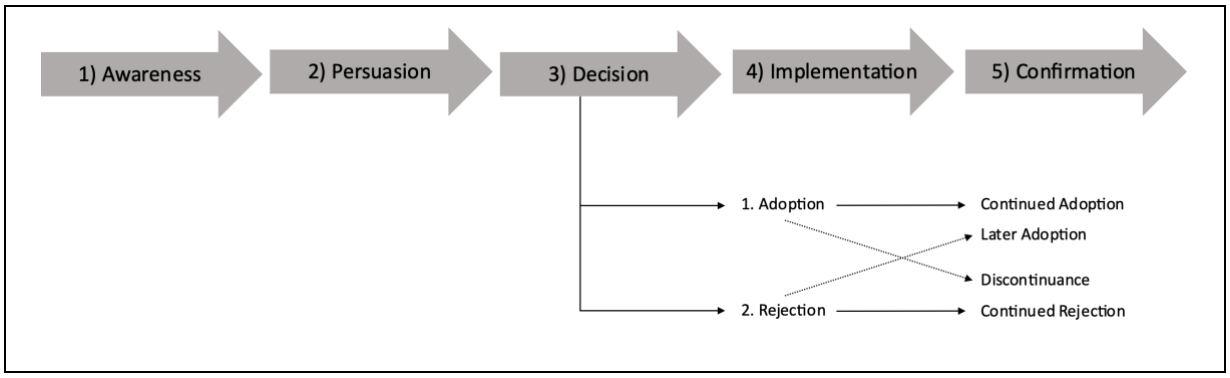

Figure 7: Adoption Stages (According to Rogers, 2003)

The discourse dimension illustrates the diffusion of innovation that is depending on communication (DOI), power structures within society (SCOT/UTAUT), change agents and opinion leaders (DOI) and media coverage (Hype Cycle/DOI). The different power and resource distribution, as well as the uneven access to communication channels, plays a significant role in shaping the discourse and hence facilitating adoption (SCOT/DOI/UTAUT). Uneven power structures are, furthermore, re-affirmed by change agents and opinion leaders that are perceived as knowledgeable by members of society (DOI/UTAUT). The prominent position and privilege attributed to change agents and opinion leaders as described in DOI enable diffusion through lobbyism through their channels. Mass media plays a decisive role in technology diffusion (Hype Cycle). Hence, hereinafter, five propositions are depicted that will guide the empirical research and aid to answer the research questions that were proposed in the introduction to this thesis.

P1: The perception dimension drives or impedes i-voting adoption.
P2: The evolution dimension drives or impedes i-voting adoption.
P3: Contextual factors drive or impede i-voting adoption.
P4: Adoption categorisations and stages can be observed for i-voting.
P5: Public discourse is an essential element of i-voting adoption.

4 ANALYSIS

In the following section, all findings of the empirical qualitative expert interviews paired with results from the desk research are analysed. First, the analysis presents the adoption stages of i-voting technology, then analyses the drivers and barriers and eventually analyses i-voting diffusion during COVID-19.

4.1 Adoption Stages

Alongside the analysis of adoption processes in countries and semi-autonomous regions, five adoption stages that are 1) awareness, 2) persuasion, 3) decision, 4) implementation and 5) confirmation as proposed in the theoretical framework were identified. Furthermore, the adoption of i-voting occurs in two steps (Krimmer & Schuster, 2008): The decision on the political level adoption and second the decision on the individual level, which would refer to the actual usage within society.

In the 1) awareness stage or the idea formation stage, discussions occur to introduce i-voting technology. Frequently, experts spoke of political will or mentioned a specific crisis, declining voter turnouts, procedural defects or other issues such as corruption that caused EMBs to look into the introduction of technology into their election system [3;4;5;8;10;11].

The second stage depicts the efforts to gather proof of concept, which is comparable to the 2) persuasion stage of the theoretical framework. This stage comprises feasibility projects. Usually, it entails studying the context and applying academic methodologies to investigate societal demand for i-voting and whether an IVS could be implemented, what impact it would have and which system would be effective for the context. In this step, benchmarking exercises are conducted, and guidelines will be defined on technology design, from where to procure and for what price [5].
Often, external partners are invited to visit and conduct the study for the domestic context. International organisations such as IFES, UN, International IDEA, the EU, or the OSCE are typically invited and provide their expertise and recommendations for the respective context [2;3;5;8;17]. In some instances, this stage may already be equipped with a prototype technology provided by universities. Still, the implementation will be done at a later stage, and a university

may only offer the first version of such a system for demonstration reasons [14]. In many contexts, at this stage, a legal framework would be necessary to further proceed with the adoption cycle. A legal framework may regulate the coming steps and the scope in which the IVS may be considered, the technology system, the procurement procedure and the environment in which a pilot would be able to take place [6;7;14].

In the third stage, the 3) decision-making process occurs, in which decisions are made that concern the procurement and piloting of i-voting. Either a country's election commission may look for vendors and visit technology fairs or produce the technology for various reasons in-house [7;8]. This is a crucial step in the adoption of i-voting technology and hence among the most mentioned recommendations in feasibility reports by external evaluators.

Procurement procedures frequently become an issue because trust in systems lacks since they either are not appropriately implemented, or cases of corruption might arise or the status of the equipment as such [17]. A frequent problem with external procurement is that the source codes are not made publicly available, which decreases the trust of the public in the technology. Failed procurement regulations might lead to improper procurement procedures that can bypass the competition and be susceptible to corruption [2]. Hence, proper procurement and transparency of that process and the procured technology are essential steps for achieving effective IVS diffusion [14]. When correctly done, procurement can be very time-intensive and sometimes cumbersome, which makes i-voting technology rather no ad-hoc solution for problems such as the COVID-19 pandemic [2;3]. Pilots have been identified as a crucial stage in order to give practical grounds and sufficient data to evaluate the question of whether the introduction of such technology would actually be feasible in that specific context [11]. Furthermore, pilots are a way to build trust in the system and to show in a real-world example how the new technology works and can be seen as the starting point for the second level technology diffusion, which occurs on the individual level and refers to the actual usage by the people [2]. That demonstration may differ from each context and could be instead consisting of a sophisticated technology demonstration and explanation, as this was the case in the Norwegian pilot. It could also be rather a purely bureaucratic act in which the accuracy of the process and bureaucracy would be used to convince the public of the new technology as it was done in Estonia [14].

After that stage, only those proceed to the next step, which is the implementation stage, which aims for evaluation and further growth of their IVS. Most of the considered cases in this thesis have never entered phase four of the adoption progression and instead go back and forth between different phases in the first three stages. Indeed, countries and regions seemed to have been on the path to reach the implementation stage and yet went back one step or stopped i-voting altogether [5].

In the fourth stage, the implementation stage, on the political level of diffusion, cases would start to evaluate their experience with the technology design, the procedures and their legal framework. The goal is to be able to expand the system to a broader group of the electorate and reach the fifth stage [9]. Although a legal framework might support the further deployment of IVS in elections, further adoption might be discontinued because the set-out requirements are not met, or lack of political will makes it unattractive to invest resources in a rather sensitive project [6;9].

Switzerland, France, Canada, Australia and Estonia might arguably be the only cases that ever reached the fourth stage. Estonia introduced new technology systems in that stage which allowed for individual verifiability and enhanced the IVS in terms of trust-building measures [7;11]. Switzerland re-evaluated their continuation and started introducing new regulations and establishing new security measures. The new requirements demanded individual as well as universal verifiability [11]. After having piloted i-voting for over 16 years on the cantonal level, Switzerland sought to expand their system onto the federal level. However, the requirements were not met and have been halted until today [9]. Since, April 28 a new initiative was launched to re-open the investigations for the usage of IVS, which shall determine what technology design would be able to meet the requirements (Bruderer, 2021).

The confirmation or technology acceptance stage 5) has been only ever reached by Estonia so far, and therefore all the data can only be retrieved from that context. In that phase of i-voting diffusion, a relatively high share of the population remains to utilize internet voting, and that practice has reached a certain regularity (Vinkel & Krimmer, 2017). The Estonian IVS is a very popular voting system in elections and reached in 2019's election a penetration of 40% of the electorate [7]. Furthermore, despite accusations of Estonians former right-wing party of stolen votes in the process of i-voting, 70% of Estonian voters said that they are confident about internet voting in elections and have been so since 2005's first local elections (Krimmer & Solvak, 2020). The last

phase of the adoption progression is characterised by the final diffusion and following large-scale technology acceptance within society due to a steady turnout and voter's confidence in the system over a period of time [7]. However, continuously at least in every new election cycle, the technology gets re-assessed, and critiques constantly exist who try to achieve discontinuation of the.

On the individual adoption level, there is quantitative data available from Estonia (Vassil et al., 2016), Switzerland (Serdult et al., 2015), Canada and Australia (Goodman & Smith, 2016). The empirical data shows that the usage is different in each context. In the Estonian context, it was observed that the first three elections, mainly early-adopting parties and people with particular socio-demographic features, had used i-voting technology in elections. However, since the fourth election, that has changed, and i-voting technology has been widely adopted among ordinary voters (Vassil et al., 2016). Other data from Canada as well Australia further confirms that i-voting has achieved to be widely accepted and the convenience has achieved to create a new status quo for a vast part of the electorate (Goodman & Smith, 2016). Moreover, Australian acceptance rates with their election systems have been observed to be very high [15].

In Switzerland, however, the numbers have not shown to be that confirming of higher usage, besides for diaspora voting. The collected numbers for expatriate voting in the Swiss context show an acceptance rate above 50% for i-voting technology, which is relatively high compared to the turnout in the domestic context (Germann, 2021). The reasons for less enthusiasm of domestic voters to use i-voting might have something to do with the already well-established postal voting system and the additional burden of registration for i-voting (Serdult et al., 2015).
The Estonian case might show best the different stages of technology acceptance that resemble Rogers' adopter categories. The empirical data shows that "the process of diffusion did not occur immediately, but was shown via a plateau effect, by which diffusion became visible only after the first three elections" (Vassil et al., 2016, p. 458).

The individual adoption process takes place parallel to the political level, and both influence each other throughout the process that they experience.

Figure 9 attempts to portray the cases and their distribution along the adoption stages. However, the adoption stages are no linear process but need to be seen as continuums.

Hence, Figure 9 might not depict all cases accurately as it is rather difficult to discern at what stage each context is currently located. Norway and Switzerland, for example, would not be accurately depicted for the stage that they are in currently and yet at one point, they had reached these stages, and the graph aims at capturing the furthest stage that each context ever reached.

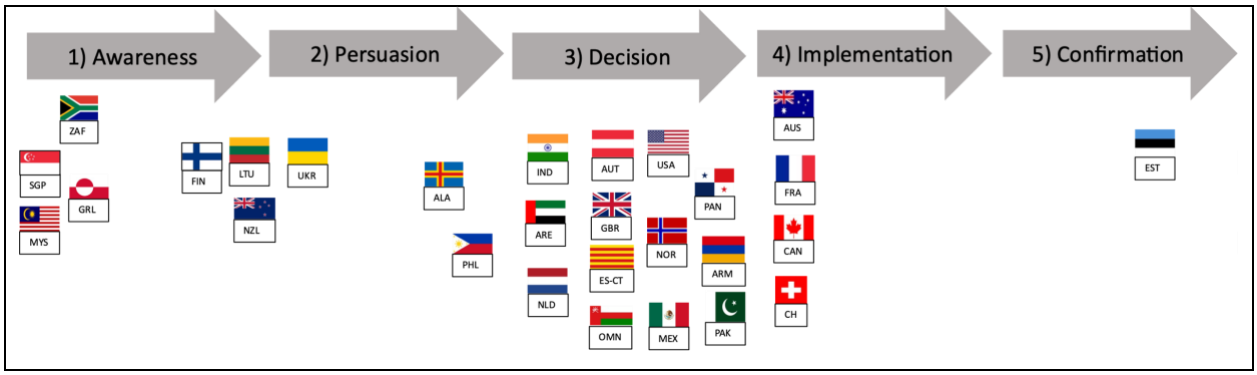

Figure 8: Case Distribution along the five Stages

In summary, it is observed that the key findings provide evidence for the adoption process, which can be divided into first, the adoption process on the political level and second, the diffusion within society on the individual level. The stages that had been defined for the political level were similar to the proposed phases of the theoretical framework. On the individual level, the findings suggest that the contexts from which data exists, vary but acceptance rates in Estonia are relatively high and resemble the adopter categories of Rogers.

The presented findings confirm the assumption that adoption stages along the adoption cycle exist that can be generally perceived for all cases. This analysis further found that no reliable distribution of regions along the adoption stages can be made due to the unique adoption nature of i-voting technology. Moreover, the findings suggest that these developments need to be regarded as continuums in which cases might go back and forth and sometimes halt their adoption for a more extended period of time due to political changes, legal or technical issues. From the given results, it becomes apparent that no other case besides Estonia has reached remained to constantly stay in the last adoption without going back from it.

4.2 Drivers and Barriers

In order to answer the question on which drivers and barriers impact the adoption of i-voting worldwide and why the findings from the expert interviews as well as the desk research are analysed hereinafter.

4.2.1 Political and Socio-Economic Context Dimension

In line with the theory, the context is very influential in the establishment of election systems (Derichs & Heberer, 2007). The findings further resemble the proposed framework and can be divided into Social, economic, cultural/historical, political, organisational, legal and procedural elements.

4.2.1.1 *Construction of Society*

An important factor is the construction of a society that enables or disables discussion, critique, and proposition of i-voting technology. A more diverse society consisting of academia, civil society organisations (CSO) and experts, enable a more varied discourse about i-voting and can be either driving or impeding diffusion. These groups are drivers if they, for example, promote the inclusion of excluded voter groups through i-voting or might be barriers if they voice security or transparency concerns. A consensus was found strong CSOs, and expert groups are located in the Western hemisphere. Furthermore, regions with a high number of IT-related content creation and the communication thereof, due to strong CSOs and expert groups, are somewhat reticent to adopting new voting technologies as they have stronger groups driving the discourse around the risks [5;8;10;13&14].

However, the presence of solid lobby groups within society, fighting for the rights of visually impaired persons and expatriate voters, have been strong drivers in enhancing IVS diffusions in several contexts [7;9;10;11&15].

Another finding was that the lack of expert communities and hence a lack of expertise within society tends to make these contexts more susceptible to be targeted by vendors. High-level lobbyism by vendors is very effective when no counterparties contribute to expertise to the debate [2;8]. Moreover, less regulated procurement methods, and the lack of civil opposition that is run by non-governmental actors, who are knowledgeable in that field, tends to lead to faster purchase

and less sustainable implementation procedures. In that sense, context matters a lot if NVTs are purchased in instances even adopted but commonly not in a sustainable way [1;2].

A third aspect observed in the findings is regarding the design of voting technology. Academia and expert groups tend to impact the creation of systems and often aid in overcoming suspicions or doubts through investigating challenges and proposing solutions [5]. Moreover, first prototypes of new technology are usually established by research institutes and universities and hence support implementation processes with practical knowledge [14].

4.2.1.2 *Economic Situation*

Internet voting systems and the respective infrastructure that is necessary to promoting i-voting can be very costly in short-term consideration [6;16]. From a long-term perspective, the associated costs per vote are via IVS are remarkably lower than conventional votes (Krimmer et al., 2021b; Krimmer et al., 2018). However, most cases that have introduced i-voting still provide traditional paper voting, i.e., postal voting, as an alternative option to i-voting, which in fact adds additional costs [2;6]. Most likely, regions that adopt i-voting would yet remain to have paper ballot boxes as it allows to overcome risks of coercion and voter intimidation and simultaneously to enhance trust in the election system [2].

In countries that already possess tight budgets, their priorities are often not to transform the electoral system but rather to win political support in other fields of interest. The arising costs for i-voting are not merely related to purchasing a system but also maintaining and updating it constantly in order to overcome vulnerabilities and foster electoral integrity [4]. On the other hand, some cases have considered that differently and adopted i-voting explicitly for reducing the cost of remote voting [1;4;11].

Another factor driving the implementation of i-voting technology is the economic power that diasporas usually have on domestic politics. Through large party donations and their general socioeconomic power, expatriates tend to have a significant influence on their home country's political discourse and use their impact on lobbying for easier access into domestic elections via i-voting technology adoption [2]

In other cases, technology in elections is considered because of the commercial implications and strong lobbying efforts by vendors that persuade governments to adopt new technologies in their elections [1;2]. Expert one specifically mentioned the push of the commercial drive and its implications for voting technology adoption.

4.2.1.3 *Culture and History*

This section analyses the findings of the cultural and historical factors.

First, the findings suggest that difference exists in the interpretation of vote secrecy and universal suffrage. Hence, the approach can also differ whether a context would consider or reject IVS altogether [6]. A relatively relaxed understanding of secrecy and a strong approach towards universal access might lead to enhanced i-voting efforts. On the contrary, where a particular emphasis on secrecy is present, further i-voting diffusion might be rejected if not enough proof is given via universal verifiability of how a vote is cast, count and kept secret. Last, an increased emphasis on universal suffrage, and therefore, a strong focus on the inclusion of diaspora voters or visually impaired people might lead to higher IVS uptake [6;15].

Second, elections are in some contexts seen as a community-based exercise in which the electorate follows their duty to go and vote. That exercise might be perceived as an act of physically convening and voicing one's opinion and would culturally not accept to replace that with technology [5]. This case does not describe the opposition of technology per se but the predominant proposition of tradition [3;6].

Regarding the historical influences, the interviews concluded that post-crisis situations or the newly gained independence of regions impact the creation of new voting systems [1]. Often, the act of removing old election systems is an act of trust-building and demonstration of recent ruling in which NVTs are perceived as neutral third party that politicians and administrations have no influence over [1;3;5].

4.2.1.4 *Political, Organisational and Procedural Context*

In nearly all interviews, the political will was identified as both a powerful driver as well as a strong barrier. The major political drivers and barriers are listed hereinafter.

First, governments use i-voting technology as political agenda to demonstrate modernity and progress in their political activity [17]. Some contexts have attributed electoral affairs to a ministry and restructuring the state alongside the electoral system is used for political campaigning purposes [2;18]. In essence, political actors aim to appear progressive and modern and wish to use tools like IVS to prove also tech-savviness [18].

Significant technological developments can be traced back to politically motivated events and decisions. If technology is perceived to be beneficial for the incumbent party, it is promoted; if not, the same party may become the greatest opponent to NVT development [1;2;3;5;10;15]. This observation, also known as the "middleman paradox", refers to the phenomenon that incumbents resist the move towards e-democracy because they perceive that the altered election system might lead to a decrease of their own political power and control (Mahrer & Krimmer, 2005, p. 38).

In line with further evidence, change of government was named to be another influential factor. Two scenarios were identified which have been concrete barriers to VIS diffusions: first, the election of a new governing party, also ascribable to the middleman paradox [6;14], and second a civil conflict in which the transformation of the election system is put on halt [2].
Regarding the first scenario: If certain political actors identify that their electorate is opposing the idea of i-voting and that their competitor might benefit from online voting more than they expect to do, evidence shows that this actor tends to discontinue i-voting for purely political reasons (Krimmer & Solvak, 2020) [6;11;14].

Furthermore, the findings show that i-voting is a highly sensitive subject with attached political risks, associated costs and resources needed; therefore, unless a concrete need requires it, governments tend to refrain from touching that subject [4;6;11;14;15].

The second dimension refers to accessibility and universal suffrage, which have been identified to be among the strongest general drivers for i-voting adoption. Accessibility refers to the idea that "people with disabilities should be able to use all public spaces and services in the same way as other people" (OSCE/ODIHR, 2017, p. 17). Online voting can enfranchise disabled people as they can more easily register and authenticate themselves and cast their vote from their home [3;7;9;10;15]. The provision of universal suffrage identified by the OSCE (1990) entails, further, the idea to integrate the entire electorate into the elections. Universal suffrage can be interpreted

in different ways, and countries, as well as semi-autonomous regions, have been considering for a significant part to introduce i-voting because of their aspiration to include overseas or territorially challenged voters into their elections more efficiently. Nearly all conducted interviews mentioned the aspect of voting provision for the diaspora, overseas diplomats, consular staff, general populations in extreme territorial conditions or overseas soldiers. Essentially, the intrinsic motivation is political and only promoted if the incumbent expects to gain from including these groups of voters, as sometimes the diaspora consists of political opponents and hence its exclusion from electoral matters is deliberate [5;6;8;9;10;18].

Third, as populations increase and administrative capacities need to be restructured to enable higher procedural efficiency, new technologies allow better election management and further ease electoral processes, especially regarding cumbersome remote voting processes such as postal voting [4;5;8;15;16].

And yet, from the study, it is clear that voter coercion and vote-buying in remote and uncontrolled election environments still remain to endanger the integrity of elections, and for that, specific contexts that initially have seen technology as a practical solution refrain from particularly adopting i-voting [4].

Last, the context's set-up, degree of digital governance and the understanding of digital services play a substantial role in driving i-voting adoption due to the spill-over effect that tends to occur in digital ecosystems [2;7;9;14;17].

4.2.1.5 *Legal Context*

The obtained results present evidence that legal frameworks need to be established for an effective i-voting introduction [14;16]. Passing appropriate legislation, however, tends to be rather difficult because the law is rigid in nature, and ICT is relatively flexible and needs to be evaluated regularly. Law, once passed, will remain as a reference text for future considerations and cannot simply be changed [14]. Specific contexts experience the already written law to be a barrier, and lawmakers would need to pursue passing actively or amending the law, which allows for IVS considerations.

Furthermore, the empirical data shows that law is subject to interpretation and that certain regions may therefore understand the legal text differently and hence court interpretations can be essential

in the development of IVS [6;7;8]. Cases were identified in which important court decisions prevented further NVT adoption and influenced third parties not to adopt [6;8], or judgements existed that paved the way for i-voting to be adopted [15].

In the interviews, it was further identified that there is a lack of a general legal and technical framework/design that describes and defines the appropriated provisions of i-voting systems. That lack becomes a barrier because the standard according to which a potentially suitable system would be compared against does not exist, and hence the debate is less structured [9;10;11]. The other scenario was described that a legal framework exists, but it is impossible to comply with the requirements, and it makes it merely impossible to proceed with i-voting development [9].

The following section combines the perception and discourse dimension as they are closely linked to each other.

4.2.2 Technological Context Dimension

The following issue concerning technology and security features mainly concern the adoption process on the pollical level but is influenced by the narratives and discourses on the individual level. The simplified term ‘the technology’ will be used to describe i-voting technology in general terms. However, during the interviews, it was mentioned that various technology designs exist, and no single universally deployed technology exists. For reasons to enable holistic discussions, it will not be referred to a specific technology design hereinafter.

In essence, technological capabilities exist worldwide to host and conduct elections using i-voting. A threshold for many countries in terms of technology and security is the concrete definition of what technology should be used for the elections. A concrete framework that was developed and is tailor-made for the concrete context is lacking [10;14]. For that framework to be established, it often lacks in certain contexts the respective experts that know how the systems work and that are able to provide the right guidance for it to be successfully implemented [11;13]. Furthermore, a legal framework could also become a barrier, not just a facilitator for sustainable implementation. Legal frameworks can be worded in various ways, promoting or demoting the usage of remote online voting components [9].

Furthermore, the technology is considered so complex that most citizens tend not to understand how the vote is being cast, counted, kept secret and how they can verify that their vote was counted as intended [3;16]. Therefore, it is technically possible but often not viable to exchange a functioning system that is operating with paper (e.g. postal voting) with a new system that needs to provide transparency, secrecy and integrity proof to all stakeholders. Hence, the complex nature, in cases, is seen to be a barrier [1]. It is, moreover, important to differentiate hereby between full-scale adoption and partial adoption. In contexts of partial adoption, technical failures and security breaches seem less concerning than if they were to occur in full-scale adoption contexts. Therefore, imposing the task of expanding with i-voting diffusion is a more complex endeavour than offering it for a share of the eligible electorate [2;15].

One of the biggest challenges from the technology side is to provide either individual or universal verifiability [1]. The technical abilities exist to provide these features in a reliable way but need to be acknowledged by the decision-making party in order to be fully useful [10]. Although the demand for such verifiability feature to be present in the election system has increased, barely any state legislator has acknowledged and integrated such features into their requirements which can be both a barrier as well as a driver [14]. On the one hand, it facilitates eased implementation efforts as they need to meet fewer requirements. On the other hand, the system is also more vulnerable to criticism of transparency and integrity.

Furthermore, internet voting does require not only the technology but also the infrastructure that would facilitate the execution of the election. Such infrastructure would be broadband networks with high penetration rates, especially in remote areas. If no internet access exists in remote areas, there is no utility gain from adopting IVS for the purpose of including remote areas better into elections [5;16;18].

The mentioned issue is subject to the geographical context and is related to the digital divide, which is a term used to describe the gap between contexts that benefit from digital technology and those who do not (Hilbert, 2011).
The empirical findings suggest that the digital divide, which had been more so visible in the early 2000s, was a barrier to many non-Western contexts [4;16;] (Norris, 2001; Ronquillo & Currie, 2012; UNCTAD, 2005).

Hence, these findings suggest that while none sufficient ICT infrastructure seemed to have been a barrier for IVS in non-Western contexts, the increase in broadband penetration with the beginning of the second decade drove IVS development to see the first advent of IVS cases in non-Western contexts (Ronquillo & Currie, 2012). Still, the digital divide remains to exist and further is a barrier to IVS development in certain regions [16;18] (Fokane, 2021).

4.2.3 Perception and Discourse Dimension

One of the major findings from the interviews in terms of perception is regarding the issue of trust. Although trust is hard to measure and still subject to ongoing academic investigations, certain parameters could have been identified. The public perception is mostly referring to the drivers and barriers that impact the diffusion that occurs on the individual level after the political decision has been made to introduce IVS in society.

The findings support the assumption that election systems are as much trustworthy as the people who erected and proposed them. Hence, if people mistrust the government and or EMBs who implement IVS, they tend to mistrust the technology [5]. Furthermore, regardless of the previous trust given to one election system, it is not granted that this trust is simply transferable to any novel election system. On the contrary, it seems that strong trust in EMBs in primarily Western democracies might be one of the bigger barriers to i-voting adoption as the primary assumption is to question whether new technology is necessary and simultaneously to endanger a well working system [1;10;14]. This may be further supported by the concept of path dependency, which states that individuals would decide to trust and use a system based on previous experiences, decisions and preferences that they made (Banton, 2021; David, 1985). That phenomenon exists along with all fields of social spheres and might certainly affect the choice of usage of election systems.

Internet voting technology requires a great amount of trust from the electorate since its technological setup is relatively complex, and very few experts do understand the system entirely [1]. Whether one may trust in one particular aspect or not is rather incoherent with objective measurements. Regardless of objectively measured and relatable evidence that would suggest that appropriate i-voting technology exists, many cases experience one of the biggest barriers to be the lack of trust [1;3;5;11;14]. Additionally, objectivity and trust tend to be fragmented by public

discourse and the strong presence of social media that influences public opinion on electoral matters (Krimmer et al., 2021 forthcoming).
Moreover, specific expert groups and CSOs have made it their duty to detect and inform about vulnerabilities in i-voting systems particularly, since the 2016's US presidential election, increased interest in cybersecurity around elections [6;7;9;18].
Although public discourse has been identified to be a barrier in many instances, there are also cases in which pressure by CSOs and media on politicians have paved the way for the introduction of IVS [15].

Although certain risks had been already present in the early 2000s and cyber hacking and lobbyism against the introduction of i-voting existed since the first hour [10], it was, however, on a much smaller scale. In comparison to nowadays, there was less awareness of the entirety of cyber-risks and also less internet usage penetration in general [6] which can nowadays be seen as a barrier to further diffusion.
The perception of technology its potentials and risks has shifted. Common cyber threats and dangers have been put more in focus around the discussion for i-voting introduction than it was the case in the early 2000s. That is mostly due to the fact that the technology was relatively novel and less experimented with than it is nowadays. Hence, more threat and risk awareness exist as common knowledge in the electorate, and hence success stories back then might not be as successful today [6;7].

Since i-voting technology is to a degree somewhat intangible for the large share of people, i-voting demonstrations are used to build trust in the system [1;10;14]. Including rhetoric and competence demonstration seem to be useful in convincing the electorate about the system, as suggested by the findings. These demonstrations can be of bureaucratic nature, in which the focus is rather on the institutions and has been proven to be successful in contexts in which a history of malfunctioning of institutions exists. In a context in which previously technical failures in election systems had occurred, trust-building via technology demonstrations have proven to be successful [14].

Last, perception may be impacted by security breaches and technical failures. The identified cases in which that occurred show different results for the degree of usage [6;7;14]. However, more data is needed to look into the issue impact of trust in election systems as a result of technical failures.

A summary of drivers and barriers can be found in Table 4 and 5, respectively.

Drivers
Political level
Universal access (Expatriate & overseas staff voting, voting in territorially challenging locations)
Accessibility
The political will to appear modern and innovative
Contactless democracy
Vendor's commercial drive
Increase turnout/prevent further decline
Strong lobby groups
Perception of technology as neutral third party
Cost reductions
Process improvements
Integrity improvements in administrative operations
Socioeconomic status and high technological infrastructure (geographics)
Individual-level
Convenience voting
Spill-over effect within already digitised societies and their ecosystem
Socioeconomic status of the voter

Table 4: Drivers of Internet Voting

Barriers
Political level
Middleman Paradox
Political crisis
Change of government (related to middleman paradox)
Security concerns
Theoretical technical vulnerabilities
Strong opposition from academia & CSOs
Lack of a framework
Lack of technological infrastructure/Digital divide
Lack of verifiability
Procedural barriers
Change of legal requirements
Individual-level
Path dependency
Cultural traditions
Mistrust in technology
Mistrust in government and EMBs

Table 5: Barriers of Internet Voting

Subsequently, the most recent developments in i-voting adoption that happened during the COVID-19 pandemic are analysed and portrayed.

4.3 COVID-19

Until most recently, the demand for internet voting was considerably in decline, but worldwide discussions around the introduction have sparked due to the COVID-19 pandemic [1;3;5]. In many cases, the fear of going out and being around people also affected elections, so that over 78 elections in countries and territories were stopped and postponed, and discussion around the issue of contactless democracy increased since COVID-19 started (Asplund, 2021; Thakur, 2020). In some instances, actual projects and discussions to introduce internet voting as a direct response to safeguarding elections and the electorate during elections in the COVID-19 pandemic occurred but did not end up being successfully implemented [2;17].

In many cases, i-voting technology introduction was discussed, but no actual considerations such as in terms of feasibility studies or pilots took place [8;9]. Although the perception that remote voting avenues need to exist for pandemic situations (James, 2021), the majority of governments realised that the implementation of i-voting is a complex endeavour and not a quick fix to a pandemic [17]. Hence, with the fast provision of a vaccine at hand, most countries would have needed to have internet voting introduced within a year, and that simply is not feasible [2;10;17]. Furthermore, many regions were able to hold their elections in person as planned with risk calculations, proper planning and certain holistic approaches and did not need to implement internet voting for that [5].

Although the necessity for i-voting might not have been so imminent for the period of COVID-19, more and more EMBs and governments generally have realised that their current administrative capacity is not high enough to operate fully remote if needed and that more digitisation efforts are needed [14]. It can be expected that as digitisation continues to penetrate society, higher numbers of people will question the reasons that services such as online banking and further governmental services are available online, but voting is not provided online [3]. Furthermore, the international interest to look into all sorts of e-voting technology has increased so that international

organisations such as the European Union have commissioned studies to be conducted as preparations for the next European Parliamentary elections in 2024 [6].

COVID-19 has impacted the debate around i-voting and might have been a driving force for its development in the sense that now the debate around i-voting is more focused on the need of having remote voting technology. Thus, current debates have shifted from merely focussing on the risks and threats associated with i-voting and have started to focus more on the advantages that internet voting provides [11]. This fact might allow for more objective debates and hence be useful for the development of i-voting technology. However, it has become apparent that transforming an old election system and add the feature of online voting to it cannot be achieved in such a short time. Perhaps, a year of a global pandemic is not enough time and pressure to change the election system, but rather it only was enough time to spark new debates as political decision-making is notoriously slow [17]. For the time being, it has been observed that governments and EMBs opted for special voting arrangements or have postponed their elections [1].

Despite the global COVID-19 pandemic, the year 2020 also showed that continuous debates on social media and increased amounts of spread misinformation further harmed the trust even in more traditional election systems. It is, therefore, likely that internet voting would experience similar if not even worse backlashes and opposition [5;10;13]. One could even see that simply the controversy around the global pandemic itself was an issue for discussion in certain groups of the population. Hence, introducing a form of voting that is highly complex and not as transparent as paper-based elections in response to COVID-19 might have amplified further disputes even more.

Mexico, after i-voting had been stalled for several years, currently is reconsidering the implementation of i-voting for their diaspora voters. According to expert 8, the Mexican IVS might be already deployed for the upcoming congressional elections in June 2021.

Furthermore, Greenland changed its law to move forward with i-voting, Malaysia, Singapore and Lithuania had considered the introduction of IVS' during the COVID-19 pandemic, which, however, were cancelled due to procedural issues and security concerns [14;17].
In the following chapter, the results of this analysis are compared with the theoretical framework and discussed in light of the research questions.

5 DISCUSSION

This section discusses the findings in light of the research question, its three subquestions, along with the provided theoretical framework and its five propositions. The first subquestion has been informed by P4, stating that adoption categorisation and stages exist for i-voting technology. The second question by P1, explaining adoption via technology perception, P3 explains adoption via contextual factors, and P5 offers the aspect of public discourse as an explanation for i-voting adoption. The last subquestion offers an explanation via P2, which states that technology is adopted following an evolutionary approach. The theoretical framework used five theories to demonstrate and formulated five dimensions that were tested in the empirical study. Subsequently, the findings will be discussed in relation to the sub-question of this thesis.

Sub-question 1. In order to deliver answers to the question of which adoption stages could be identified along the adoption process and why, the attributed propositions were tested and despite the observed back and forth movements of countries and regions in their adoption behaviour and hence the impossibility to accurately describe the respective status of their adoption, general adoption stages and processes were identified. The evidence suggests that the adoption of i-voting does not occur in a single adoption process but in two partially parallel occurring processes.
The first process is a political process and characterizable as a collective decision-making process. This collective adoption approach involves governments, administrations and other leaders in a society that adopt i-voting technology. This adoption process is congruent to the described adoption stages of the theoretical framework. The five stages that were specifically described in Rogers were tested and confirmed to exist in the first adoption process for i-voting technology.

The second level is the individual adoption process in which technology is accepted, and large-scale diffusion among society has been identified. This stage basically deals with the technology acceptance and usage patterns. Therefore, the features attributed to explain individual adoption decisions related to usage and effort as well as the adopter categories that describe the process of innovation diffusion were tested, and the found evidence suggests that the theory appropriately makes the case to explain i-voting diffusion on the individual level. However, it was discovered that only four countries provide data for sufficient analysing the technology diffusion patterns in the individual adoption process (Germann, 2021; Goodman & Smith, 2016; Serdult et al., 2015; Vassil et al., 2016). The lack of cases that have been proceeded as far as Estonia, Canada, Australia

or Switzerland creates a lack of empirical data to create a more generalisable tendency of the diffusion patterns on the individual level. However, Estonia's case is well-documented and provided evidence that identified the adopter categories that had been presented in the theoretical framework. Furthermore, the findings showed that the technology acceptance in Estonia, Canada, Australia and Switzerland among the expatriates is pretty high. In Estonia, for example, of all the people that had used i-voting in Estonia's first online local elections in 2005, two-thirds were identified to have been first-time users of the e-ID card, which shows that the technology was very well accepted and considered relatively useful, given the effort needed to acquire an e-ID card (Kitsing, 2011).

In summary, P4 can be confirmed to be an accurate proposition to the explanation of i-voting adoption. Furthermore, the research question has been answered by providing proof for the five-stage adoption process model and the two different adoption levels as described in the theoretical framework.

Further difficulties were encountered when aiming to categorise the respective countries and regions along the five stages. The back and forth of regions in terms of their adoption status makes it difficult to determine one particular direction. It was found that i-voting can be rather seen as a continuum than a linear process due to several reasons, which are discussed in the following.

Sub-question 2. In order to answer the question of which drivers and barriers impact the adoption of the findings of the analysis are discussed against the second research question, and the propositions P1, P3, P5 and P6 against the empirical data are discussed. The drivers and barriers on the two levels of adoption can vary and will be discussed after one another. The driver for the political decision level, in the empirical findings, have identified to be universal access and accessibility for disabled voters, the pursuit of a contactless democracy, they wish to appear modern, the vendor's push, the process improvements, the perception of technology to be a neutral third party, the perception of increased administrative integrity, cost reductions, strong lobby groups, expected increase in voter turnouts and the presence of high socioeconomic power and well-established technical infrastructure.

The key findings of the empirical study have found evidence for the assumption that perception is a driving force for i-voting adoption on the political level. The perception of technology as a

neutral party by specific political actors that would bypass human errors and exclude corruption and institutional flaws supports the introduction of i-voting. However, these are merely perceived reasons, and many interviewees voiced their concerns about that particular technological optimism. This finding confirms P1 to be applicable to the case of i-voting adoption.

The tested theory has proven to be correct in many cases as to the contextual argument, which encompasses the political, economic, cultural and social construction of society. Particularly, the argument of relevant social groups, which were defined in SCOT, can be confirmed. The relevant social groups in many cases have been observed to be the diaspora, territorially challenged voters or disabled voters. Furthermore, the political will has been identified to be a major driver for i-voting adoption on the political level. In the interview data, it became apparent that a concrete political need is required for incumbents to consider the change of the election system. That might be to prevent decreasing voter turnouts or the urgency to provide an appropriate election system for the context of an evolving contactless democracy or to appear modern through the introduction of NVTs.

Furthermore, if a region possesses high socioeconomic status, this feature has further confirmed to drive adoption. The aforementioned drivers found from the interviews can be seen as confirmation for P3 because of their contextual factors such as political climate and its agenda.

Further identified drivers in line with the theory dimension were the respective lobby groups that drove the i-voting adoption on the political level. These lobby groups were in some instances identified to be CSOs, academia or commercial drivers that impacted the adoption process at the highest political level. These lobby groups have a resemblance to the change agents and opinion leaders identified in the theoretical framework. These findings suggest that P5 can be further confirmed.

On the individual adoption level, the drivers have identified to be convenience voting, spill-over effects within a digital society and the socioeconomic status of voters. The aspect of convenience voting is still under further academic investigation. However, the empirical findings suggest that the proposed theory of relative utility in regard to effort can be confirmed for the individual level, which would support the confirmation of P4.

Furthermore, the findings have also identified that, although an early interest might exist for i-voting, further usage with the given infrastructure would be driving technology acceptance. In Estonia, the first technology acceptance was kept alive with further utilities and benefits provided for online banking. Estonia managed to maintain the attractiveness for the e-ID by restricting bank transfers for transactions without the e-ID to an amount that was equal to the Estonian average salary of that time (Martens, 2010). In contrast, the Austrian case failed to mobilise enough supporters for its online voting systems because it had no further utility to its voters than to vote (Krimmer, 2017). These findings support P3 that a context in which a digital ecosystem already exists would create a spill-over effect and hence drive i-voting technology.

The following barriers were identified for the political level adoption process: the middleman paradox, political crisis, change of government, security concerns, theoretical technical vulnerabilities, strong opposition from CSOs and academia, lack of a framework, lack of technological infrastructure, lack of verifiability, procedural barriers and the change of legal requirements.

From the finding, a central part that impedes further global i-voting adoption has been the middleman paradox. This is a central barrier for many regions as the first adoption decision is made on the political level and later transferred to the individual level. However, the fear of losing one's own power that could only be bypassed if an urgent need for the election reform would appear impedes further i-voting in many contexts around the world. These findings are congruent to the contextual factors from the theory. SCOT, particularly, explains this phenomenon according to which preferences and political decisions shape technological diffusion more than the actual technology itself. Further, findings can be allocated in the same camp, as for example, political crises, change of legal requirements, procedural barriers, change of governments and a lack of a framework. Further contextual barriers were identified to be security concerns, lack of verifiability and theoretical vulnerabilities. In line with these findings, P3 can be confirmed to describe the reasons for barriers accurately.

Public discourse is not only a driver but also an opposing force for the development of NVTs. CSOs, academia and expert groups in many cases actively oppose the idea of i-voting implementation due to security and verifiability concerns. Their ability to provide expertise, facilitate communication, to have access to prototypes and further resources such as data and

expert knowledge. These findings are consistent with what has been found in the theoretical framework due to their resemblance to leaders and change agents that are particularly effective and influential within society and in the process of technology diffusion, which leads to a confirmation of P5.

Barriers to adoption on the individual level have been identified as path dependency, cultural traditions, mistrust in technology and mistrust in EMBs and governments. Path dependency has been often described as a common barrier to technology improvements and is a purely social issue (David, 1985; Gross & Hanna, 2019). The theoretical framework provides an explanation with regard to that phenomenon which is mainly built on the concept of SCOT. Furthermore, cultural norms and values amplify the problem of path dependency and confirm the cultural explanation for why technology is adopted. The social construction society and perception of technology are decisive in explaining adoption and would be confirmed by the issue of path-dependency for why P3 is confirmed to be applicable for the individual decision level.

Mistrust in technology is strongly depending on perception and consists of the fear that the technology might not be secure, which mostly is related to the fact that the technology is too complex for the average person to understand fully. Furthermore, the mistrust might also exist towards the decision-makers generally, and therefore the technology might not be accepted. The proposition P1 offers that explanation and is therefore confirmed to be true.

Sub-question 3. This part discusses the most recent developments of i-voting adoption due to COVID-19 and gives explanations via P2 and P4. COVID-19 has repeatedly been named as a facilitator for new starting diffusion discussions of i-voting technology (IDEA, 2020; James, 2021; Krimmer et al., 2020). According to P2, this would, given the hype in the early 2000s and the later decline until recently, mean that an uptake is to be expected. The current debates and trials suggest that a new interest arose definitely due to the contactless democracy debates in a pandemic situation, but no new large-scale diffusion has happened yet. Nevertheless, the findings from the interviews also stated that i-voting is no quick-fix solution, and the pandemic has only lasted for over a year, and that time frame is too short to be able to observe the described uptake from the theory, particularly from TEP and Gartner's hype cycle. Further research is needed in order to investigate whether COVID-19 might be the turning point that specifically TEP described and whether the plateau of large-scale deployment will be reached, as proposed in the Hype Cycle.

Therefore, P2 is neither confirmed nor discarded yet, since no sufficient data exists for that. Hence, a possible correction to the theory would need to be made in that regard if the expected uptake does not arrive after the COVID-19 pandemic.

This section discussed the findings in relation to the sub-questions and tested the propositions provided by the theoretical framework. The following chapter comprises the conclusive summary of this thesis that gives an overview of what issues were discussed, what findings were acquired and what conclusion for future research can be made.

6 CONCLUSION

This thesis examined the global adoption of internet voting technology and discussed adoption stages, drivers and barriers and the most recent developments during COVID-19. The guiding research question was to answer how internet voting is adopted in the global context. This research question was supported by a set of sub-questions on 1) which global or respectively regional trends and adoption stages can be identified and why? Further, 2) which drivers and barriers impact the adoption process and why? And last, 3) How are the current COVID-19 developments impacting the development of i-voting technology? The present work used a theoretical framework consisting of five theories that provided explanations for technology adoption that occurs in a context, in evolution over time, and is influenced by perception, discourse and the individual adopter categories. This study was conducted via 18 expert interviews and complemented by desk research. The research question can be answered by providing individual responses to each sub-question.

The first sub-question can be answered by evidence showing a global decline of i-voting was observed up until recently when the COVID-19 pandemic sparked new discussions for providing solutions in an effort to provide contactless democracy. Furthermore, the adoption process of i-voting was identified to occur on two levels, the political and the individual, which occur partially in parallel. The process can be divided into five distinct adoption stages. However, a precise categorisation for the respective regions is hardly doable as the adoption processes occur in a continuum rather than as a linear process.

The second sub-question can be answered through the depicted evidence showing that in total, 15 drivers, 12 on the political and three on the individual level and 15 barriers, with 11 on the political and four on the individual level, have been identified. Considering the number of drivers and barriers on the political level, the bottleneck of adoption seems to be the political level and not the individual level. Even if it needs to be considered that not every driver or barrier has the same significance and strength, it is still apparent that the individual level adoption has less influence on i-voting overall.

The answer to the third sub-question, in summary, states that COVID-19 has caused new discussions to occur around topics such as contactless democracy and remote voting techniques.

In that sense, i-voting was more discussed than before and considered as a potential solution by certain regions. However, at the same time, no large-scale uptake has been observed since the technology cannot be seen as a short-term fix, and hence more data and academic investigation would be needed.

As an outlook and with regard to the findings of this thesis, it became apparent that further research will be necessary to investigate in the following years whether COVID-19 can be seen as a turning point for i-voting technology diffusion or not. Further research would be necessary to be conducted in the field of trust in elections and specifically in election technology. Possible questions to consider could be how can trust be measured and how can trust-building of new voting technologies be formed? Last, in order to understand how various contexts deal with electoral crises and why certain regions stopped their i-voting while others remained to deploy IVS in their elections, a follow-up study on Estonia's foreign cyber interference, France's discontinuation in 2017 and Norway's case of their technical vulnerabilities may be proposed.

Internet voting had initially sparked many hopes to start off technological or even democratic revolutions. To date, this has not happened, but rather an evolution took place whose breakthrough is still expected to happen. It is possible that the COVID-19 pandemic, being a potential turning point, has initiated the large-scale deployment of internet voting technology.

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APPENDICES

Appendix 1. List of Experts

Nº	Position	Background	Expertise	Region
1	Senior Advisor	IO	Policy/Admin.	Global
2	Consultant	Consulting	Policy/Admin./Technology	Europe/ Asia
3	Polit. & Electoral Officer	IO	Policy/Admin.	Global
4	Consultant	Consulting	Policy/Admin./Law	Africa
5	Director	IO	Policy/Admin.	Global
6	Deputy Head of Department	EMB	Policy/Admin./Practitioner	Europe
7	Consultant	Consulting	Policy/Admin./Practitioner	Europe
8	Professor	Academia	Policy/Admin./Law	Europe/ Latin America
9	Legal Expert	IO	Policy/Admin./Law	Europe
10	Professor	Academia	Technical	North America
11	SVP & CSO	Vendor	Technical	Global
12	Former CIO	EMB	Technical	Latin America
13	Consultant	Consulting	Policy	Latin America
14	Professor	Academia	Technical	Global
15	Former CIO	EMB	Policy/Admin./Technical	Oceania
16	IT Expert	EMB	Technical	Asia Pacific
17	Senior Adviser	IO	Policy/Admin.	Eurasia, North America,
18	Technology Adviser	Consulting	Technical	Asia, Europe

Appendix 2. Interview Questionnaire

INTERVIEW QUESTIONNAIRE

Research Purpose

Thank you for agreeing to participate in this interview.

My name is Nathan Licht, and I am a student of Technology Governance and Digital Transformation at TalTech University in Tallinn, Estonia. As part of a research team, we aim to explore patterns of e-voting technology acceptance/adoption/rejection in various contexts around the world. In order to explore this fully, I have chosen several candidates as experts to assist with their knowledge. This interview is exploring patterns of innovation diffusion.

Introductory Question

1. **(If they have not given consent already)** Do you agree to this interview being recorded and analysed for research purposes described in the handout? 2. Please introduce yourself with your name, profession, affiliation towards e-voting technology and your geographical expertise!

Main Body of Questions

1. What is the status of e-voting technology in your geographical area of expertise? 2. What were the development steps of e-voting / i-voting technology in your geographical area of expertise? (please include key dates of the development process)
3. How do you assess the current developments of e-voting technology, in particular, i-voting in your area of expertise since the beginning of 2020?
4. General: What are the factors that influenced the adoption of e-voting technology? 5. What are the drivers that influenced the adoption of e-voting, in particular i-voting technology? 6. What are the barriers that influenced the adoption of e-voting technology?
7. What is your prediction for future developments in e-voting / i-voting technology?
8. Would you like to add any other points that you think were not mentioned in this interview so far?
9. Would you please refer us to further experts that you think would be necessary to talk to in that regard?

Appendix 3. Informed Consent

Informed Consent Form

Research Project Information

You have been invited to take part in a research project on the topic of history of global e-voting technology adoption and determination of general adoption patterns.

This project is part of the research for my Master thesis in the study program Technology Governance and Digital Transformation at Tallinn University of Technology (‚TalTech'), Estonia under the supervision of Prof. DDr. Robert Krimmer and Prof. Dr. David Dueñas Cid.

Summary of the Research Project
The overarching purpose of this project is to examine the global adoption status of e-voting technology, in particular internet voting and to identify drivers and barriers as well as general adoption patterns of e-voting technology.

In this vein, I am using expert interviews to understand the status of e-voting technology around the world in different geographical areas. I am, furthermore, seeking to find the reasons for why the technology was adopted and why not. In that regard, it will be interesting to identify drivers and barriers of all the different contexts and to compare against each other eventually, in order to identify general adoption / rejection patterns. Eventually, I want to understand the current momentum, given by COVID-19 and the global realization that remote voting has become more anticipated by many organizations worldwide and to examine whether the technology adoption is experiencing a revival.

The project runs from February 2021 through May 2021. Initially, the results will be provided to the examination board at TalTech University but later will be used for drafting an academic publication.

What does participation in the project imply?
Your participation in this research project is voluntary. By participating in an interview with me, you will make a substantial contribution to the research project.

The key questions of the interview will be:

- What is the current status of e-voting adoption in your geographical area of expertise?
- How has the adoption of e-voting technology been taking place and why?
- What were barriers and drivers that influenced the adoption of e-voting technology and why?
- Who have been the key stakeholders in driving e-voting technology adoption?
- How has the current COVID-19 developments impacted e-voting technology adoption?

I hope to record our interview with you, so that I can fully utilize your insights for this research project. I would also be excited to utilize such a recording for further processing of purely academic purposes, in preparing the draft of an academic publication. In this case, I may continue storing your data after the submission of my Master thesis in May 2021.

At all times, I assure the compliance with the current national and European legislation especially the General Data Protection Regulation. By default, I will anonymize your data. If you so wish, I can de-anonymize your responses in the final report. The data will not be deleted after the publication of the Master thesis but after the following academic paper is published.

Giving Consent

I,_____, have read and understood the information provided above and have had the opportunity to ask questions. I understand that my participation in the research project is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I voluntarily agree to take part in this study.

☐ **I agree** ☐ **I do not agree**

Place, date Interviewee Signature

Appendix 4. Core Elements of Theoretical Framework

Core Elements	SCOT	Hype Cycle	TEP	DOI	UTAUT
Perception					
Subjectivity Towards Innovation	x			x	x
Demand Side's Perception	x			x	x
Dependency of Problem Definition	x				
Evolution					
Development of Technology along Timeline		x	x		
System-centricity		x	x		
Consideration of Supply Side (Technology's maturity)	x	x	x		
Relevance of time		x	x	x	
'Survival of the fittest'	x	x	x	x	x
Context					
Social Context	x			x	x
Economic Context	x			x	x
Political context	x			x	x
Power structures	x			x	x
Construction of society	x			x	x
Organizational Adoption					x
Cultural Context				x	
Adoption Categories					
Characteristic traits of adopters				x	x
Adoption Stages		x	x	x	
Adopter categories				x	
Socioeconomic status	x			x	x
Discourse					
Advertisement	x	x	x	x	
Change agents / Opinion Leaders	x			x	x
Access to communication channels	x	x		x	
Mass media		x	x	x	

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