Internet voting: the role of personality traits and trust across three parliamentary elections in Estonia

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Abstract

Some countries offer options to vote in elections remotely via the internet. However, not all voters take up this opportunity. This study investigates the role of the Five-Factor Model personality traits in the choice to use internet voting, and the potential mediating effects of trust in internet voting, controlling for sociodemographic variables. Survey data collected after national elections in Estonia in 2011 ($N = 482$), 2015 ($N = 535$), and 2019 ($N = 546$) were analyzed. Agreeableness was positively correlated with trust in internet voting in all samples. Additionally, Agreeableness was related to internet voting via trust, but not in all samples. Internet voting was predicted by higher trust in internet voting, better PC literacy, and speaking Estonian at home, across all samples. These results indicate that easy access to, and trust in, internet voting may play a bigger role in the decision to use internet voting than personality traits.

Keywords Big five · E-governance · Estonia · Five-factor model personality traits · Internet voting · Trust

Introduction

Free and fair elections are important in democratic societies

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and include the opportunity to participate in an election for every person allowed to vote (Elklit & Svensson, 1997). Due to developments in the area of information and communication technologies, several countries around the world offer eligible voters the option to vote remotely via the internet to increase voter turnout (Alvarez et al., 2009). Despite initial enthusiasm, casting votes remotely via the internet in public elections is not as widespread as expected (Schumacher & Connaughton, 2020; The Electoral Knowledge Network, n.d.). However, the ongoing pandemic has renewed the interest in internet voting, as it could offer an additional socially distanced and safe way to vote.

In countries where internet voting has been trialed or fully implemented, such as Estonia and Switzerland (in some cantons), the percentage of people who use the internet voting option hardly exceeds 40% in national elections in Estonia (valimised.ee, n.d.), or 20% in Geneva, Switzerland (Gerlach & Gasser, 2009). Thus, not all individuals who can use internet voting actually do so. Previous studies have emphasized the role of various sociodemographic factors in the use of e-government functions, including internet voting (Alvarez et al., 2009; Bakon & Ward, 2015; Mendez & Serdült, 2017; Trechsel & Vassil, 2010; Vassil et al., 2016; Vassil & Weber, 2011). Yet, little is known about the role of personality traits in the decision whether to use internet voting.

Personality traits are known to be important predictors of many consequential life outcomes and choices (see Soto (2021) for a recent review on the generalizability of such associations), including people's political preferences and political participation, as well as willingness to use certain e-government services (Bromme et al., 2022; Gerber, Huber, Doherty & Dowling, 2011; Venkatesh et al., 2014). Therefore, it is highly probable that certain personality traits are related to the use of internet voting. We thus aim to investigate the associations between personality traits and the use of internet voting, while also controlling for relevant sociodemographic factors. Furthermore, we want to examine a specific potential mechanism via which particular personality traits might be related to internet voting. Namely, based on the theoretical and empirical literature detailed below, we expect trust in internet voting to be a mediating variable in the relationships between certain personality traits and internet voting. More specifically, the mediating role of trust in internet voting in these relationships is based on (i) theories indicating that trust is influenced by personality (Beilmann et al., 2021; Thielmann & Hilbig, 2015) and (ii) theories and empirical findings outlining trust to be a crucial prerequisite for the use of e-governance services such as internet voting (Carter & Bélanger, 2005; Schaupp & Carter, 2005; Solvak & Vassil, 2018; Vassil et al., 2016).

To shed light on the underlying psychology of the choice of whether to use internet voting or vote in a more traditional way, the present work is structured as follows: In the next sections, the empirical and theoretical considerations underlying the research model and hypotheses of the present work are described. After that, the methods are described. Data from three independent samples from Estonia, a country well-known for its high implementation of e-governance services (e-estonia, n.d.), are analyzed. Afterward, results are presented, which are put into relation to existing literature and discussed in light of potential implications for policy making.

Internet voting in Estonia

The Estonian voting system offers various ways to vote: For example, one can vote in advance of the actual voting day at polling stations, or on election day at polling stations (Alvarez et al., 2009). There are some additional ways to vote under special circumstances, but these are not in the focus of the current study (for more detailed information please see: https://www.valimised.ee/en). Finally, Estonia offers the option to vote remotely via internet-connected devices to registered voters, hereafter referred to as internet voting (Alvarez et al., 2009; Ehin et al., 2022; Solvak et al., 2019; Tsahkna, 2013; Unt et al., 2017; Vassil et al., 2016). All voters need to vote via the internet is an internet-connected

device, an Estonian ID card and a reader, or an Estonian mobile ID (valimised.ee, 2021). The Estonian internet voting system is one of the most advanced in the world. It was introduced in 2005 and has consistently been used in local, national, and European elections since (Elections Canada, 2020). After its introduction, internet voting has increasingly been used by Estonians: In the past three parliamentary elections, the percentage of internet voters among participating voters increased from 24.3% (2011) to 30.5% (2015) to 43.8% (2019) (valimised.ee, n.d.). Given that in Estonia, 69.4% (2011), 87.7% (2015), and 90.4% (2019) of households had internet access (Statistics Estonia, 2021) and as can be seen from the numbers of internet voters, not everyone who can use internet voting seems to do so. This raises the question of which factors are associated with one's decision to vote via the internet.

The Five-Factor Model of personality and internet voting

To understand individual differences in the use of internet voting, personality traits may be important. Personality traits can be defined as "enduring tendencies to think, feel, and behave in consistent ways" (McCrae & Allik, 2002, p. 304). One of the most widely applied personality taxonomies is the Five-Factor Model (FFM) of personality (Digman, 1990; Fiske, 1949; Tupes & Christal, 1992). According to the FFM, personality can be described on the basis of five broad domains. Frequently, the domains are subsumed under the term Big Five of personality and are labeled Openness (to Experience), Conscientiousness, Extraversion, Agreeableness, and Neuroticism or its opposite Emotional Stability (Costa & McCrae, 1992a; Goldberg, 1990; Gosling et al., 2003; John & Srivastava, 1999).

The Big Five personality traits are known to predict many important life outcomes and choices, such as political preferences and voting intentions. For instance, positive associations between Openness, and negative associations between Conscientiousness and voting for left-wing political parties and a left-/liberal-leaning ideological position have been repeatedly reported (Gerber et al., 2011; Krieger et al., 2019; Mondak et al., 2010; Mondak & Halperin, 2008; Sibley et al., 2012; Sindermann et al., 2020). Moreover, various studies have reported associations between the Big Five personality traits and voting in elections (versus not voting) and voter turnout. Despite results indicating a positive link between Extraversion and voter turnout in several studies, results on personality trait associations with voting behavior are generally inconsistent across studies (Cooper et al., 2013; Dinesen et al., 2014; Gerber et al., 2011; Gerber, Huber, Doherty, Dowling, et al., 2011; Mattila et al., 2011; Mondak & Halperin, 2008; Sindermann & Montag,

2021). For example, while Conscientiousness has been positively associated with the self-rated importance of voting and voter registration (Cooper et al., 2013; Dinesen et al., 2014), it has been negatively associated with voter turnout or not related to voter turnout/intention to vote in other studies (Gerber, Huber, Doherty, Dowling, et al., 2011; Sindermann & Montag, 2021). Furthermore, while Agreeableness was (marginally) negatively associated with voter turnout in one of two US samples (Mondak & Halperin, 2008), it was not found to be related to intentions to vote in a German study (Sindermann & Montag, 2021).[1]

Nevertheless, given that several of the Big Five personality traits have been associated with political variables, it is likely that some of them are also associated with the use of internet voting. However, no theories or previous studies on direct relations between the Big Five and the specific variable of "voting via the internet" are available, yet. Thus, to form specific and directed hypotheses on the relationships between certain Big Five personality traits and internet voting results from related fields of research need to be considered (see previous paragraphs). Additionally, it is important to take into account the potential mechanisms that link the Big Five personality traits to the use of internet voting.

The mediating role of trust in the relationships between the Big Five personality traits and internet voting

Generally, trust can be defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer et al., 1995, p. 712). Among others, trust is crucial in human-technology interactions, and the decision to use internet voting can be seen as a trust-based decision. According to different experts (Abu-Shanab, 2014; Schaupp & Carter, 2005), trust in e-government options, such as internet voting, is based on trust in both the government and the technology. In line with the assumption of participation in internet voting being a trust-based decision, trust – be it in the government, the technology, or in internet voting in general – is a well-known prerequisite for the use of e-governance services/systems like internet voting (Carter & Bélanger, 2005; Schaupp & Carter, 2005; Solvak & Vassil, 2018; Vassil et al., 2016).

Based on this knowledge, trust in internet voting can be assumed to positively predict individuals' decisions to use internet voting options (Vassil et al., 2016).

Regarding the antecedents of trust, many theories of trust highlight the importance of personal characteristics, such as personality traits (Beilmann et al., 2021; Thielmann & Hilbig, 2015). Thus, trust in internet voting is likely to be influenced by some of the Big Five personality traits and to act as a mediator in the relationships between personality traits and internet voting, accordingly. On the one hand, existing trust theories indicate that it is primarily Neuroticism that is negatively associated with trust via a fear/anxiety of being betrayed. Agreeableness, on the other hand, seems to be positively related to trust via positive expectations of the trustworthiness of the other party (Thielmann & Hilbig, 2015).

To the best of our knowledge, no previous empirical study has examined the associations between the Big Five personality traits and trust specifically in internet voting (or e-governance). However, research from two related fields of research can provide some helpful insights into the potential associations. The first research field is related to trust in automation and e-services, such as e-retailing and mobile payment services. Studies in this field of research mostly reveal inconsistent results regarding the significance and size of the associations between the Big Five personality traits and trust in automation/internet services (Chien et al., 2016; Kim et al., 2016; Walczuch & Lundgren, 2004). Nevertheless, Agreeableness was related to trust in automation/internet services across different studies (Chien et al., 2016; Kim et al., 2016). Secondly, research from the field of trust in politics revealed positive associations between Agreeableness and trust in political officials and local authorities across two studies (Freitag & Ackermann, 2016; Mondak & Halperin, 2008). Results regarding the other Big Five personality traits, however, were inconsistent across these two studies. Moreover, a recent study investigating "general political trust" (i.e., trust in politicians, system trust, trust in institutions, and external (political) efficacy) reported a negative association between general political trust and Neuroticism, and positive associations with Openness and Agreeableness. In a second study reported in the same article, general political trust was negatively related to Neuroticism, and positively to Openness and Extraversion (Bromme et al., 2022).

Thus, theory as well as empirical research from two fields related to trust in internet voting repeatedly link Agreeableness positively with trust, or more specifically, to trust in internet-related services, political officials/authorities, and general political trust. The positive association between Agreeableness and trust is understandable given that trusting is a core facet of Agreeableness (Costa & McCrae,

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[1] One potential explanation for the inconsistencies in results might be related to differences in the sociodemographic compositions of the samples in previous studies (see the study on the differential effects of personality traits on voter turnout depending on gender (Wang, 2014)). Another explanation is that the effects of personality traits differ by country (Weinschenk, 2017). Unfortunately, no study on the associations between personality and voter turnout from Estonia seems to be available.

1992a), and the findings fit with the theoretical assumption that highly agreeable individuals tend to expect other parties, such as the internet voting system, to be trustworthy (Beilmann et al., 2021; Thielmann & Hilbig, 2015). Moreover, theory and empirical results on general trust in politics indicate a negative association between trust and Neuroticism (as found in two independent samples). This association is also understandable according to trust theories and putatively explained via a fear of being betrayed, which might be higher in highly neurotic individuals (Beilmann et al., 2021; Thielmann & Hilbig, 2015). Theory and research related to the other Big Five traits are not as consistent as those related to Agreeableness and Neuroticism and their associations with trust-related variables.

Considering both the theory and empirical findings, it can be expected that personality, specifically Agreeableness (positively) and Neuroticism (negatively) are related to trust in internet voting, which, in turn, positively predicts the use of internet voting options. The relationships between the other Big Five traits and trust and the use of internet voting are unclear.

Controlling for the effects of sociodemographic variables

Based on previous studies that have demonstrated associations between gender, age, education, and personality (Costa et al., 2001; Edmonds et al., 2008; Mammadov, 2021; Roberts & Mroczek, 2008; Schmitt et al., 2008; Vedel, 2014; Weisberg et al., 2011) and associations between age, gender, education, income, PC literacy (general computer skills), and internet voting (Alvarez et al., 2009; Bakon & Ward, 2015; Mendez & Serdült, 2017; Trechsel & Vassil, 2010; Vassil et al., 2016; Vassil & Weber, 2011), we also take these sociodemographic variables into account in our analyses. Moreover, the internet voting system in Estonia is available only in the Estonian language, which is the country's only official language. However, roughly 30% of Estonians speak Russian as their first language putatively hindering their understanding and trust in the internet voting system (Eesti Statistika, 2017; Nestas & Hole, 2012; Statistics Estonia, 2020; Volkamer et al., 2011). For this reason, we also control for the language spoken at home when examining the relationships between the Big Five personality traits, trust in internet voting, and the use of internet voting.

Aims of the present study

Taken together, given the increasing interest in internet voting because of the ongoing pandemic, it is crucial to understand the underlying mechanisms of the decision to use, or not to use internet voting. To investigate this, we not only examine the role of the Big Five personality traits in the use of internet voting but also the potential mediating effect of trust in the relationships between the Big Five personality traits and the use of internet voting, while also controlling for relevant sociodemographic factors. More specifically, based on the theories and empirical research results presented above, we built the following research model: First, we hypothesize that people with higher levels of Agreeableness and lower levels of Neuroticism are more likely to trust internet voting. Second, we hypothesize that trust in internet voting acts as a mediating factor, and accounts for some, if not all, of the relationship between the two personality traits and the use of internet voting. The relationships between the other Big Five personality traits and trust in internet voting and the use of internet voting are less clear and are therefore investigated in an exploratory fashion. Hence, other Big Five traits, for which no hypotheses are formulated, are still included in the analysis in order to examine their potential relations with trust and participation in internet voting. Since no study has investigated these relations beforehand, both significant and non-significant relations between any Big Five trait and trust and participation in internet voting provide valuable insights into the personality-psychological basis of internet voting. Finally, we will control for the effects of sociodemographic variables in all our analyses (see Fig. 1). In order to test the generalizability and robustness of findings across samples and time, we investigate the associations within three samples recruited over the course of three national elections in Estonia.

Materials and methods

Procedure

The samples under investigation stem from computer-assisted telephone interviews or computer-assisted personal interviews conducted after the national elections in 2011, 2015, and 2019 in Estonia. Each sample is independent and all samples were recruited through professional polling companies via the Population Registry. All Estonian residents are included in that database. All participants provided oral informed consent.

Sample

After data cleaning (see Supplementary Material), final samples of $N = 482$ ($n_{males} = 189$, $n_{females} = 293$; $M_{age} = 49.11$, $SD_{age} = 15.71$) participants recruited after the national elections in 2011, $N = 535$ ($n_{males} = 237$, $n_{females} = 298$; $M_{age} = 50.66$, $SD_{age} = 17.24$) participants recruited after the national elections in 2015, and $N = 546$ ($n_{males} = 255$, $n_{females} = 291$;
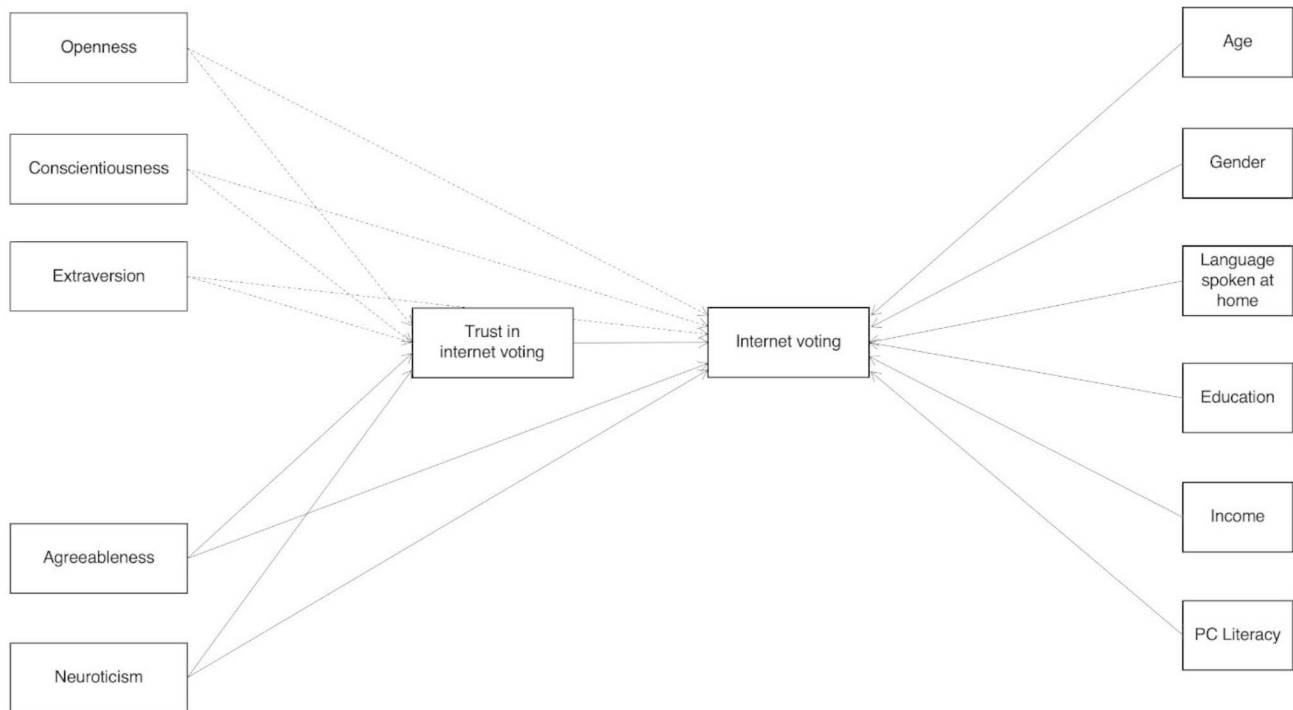
Fig. 1 Research Model; dashed arrows indicate associations of personality traits which are investigated exploratory

M_{age} = 49.18, SD_{age} = 15.66) participants recruited after the national elections in 2019 remained. More specific descriptive statistics of the three samples are presented in Table 1.

Measures

Voting mode, i.e., internet voting versus "other ways of voting" was operationalized as follows: In each sample, the individuals who stated they had used options such as voting on election day, in advance at polling stations, and "others" were included in one group. This group was compared to participants who used internet voting in the respective election.

Personality traits were assessed with the Estonian version (Kalmus et al., 2011) of the Ten Item Personality Inventory (TIPI; Gosling et al. (2003)). Each Big Five domain was assessed by two items. Participants were asked to indicate their agreement with each of the items on a 5-point rating scale ranging from 1 = "disagree strongly" to 5 = "agree strongly". The inter-item correlations were 0.18/0.31/0.26 for Openness, 0.25/0.41/0.32 for Conscientiousness, 0.27/0.42/0.33 for Extraversion, 0.10/0.15/0.14 for Agreeableness, and 0.41/0.46/0.41 for Neuroticism in the samples of the 2011/2015/2019 elections, respectively. Because of the low correlations between the two Agreeableness items, we decided to use only one of the two items (the one on being critical and quarrelsome (reverse coded)), which was

positively associated with trust, to calculate Agreeableness scores. We did not exclude the Agreeableness scale from analyses because we formulated a hypothesis for this trait.

Trust in internet voting was assessed by one item formulated as follows: "How much do you trust the procedure of internet voting?" (2011 election sample) and "Please say on a scale of 0 to 10 how much you personally trust the following transactions on the internet. 0 means you do not trust [them] at all and 10 means you trust [them] fully: Online voting." (2015 and 2019 election samples). In 2011, response options ranged from 1 = "don't trust" to 4 = "totally trust". In 2015 and 2019, trust was assessed on a scale from 0 to 10; this scale was transformed into the 4-point scale as follows: 0, 1, 2 = "don't trust" (= 1); 3, 4, 5 = "tend not to trust" (= 2); 6, 7, 8 = "tend to trust" (= 3); 9, 10 = "totally trust" (= 4)). One reason for doing this was to make the results between samples more comparable and to be able to merge the samples (but due to differences between the samples in the final results, we refrained from doing so). Another reason for this was the extremely skewed distribution of responses to the trust item when using the 0–10/11-point scale, especially in the 2019 sample; e.g., only $n = 9$ participants chose the response option "4" of the 11-point scale while $n = 177$ chose the option "10". Such imbalances could negatively impact the interpretability of results related to this (ordinal) variable, which is why we transformed the 11-point scale into a 4-point scale.

Sociodemographic variables such as age and gender (0 = "female", 1 = "male"), language spoken at home (0 = "Russian or other", 1 = "Estonian"), educational background (1 = "elementary/basic, 2 = "secondary education", 3 = "vocational secondary education", 4 = "higher"), and income (in deciles) were each assessed by means of a single variable each. Additionally, PC literacy was assessed by one item with response options ranging from 1 = "no computer skills" to 5 = "very good (computer skills)".

Analysis

Data were analyzed in R version 4.1.0 and R studio version 1.1.463 (R Core Team, 2021; RStudio Team, 2020). All analyses were carried out separately in the samples from each election. In this way, it can be tested whether the same variables are associated with internet voting across time/elections.

After descriptive statistics for all variables were calculated, internet voters and individuals who casted their vote another way were compared by distribution of gender, education, and language spoken at home with χ^2-tests. The two groups were also compared by income using Mann-Whitney U-tests as well as by age and the Big Five personality traits using t-tests. Differences between the two groups in PC literacy and trust in internet voting were investigated using both Mann-Whitney U-tests and χ^2-tests. Zero-order bivariate Spearman correlations for trust in internet voting and the TIPI scales were calculated. The results of these analyses are summarized here and further details are provided in the Supplementary Material.

Finally, we performed path analysis. Path analysis provided the opportunity to examine the direct and indirect relations of all Big Five trait scales with internet voting in one model while also taking into account the effects of sociodemographic variables. This is why we decided against regression models (in which mediation/indirect effects cannot be tested) or simple mediation models (which include one independent variable, i.e., one Big Five trait scale). We included all the variables detailed in Fig. 1 as manifest variables in the model. In more detail, the mean scores of the two respective items of each Big Five trait scale (except Agreeableness) were included as manifest variables in the model. For Agreeableness, only the score of one item was included as a manifest variable in the model. No structural equation models and confirmatory factor analyses were used to model the Big Five or other variables given the brevity of the scales (oftentimes 1-item scales) and in order to ensure that the model would converge. The weighted least squares mean- and variance-adjusted (WLSMV) estimator was used. The trust variable and the voting mode variable were included as ordinal variables in the model. While we initially planned

to conduct analyses on measurement invariance across the three samples, we refrained from doing so. This is because configural invariance – the lowest level of invariance – is defined as the same model holding in each sample and is a prerequisite to further testing higher levels of invariance. Since the fit values of the proposed model within each sample were non-satisfactory, this criterion was not met.

Results

Descriptive statistics

Table 1 presents the descriptive statistics of all variables of interest in the three samples.

Differences between internet voters and others in the Big Five personality traits, trust in internet voting, and sociodemographic variables

In the 2011 sample, participants who used internet voting had higher scores in Openness ($t(480) = -3.57, p < .001$) and trust in internet voting ($W = 13,807, p < .001$) than those who did not use internet voting. In the 2015 sample, internet voters had lower scores in Neuroticism ($t(533) = 2.63, p = .009$) and higher scores in Openness ($t(287.61) = -1.97, p = .050$ (more exact p-value: 0.04966)) and trust in internet voting ($W = 13,142, p < .001$). Finally, in the 2019 sample, internet voters scored higher in Extraversion ($t(524.37) = -2.88, p = .004$), Agreeableness (only in the 1-item score based on Mann-Whitney U-tests; $W = 32,416, p = .005$), and trust in internet voting ($W = 18,002, p < .001$) than those who did not use internet voting.

In all samples, internet voters were significantly younger, were more likely to speak Estonian at home, and had higher levels of education, income, and PC literacy than participants who did not use internet voting. See Supplementary Material for additional information.

Associations between personality and trust in internet voting

Significant zero-order correlations between TIPI scales and trust in internet voting were observed for Openness in the 2011 ($\rho = 0.15, p < .001$) and 2015 ($\rho = 0.11, p = .008$) samples, for Extraversion in the 2019 ($\rho = 0.12, p = .006$) sample, for the 1-item Agreeableness score in all three samples (2011: $\rho = 0.10, p = .027$; 2015: $\rho = 0.11, p = .010$; 2019: $\rho = 0.10, p = .022$; no significant associations for the 2-item scale were observed), and for Neuroticism in the 2011 ($\rho = -0.10, p = .036$) and 2015 ($\rho = -0.13, p = .003$) samples.

Table 1 Descriptive statistics on voting, personality, trust in internet voting, and sociodemographic variables in the three samples recruited after the different national elections

	2011 (N = 482)	2015 (N = 535)	2019 (N = 546)
Voting mode			
Internet voting	282 (58.51%)	145 (27.10%)	274 (50.18%)
Other ways of voting	200 (41.49%)	390 (72.90%)	272 (49.82%)
Personality			
Openness	M = 3.39, SD = 0.85	M = 3.41, SD = 0.81	M = 3.62, SD = 0.81
Conscientiousness	M = 4.45, SD = 0.63	M = 4.20, SD = 0.66	M = 4.40, SD = 0.63
Extraversion	M = 3.84, SD = 0.89	M = 3.68, SD = 0.88	M = 3.81, SD = 0.86
Agreeableness	M = 3.93, SD = 0.73	M = 3.80, SD = 0.67	M = 3.89, SD = 0.66
Agreeableness (1-item score)	M = 3.51, SD = 1.20	M = 3.46, SD = 1.05	M = 3.45, SD = 1.05
Neuroticism	M = 2.14, SD = 0.93	M = 2.42, SD = 0.88	M = 2.22, SD = 0.86
Trust in internet voting	M = 3.12, SD = 1.01	M = 2.78, SD = 1.13	M = 3.08, SD = 1.09
Don't trust	56 (11.62%)	112 (20.93%)	76 (13.92%)
Tend to not trust	52 (10.79%)	79 (14.77%)	74 (13.55%)
Tend to trust	153 (31.74%)	159 (29.72%)	128 (23.44%)
Totally trust	221 (45.85%)	185 (34.58%)	268 (49.08%)
Language			
Russian or other	46 (9.54%)	95 (17.76%)	69 (12.64%)
Estonian	436 (90.45%)	440 (82.24%)	477 (87.36%)
Education			
Elementary/basic	19 (3.94%)	65 (12.15%)	20 (3.66%)
Secondary education	83 (17.22%)	115 (21.50%)	274 (50.18%)
Vocational secondary education	148 (30.71%)	165 (30.84%)	8 (1.47%)
Higher	232 (48.13%)	190 (35.51%)	244 (44.69%)
Income deciles			
1	230 (47.72%)	68 (12.71%)	44 (8.06%)
2	-	41 (7.66%)	15 (2.75%)
3	-	26 (4.86%)	118 (21.61%)
4	-	108 (20.19%)	-
5	-	-	75 (13.74%)
6	102 (21.16%)	103 (19.25%)	56 (10.26%)
7	-	-	54 (9.89%)
8	69 (14.32%)	124 (23.18%)	56 (10.26%)
9	41 (8.51%)	23 (4.30%)	128 (23.44%)
10	40 (8.30%)	42 (7.85%)	
PC literacy	M = 3.35, SD = 1.15	M = 3.30, SD = 1.15	M = 3.85, SD = 1.03
No computer skills	38 (7.88%)	49 (9.16%)	17 (3.11%)
Basic	62 (12.86%)	66 (12.34%)	28 (5.13%)
Average	164 (34.02%)	181 (33.83%)	148 (27.11%)
Good	131 (27.18%)	154 (28.79%)	179 (32.78%)
Very good computer skills	87 (18.05%)	85 (15.89%)	174 (31.87%)

Note. Percentages do not add up to 100% due to rounding; the 1-item Agreeableness score is based on the reverse coded item on being critical, quarrelsome
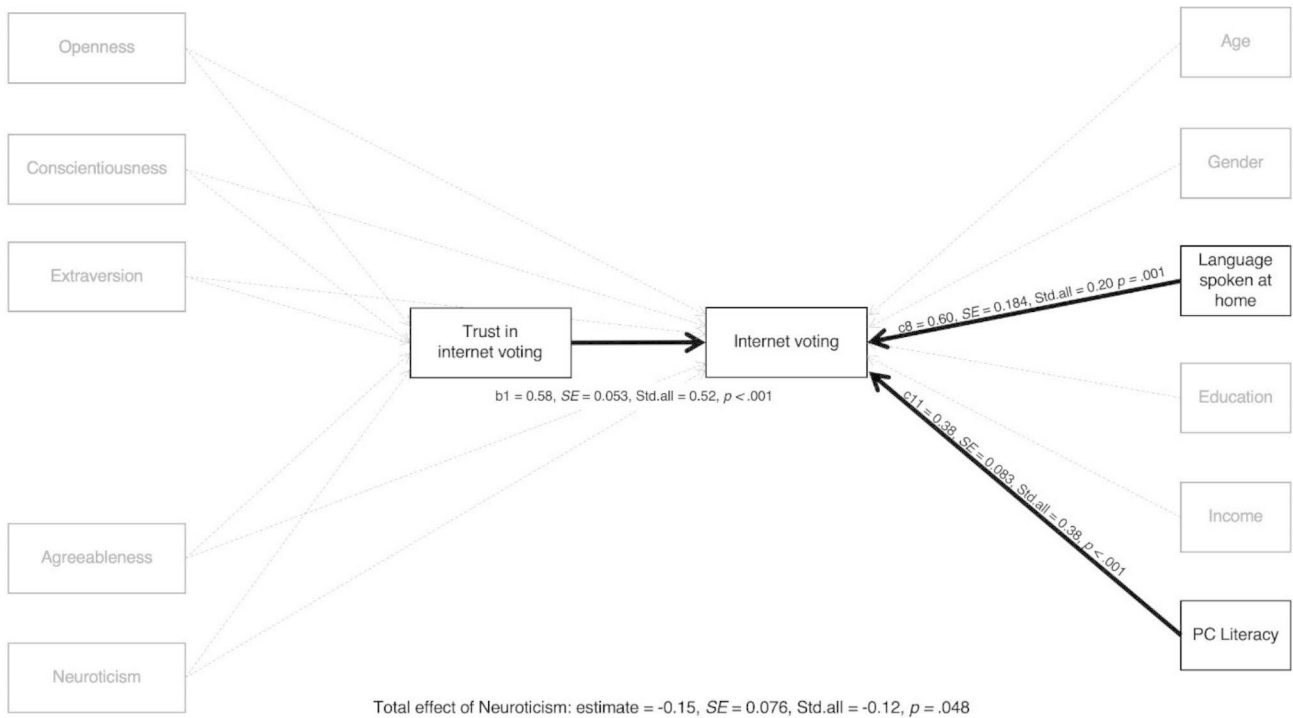
Path analysis

The models to investigate links between TIPI scales and internet voting via trust in internet voting while controlling for sociodemographic variables are presented in Figs. 2 and 3, and 4. As can be seen in these figures, one significant association consistently found in each sample is the positive association between trust in internet voting and the use of internet voting (2011: estimate = 0.52, SE = 0.057, Std. all = 0.40, p < .001, 2015: estimate = 0.58, SE = 0.053, Std. all = 0.52, p < .001, 2019: estimate = 0.55, SE = 0.053, Std. all = 0.47, p < .001). The effects are of similar size in all
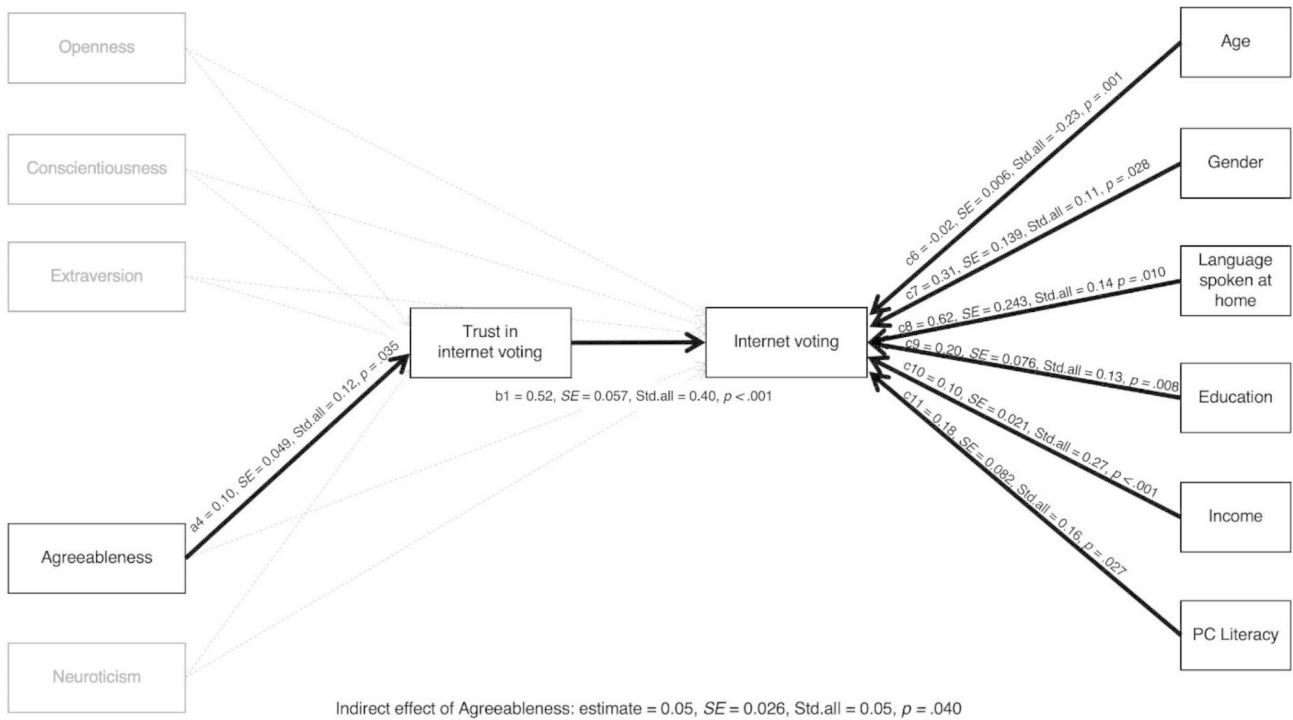
Fig. 2 Significant paths (indicated in bold) in the path analysis in the sample of the 2011 national elections
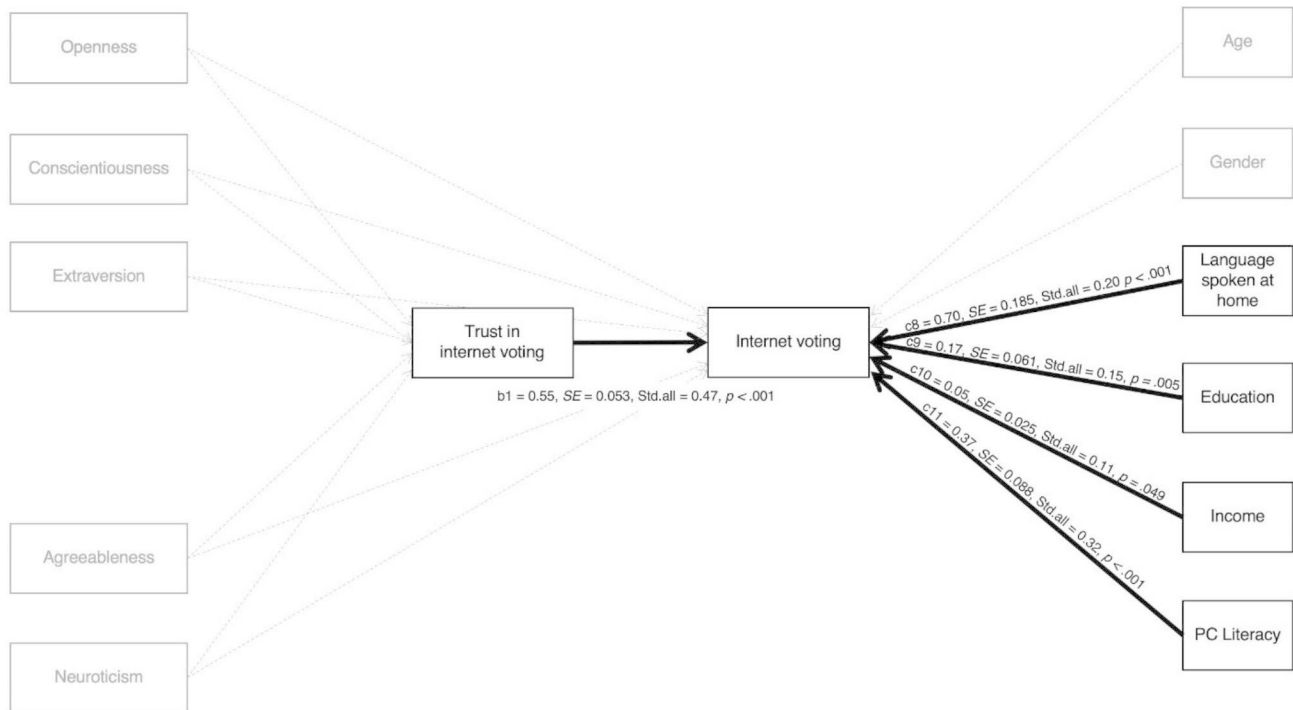

Fig. 3 Significant paths (indicated in bold) in the path analysis in the sample of the 2015 national elections

samples. Regarding the other variables, only the control variables language spoken at home and PC literacy are consistently associated with internet voting. The effects indicate that speaking Estonian at home and having higher PC literacy are associated with internet voting versus voting another way.

Fig. 4 Significant paths (indicated in bold) in the path analysis in the sample of the 2019 national elections

Regarding personality, only Agreeableness showed a significant positive association with trust in internet voting and a significant indirect effect (estimate = 0.05, SE = 0.026, Std. all = 0.05, p = .040) on the use of internet voting via trust in the 2011 sample; see Fig. 2. In the 2019 sample, the effect of Agreeableness on trust in internet voting just failed to be significant (estimate = 0.09, SE = 0.052, Std.all = 0.09, p = .088; indirect effect on internet voting: estimate = 0.05, SE = 0.029, Std.all = 0.04, p = .091; total effect on internet voting: estimate = 0.11, SE = 0.059, Std.all = 0.10, p = .057). The total effect of Neuroticism on internet voting was significant in the 2015 sample (estimate = -0.15, SE = 0.076, Std.all = -0.12, p = .048), but neither its direct nor its indirect effect on internet voting was significant in this sample. Aside from these effects, personality did not have significant effects on either trust or internet voting in any of the samples. Complete results of the models are presented in the Supplementary Material.

Overall, none of the models showed a good fit in any of the samples. Robust fit indices were: 2011: Comparative Fit Index (CFI) = 0.61, Tucker-Lewis Index (TLI) = 0.94, Root Mean Square Error of Approximation (RMSEA) = 0.10, Standardized Root Mean Square Residual (SRMR) = 0.00; 2015: CFI = 0.67, TLI = 0.95, RMSEA = 0.11, SRMR = 0.00; 2019: CFI = 0.57, TLI = 0.93, RMSEA = 0.12, SRMR = 0.00. This finding is in line with the many non-significant paths observed in each of the models. Based on the low fit values,

measurement invariance across samples was not tested any further because the fit of the model within each sample is the first step in investigating measurement invariance.

Discussion and conclusions

The present study aimed to shed light on what makes people use internet voting versus other voting options. Specifically, the associations between the Big Five personality traits and the use of internet voting were investigated, including the potential mediating effects of trust in internet voting on these associations, while controlling for relevant sociodemographic variables.

Results of the present study in relation to previous works

Firstly, comparing internet voters and individuals who cast their vote another way across the three Estonian national election poll samples, we found that internet voters showed higher trust in internet voting. Moreover, in all poll samples, internet voters were significantly younger, were more likely to speak Estonian at home, and had higher levels of education, income, and PC literacy than participants who did not use internet voting.

Similarly, in path analysis, we found consistent positive associations between trust in internet voting and the use of internet voting. This finding is not only in line with results from previous studies (Carter & Bélanger, 2005; Madise & Martens, 2006; Schaupp & Carter, 2005; Vassil et al., 2016) but also with our proposed research model. Moreover, across countries, trust has been found to be an important factor in e-governance acceptance (Stephany, 2020). Given the important role of trust in internet voting, many resources have already been put into identifying the factors influencing and increasing trust in internet voting. It has been argued that there are several system prerequisites that are necessary for trust-building in internet voting, such as procedural security, an enhanced legislative framework, and increased staff training (Xenakis & Macintosh, 2005). Other aspects, such as simplicity, perception of security, and efficient vote counting processes, have also been identified as important prerequisites for trust (Salem, 2007). Thus, governments aiming at implementing internet voting in their country should consider those factors in order to enable citizens to trust internet voting. However, until now little was known about the individual characteristics influencing trust in internet voting.

The present study contributes to this topic of research by its investigation into personality trait associations with trust in internet voting. More specifically, we found consistent positive correlations between Agreeableness and trust in internet voting across all samples. However, in path analysis (and controlling for sociodemographic variables), no consistent significant associations of any of the Big Five personality traits with trust in, or use of internet voting were found. In the 2011 sample, there was a significant indirect effect of Agreeableness on internet voting via trust in internet voting. More specifically, Agreeableness positively predicted trust in internet voting, which, in turn, positively predicted the use of internet voting versus voting another way. In the 2019 sample, similar effects were found. However, in that sample, these effects were marginally non-significant. In the 2015 sample, no association between Agreeableness and trust in or use of internet voting was found. However, it also should be mentioned that this sample differed from the other two samples in terms of distribution of voter modes: In the sample from 2015, there were much fewer internet voters than individuals who casted their vote in other ways compared to the other two samples. This might explain the differences in results.

Generally, these results might provide initial support for the notion of an association between Agreeableness and trust in internet voting and might support the assumption that Agreeableness and internet voting might be related via the mediating effect of trust in internet voting. These findings are in line with our initially proposed theoretical model.

However, significant associations in path analyses were – as mentioned before – only found in one sample. Thus, further studies will need to replicate the present work in order to test the robustness of the findings. Nevertheless, based on theories of trust (Beilmann et al., 2021; Thielmann & Hilbig, 2015), the relationship between Agreeableness and trust in internet voting is reasonable and might be explained by a higher propensity to believe that the other party, i.e., the internet voting system, is reliable and trustworthy, in individuals scoring high in Agreeableness. Also, the results are reasonable given that individuals scoring high in Agreeableness are generally described as being compliant, decent, and trusting (Costa & McCrae, 1992b). In addition, based on the present findings it seems like individuals scoring low in Agreeableness trust internet voting less, and might thus profit from measures to increase trust in order to increase internet voting turnout, accordingly. Additionally, when taking into account studies on system characteristics in relationship to trust (Salem, 2007; Xenakis & Macintosh, 2005), it can be concluded that it might be especially important for individuals low in Agreeableness (associated with less trust) to learn about, for example, how the internet voting system is secure (Salem, 2007) to increase their internet voting turnout. The effectiveness of such an information campaign in groups of individuals with different personality traits should, therefore, be investigated in future studies. However, we again draw attention to the necessity of replicating the present findings, first.

Aside from the associations with Agreeableness, the role of the other Big Five personality traits in the level of trust in internet voting or in the use of internet voting was inconsistent across different samples and mostly non-significant when controlling for relevant sociodemographic factors. The inconsistencies in these relations might be due to different sample characteristics or environmental factors prevalent only in certain years. As an example, in 2014, a security report mentioning limitations of the Estonian internet voting system was published (Springall et al., 2014) and also discussed in the media (Koorits, 2014), which might have impacted certain individuals' decisions on whether to use internet voting in the 2015 elections. Since such environmental factors and their influences on individuals' decisions were not assessed in the present study, however, we cannot draw any final conclusions as to why relations differ between the samples.

Regarding sociodemographic variables, we found that speaking the Estonian language at home and higher PC literacy were positively associated with internet voting in all samples in the path analysis. The finding that people who speak Estonian are more trusting of internet voting is quite expected as the Estonian internet voting system is only available in the Estonian language. Additionally, the

prominent Technology Acceptance Model (TAM) might be of relevance here (Davis, 1989; Venkatesh & Davis, 2000). This model proposes that perceived ease of use of a technology influences perceived usefulness of this technology, and both impact intention to use (attitude towards using), which, in turn, influences usage behavior of the technology. Although not directly addressing trust, considering the TAM can be helpful in explaining the present findings: Individuals who do not speak Estonian at home, and, therefore, are likely to not have the Estonian language as their native language, might have difficulties perfectly understanding the Estonian internet voting system. Therefore, these individuals might perceive internet voting to be less easy to use and therefore tend to use the system less. But it should be noted that the present study did not directly assess how well individuals understand the Estonian language. Moreover, one might think that individuals speaking Russian at home, or more specifically ethnic Russians (which was not directly assessed in the present work), trust the political system or government less and therefore also trust internet voting less. However, the Estonian integration monitoring report from 2017 (https://www.kul.ee/eesti-uhiskonna-integratsiooni-monitooring-2017) suggests no differences in trust in the government or parliament between ethnic Estonians and non-ethnic Estonians.

The same reasoning as for the language spoken at home related to the TAM can be applied to explain the positive associations between computer skills (PC literacy) and trust in internet voting: Individuals who do not have a high PC literacy might use the internet voting system less due to lower perceived ease of use of the system.

Limitations of the present study

When interpreting the present findings, one needs to take into account the following limitations. First, the groups of internet voters most likely comprise individuals who have already internet-voted several times as well as first-time internet voters. This might influence the results because trust in internet voting might be influenced by familiarity and previous experiences with the system; see results/model on trust in Artificial Intelligence differentiating between initial and continuous trust (Siau & Wang, 2018). Hence, previous use of internet voting is likely to influence trust as well as, possibly, the relationship between personality and trust. Unfortunately, we could not control for the number of times individuals had already internet-voted before participation in the present polls. This should be taken into account in future studies. Next, the TIPI questionnaire can be criticized for its shortness and for only assessing specific aspects of the broad Big Five, as well as for its rather low reliabilities/inter-item correlations (see also results on this

in the present study; Ahmed and Jenkins (2013)). However, generally speaking, various studies in various languages (unfortunately not in the Estonian language) underline the convergent and discriminant validity (but rather low internal consistency) of the TIPI (Ahmed & Jenkins, 2013; Ehrhart et al., 2009; Gosling et al., 2003; Romero et al., 2012; Storme et al., 2016). Thus, the TIPI can generally be seen as an acceptable measure of the Big Five when time and space for data assessment are limited. This was the case in the larger research project from which the present data were derived. A large sample size and the assessment of various constructs were deemed more important than the in-depth examination of a few constructs in order to receive a broad perspective on voting in the Estonian context. Nevertheless, especially the small inter-item correlations between the two Agreeableness items in the present work might give reason for some concern; of note, the Agreeableness scale of the TIPI was found to be problematic in terms of internal consistency also in other studies (Romero et al., 2012; Storme et al., 2016). It is possible that future studies applying longer measures of the Big Five traits and investigating various sub-facets might find results slightly differing from the present ones. However, given that, for example, correlational results on relations of Agreeableness and Neuroticism with trust in internet voting are mostly in line with our initial hypotheses, we do expect studies applying longer Big Five measures to find stronger results rather than weaker ones. Also, the present study is of a cross-sectional nature, therefore not allowing for any causal interpretations of the associations observed. Moreover, the generalizability of the present findings to samples from other countries than Estonia must be tested in future studies. Finally, the samples under investigation were assessed after the national elections in 2011, 2015, and 2019. Internet voting, however, was introduced in Estonia in 2005. It is possible that personality played a more important role in the first years in which internet voting was possible, i.e., when it was something rather unknown and new. Unfortunately, data on personality traits were not available for samples assessed after elections in the early years of internet voting in Estonia. Moreover, the long periods of time between the collection of data of the present samples allows for environmental factors (such as the security report published in 2014 (Springall et al., 2014)) impacting voting, including decisions on whether to vote via the internet, and relations of personality with the decision on whether to vote via the internet. Controlling for such factors might explain some of the inconsistent findings across the three samples. Unfortunately, no data on this issue were available.

Finally, we also want to point out the rather small effect sizes of the personality associations found in the present work, which is a common finding in (personality)

psychological research (Funder & Ozer, 2019). Trust, and trust in internet voting specifically, are psychological phenomena and, thus, very complex. Hence, there are putatively many different variables impacting trust. Next to personality traits such as Agreeableness, one's attitudes toward the internet, the government, and so on, might shape individuals' trust in internet voting (Carter & Bélanger, 2005). Additionally, variables from the TAM or the compatibility variable of the Diffusion of Innovation Theory might influence trust in internet voting (Carter & Bélanger, 2005; Davis, 1989; Rogers, 2010). Each individual variable – and the personality traits specifically – might only have a small individual effect (Götz et al., 2021). Therefore, more variables aside from personality traits need to be investigated in forthcoming studies in order to better explain the variance in trust in internet voting and the use of internet voting. Moreover, considering the two subdimensions of trust in internet voting, trust in the technology and trust in the government, it is possible that both dimensions are differentially affected by different dispositional characteristics. Investigating these associations is an interesting new research aim.

Conclusion

In conclusion, the present work indicates that, out of the Big Five personality traits, it is only Agreeableness that seems to be related to trust in internet voting and the use of internet voting. More importantly, trust in internet voting was consistently positively linked with internet voting. This highlights that trust plays an important role in the adoption of technologies like internet voting. Therefore, the present findings indicate that governments aiming to adopt internet voting in the future should try to increase trust in the internet voting technology in eligible voters to make it a widely used technology, and profit from its advantages, such as saving time (e-estonia, n.d.). Especially in times of a pandemic, internet voting can also be seen as a safe alternative to voting at polling stations and therefore enhance voter turnout. Measures to enable or increase trust in internet voting might increase internet voting turnout specifically in individuals low in Agreeableness, who seem to generally trust internet voting less.

Declarations

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