Enhancing the diffusion of e-participation tools in smart cities

Abstract: E-participation tools are a part of the transition process to smart governance, but sometimes the adoption rate among citizens is lower than municipalities expect. This article aims to find new or underestimated factors that drive the change from non-adopters to adopters of innovative e-participation tools. Research data help explore three adoption factors: Citizens' Participatory Experience (how experienced people are in offline participation), Citizens' Technological Innovativeness (how innovative people are), and Innovativeness of City (how many participatory technologies municipalities offer). Based on logistic regression, all these factors proved significant. Next, we show how important it is for the municipality to offer more e-participation tools. More tools increase the adoption rate up to more than 70%. In addition, we show which tools are most successful among Czech cities and their citizens.

1   Introduction

The importance of citizen participation and engagement is reflected in a wide range of research literature that emphasizes the so-called "citizen-centric approach," a style of governance that respects the needs and requirements of citizens (e.g., Denhardt & Denhardt, 2000; Chan & Pan, 2008; Crețu & Crețu, 2014; Joss et al., 2017; Du & Dai, 2018; Kopackova and Libalova, 2017). Participation and engagement give citizens the power to manifest their democratic citizenship and show their interest in public matters. The relationship between citizens and local government can change from the passive role of the citizen as a recipient to an active actor. Citizens can then provide new information that would be otherwise unavailable, participate in decision-making, or help implement a specific project.

Participation empowers citizens by giving them a feeling of importance (Fischer, 2006) that motivates them to be involved in decision-making for day-to-day policies or actions (Gil et al., 2019). They are also reassured of officials' interest in their opinions (Potapchuk, 1996). Hollands (2008) emphasized the importance of people being engaged in building smart cities, as people and their interactions represent a key critical development factor. Kopackova and Komarkova (2020) showed that participation is a necessary component of the process of shaping smart cities, forming the smart city shaping model (SCSM). This model has three levels—smart thinking, smart principles, and smart services. Smart thinking represents the basis: a willingness and ability to behave according to smart principles, which are creativity, sustainability, participation, the 3Es of management, transparency, and leadership. Smart services are a product of these principles.

Research on participation has brought different views on how to measure it. Arnstein's participation ladder (Arnstein, 1969), with its eight levels of participation (Manipulation, Therapy, Informing, Consultation, Placation, Partnership, Delegation, and Citizen Control), remains the basic approach to this issue, but other researchers have adjusted the number of levels or specified the use of this tool in a particular domain (Macintosh, 2004; Tambouris et al., 2007; Cardullo and Kitchin, 2017; Kopackova, 2019).

Traditional participation tools mostly require the personal participation of citizens; they include public hearings, briefings, citizen boards or panels, focus groups, performance (storytelling), etc. E-participation tools use information and communication technologies (ICT) as a communication channel to activate citizens and engage them in deliberation, decision-making, service design, and public service delivery (Macintosh, 2004; Saebø et al., 2008; Welch, 2012). These tools make participation easier, faster, and more transparent (Reddick and Roy, 2013).

Pereira et al. (2018, pp.9-10) summarize the benefits of using ICT in citizen-government interactions: "the ever more important role of citizens and closer interactions with government lead to a model of smart government where the relationship goes beyond service improvement and delivery and into areas of decision making, openness, wider societal issues and wider stakeholder networks." Other authors explain the link between e-participation and smart governance by emphasizing the benefits of e-decision making and e-consultations as a modern way of building trust (Giffinger et al., 2007, Bernardo, 2019; Gil et al., 2019). However, although the benefits of e-participation are extensive, they are not available to all citizens. The reason can be insufficient access to relevant information technology infrastructure or a low capability and ability to use ICT. Governments thus need to find the optimal mix of online and offline approaches to participation (UN, 2014).

Developments in e-participation technologies are difficult to classify; however, some authors tried to systemize this area and create a framework for describing the different types of technologies, e.g., Macintosh (2004), Chun et al. (2010), Desouza and Bhagwatwar (2014). Linders (2012) offers a quite clear three-part classification scheme according to who is the recipient and who is the provider: G2C (government to citizen), C2G (citizen to government), and C2C (citizen to citizen).

In G2C communication, the public administration distributes information and data. Although this type of participation does not directly require the activity of citizens, the availability of open data allows their free processing by anyone and thus supports participation.

Technologies for C2G communication are typical representatives of e-participation, as the active involvement of the population is expected. On one level, these can serve as tools providing the opportunity to discuss, collect ideas, vote, create mind maps, etc. (eRulemaking, IdeaScale, eDemocracy Party). On another, they can provide a joint solution to a certain problem. People can design solution procedures, define and prioritize requirements, participate in solutions, etc. (CrisisCommons, Challenge.gov, PeerToPatent, government-run wikis). Such technologies also offer monitoring, where people act as live sensors and provide information on a specific topic, such as service-level assessments, fault reporting, the mapping of dangerous places, etc. (SeeClickFix, FixMyStreet).

Do-it-yourself (C2C) tools represent the last type of e-participation. These tools do not necessarily require the participation of public administration but instead give people the opportunity to organize in a virtual space to improve city life ("Smart mob," community portal, virtual world), to behave in an environmentally friendly way using car-pooling, or to expand the supervision of services by exchanging experiences and recommending hospitals, schools, cultural facilities, etc. (NHS Choice). Cities can use any of these tools and combine them to support the participation of citizens.

In this article, we focus on e-participation as an implemented practice, defined by Steinbach et al. (2020), which represents the intentional activity of local government to support the participation of their citizens by digital technologies. This view highlights the high engagement of citizens and high implementation complexity at the municipality side. E-participation as an implemented practice needs to meet these requirements: 1) offer active engagement of citizens (e.g., communication, cooperation, co-decision, co-creation) and 2) e-participation tools need to be implemented by local governments. The first condition eliminates e-government tools focused only on information sharing when citizens are passive recipients. The second condition assumes the activity on a municipality level as the tool needs to be implemented before citizens use it. This condition eliminates the "voice of citizens" gathered from social networks.

A series of challenges accompany the implementation of e-participation tools through the lens of Steinbach's definition. First, the local government must be willing to accept citizens as qualified partners to start implementation successfully. The following steps are selecting and implementing a tool that meets qualitative criteria (Consoli et al., 2015; You et al., 2016). However, technology alone cannot ensure user satisfaction. It must be implemented in an organizational environment with the necessary process modifications (Consoli et al., 2015). Finally, operating personnel must be qualified and convinced of the importance of the service. All these steps are time-consuming and expensive, but they do not guarantee the success of e-participation tools. Real success happens when citizens adopt these tools, get used to them, and are satisfied with their results (the projection of citizens' needs into city strategies).

An important question arises from the complexity of the implementation process. How to enhance the diffusion of e-participation tools among citizens? This question leads us to more specific questions targeting the success factors. What factors influence the acceptance of e-participation tools? Are there any factors that can be estimated before the implementation? Can we assume higher acceptance of the new e-participation tool when the city uses others? Innovation diffusion and acceptance (adoption) theories can help to answer these questions. These theories emerged back in the sixties; therefore, the pool of eligible models is vast. They can be divided into two categories according to different viewpoints of stakeholders.

Innovation diffusion theories view the process through the lens of the innovation producer. These theories can answer many questions; what qualities should have the innovation and adopting organization as the prerequisite for the success of the innovation, how is defined the innovation-decision process, what factors influence the rate of adoption, and much more. As such, they can provide important insight into the success of an innovation. The examples of theories in this category are DOI – Diffusion of innovations (Rogers, 2003) or TOE – Technology, organization, environment framework (DePietro et al., 1990).

Acceptance theories study the diffusion of innovations at the individual level. This research aims to answer what factors affect individuals deciding whether to use new technologies. All theories in this category employ concepts from psychology and define Use as an action that is motivated by an Intention to use innovation. Individuals tend to accept innovation under three conditions. At first, innovation has some characteristics (usefulness and usability). Second, the user has some characteristics (experience, gender, age, positive attitude to the innovation, self-efficacy, willingness to change status quo). Third, the interaction between users and system is established (adjustment of processes and the innovation, preservation of power and resources distribution, top management support, cultural fit, minimization of uncertainty). The examples of theories in the second category are TRA – Theory of reasoned action (Fishbein and Ajzen, 1975), TPB – Theory of planned behavior (Ajzen, 1991), TAM – Technology Acceptance Model (Davis et al., 1989), UTAUT – Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), and resistance theories (Markus, 1983; Coetsee, 1999).

This article seeks to address two gaps in the theoretical background. At first, all these models adopt the Likert scale to study factors affecting behavioral intention to use an innovation. The most commonly used factors are perceived usefulness and perceived ease of use. Examples of typical statements include, "Using this product would improve my performance," "I would find this product useful in my job," "I would find this product easy to use," "It would be easy to become skillful in using this product." Ratings for these statements help researchers understand the process of adopting new technologies. The limiting factor of all these models is the assumption that the respondents are aware of how to use the technology and have tried to do so. Otherwise, they would not be able to respond. Local governments usually cannot ask citizens if they would use a particular e-participation tool before its implementation because the citizens will not have had a chance to try it.

The second gap is the scarcity of literature on e-participation as an implemented practice. Broader topic, the adoption of e-government services, is highly studied on both levels, either citizens or municipalities. However, these studies mainly addressed the offering of communication and transactions tools or information sharing. The adoption of social media is also studied on both levels. Citizens can use social media to post opinions and ideas, discuss the problems and possible improvements, suggest solutions, etc. Cities can distill citizens' opinions and sentiments. Although both directions are interesting, they are not the subject of research interest of this article. Neither e-government services nor social media sentiment represent the intentional activity of local government to support the participation of their citizens by digital technologies.

This article aims to find factors (variables) that significantly influence e-participation adoption while being available before implementing a given solution. Such factors need to meet two conditions:

1) They are significant for adopting e-participation tools by citizens.

2) The data for these factors are accessible without the necessity to acquaint citizens with the given tool.

We provide a systematic literature review with a conceptual exploration of theoretical frameworks to address this objective.

The article is organized as follows. The next section describes research methods together with data definition and the description of the data gathering process. The third section shows the results of a systematic literature review used to find potential variables that meet both criteria. This section also includes the results of the hypothesis testing of selected criteria with logistic regression. Section 4 discusses the results, emphasizing the Innovativeness of the City, which is a new success factor. Finally, the conclusion closes the article and summarizes the significance of all three factors tested.

2   Research methods

This section presents research methods and data we employed to fulfill the aim of the article. To find eligible factors, we carried out a systematic literature review in the fields of e-government and e-participation. The review included only articles and research papers (i.e., journal articles, reviews, book chapters, and conference proceedings) indexed in Web of Science. There was set no period for the search, so it covered all research published in the past. This chapter also defines our hypotheses.

Figure 1 depicts the whole process of the review. The first step was the definition of keywords and the gathering of data. The list shown covers general keywords. Combined with targeted searches, this allows us to find enough sources to ensure the specificity of the research. The search did not use quotation marks, but all keywords had to be included. The total number of sources was 3392, but adjusting for duplication reduced this to 2908. The next step was based on a text search of abstracts. Searching for factor(s) (factor*) reduced the number of articles to 782, all of which should deal with adoption or success factors.

Further narrowing of the topic (by searching for particip* or engage* in the abstract) selected 166 papers. After carefully reading the abstracts, 68 papers were omitted as being outside our scope, i.e., not concerned with the implementation, diffusion, or adoption of e-participation or e-government tools. A shortlist of 98 papers formed the basis for the whole-text review. Of these, 22 were unavailable, and the remaining 76 selected papers were categorized according to technology type. We found only 12 articles corresponding to the definition of e-participation as an implemented practice, as per Steinbach et al. (2020).
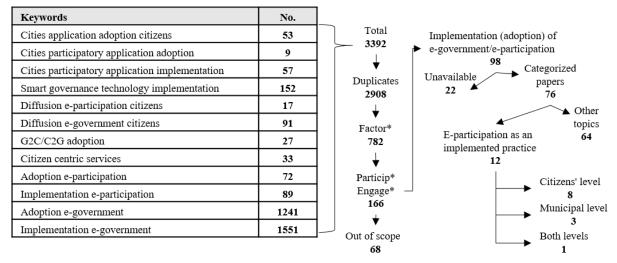
Keywords	No.
Cities application adoption citizens	53
Cities participatory application adoption	9
Cities participatory application implementation	57
Smart governance technology implementation	152
Diffusion e-participation citizens	17
Diffusion e-government citizens	91
G2C/C2G adoption	27
Citizen centric services	33
Adoption e-participation	72
Implementation e-participation	89
Adoption e-government	1241
Implementation e-government	1551

Total
3392
↓
Duplicates
2908
↓
Factor*
782
↓
Particip*
Engage*
166
↓
Out of scope
68

Implementation (adoption) of
e-government/e-participation
98
Unavailable   Categorized
22   papers
76
                              Other
                              topics
E-participation as an   64
implemented practice
12

Citizens' level
8
Municipal level
3
Both levels
1

Fig. 1: Systematic literature review process

We found two promising factors through the literature review, and one new was defined. Three independent variables are tested by binomial logistic regression: Citizens' Technological Innovativeness, Citizens' Participatory Experience, and Innovativeness of City. The whole research model is depicted in figure 2.
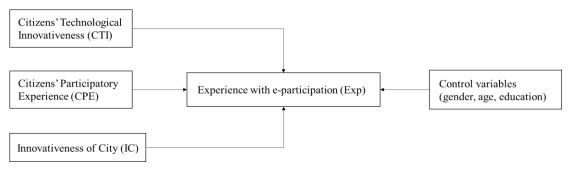
Citizens' Technological Innovativeness (CTI)

Citizens' Participatory Experience (CPE)

Experience with e-participation (Exp)

Control variables (gender, age, education)

Innovativeness of City (IC)

Fig. 2. Research model of citizens' experience with e-participation

The measure of Citizens' Technological Innovativeness (CTI), adapted from Rogers (2003) and Moore (1999), captures the relationship of the citizens to technological innovation. We followed the division into five categories: Innovators, Early Adopters – Visionaries, Early Majority - Pragmatists, Late Majority - Conservatives, and Laggards - Skeptics. Respondents selected which category best described them, according to these formulated statements:

- Innovator – I like to try new technologies without the recommendation of others; I want to be among the first to try innovation (5 points).
- Visionary – I do not try new technologies just to be one of the first, but I think of how to use the innovation (4 points).
- Pragmatist – I try technologies only when I have enough references from my surroundings, but I make sure to be "in" (3 points).
- Conservative – I use new technologies only when they are sufficiently tested; I know what to expect from them, I often succumb to the pressure of the environment (2 points).
- Skeptic – I know that technologies bring with them many problems; if I do not have to, I do not use new technologies (1 point).

Hypothesis 1. Citizens who perceive themselves as highly technologically innovative are more likely to engage in e-participation.

Citizens' Participatory Experience (CPE) is a composite measure covering five different types of participatory experience: 1) Membership in a political party; 2) Volunteering or work for a non-profit organization, charity, etc.; 3) Contribution or gift to a non-profit organization, charity, etc.; 4) Organization of a civil petition, and 5) Participation in a demonstration. Common to all these types of experience is their independence from technology. They capture a pure inclination to participate in an offline environment that is motivated by community commitment, altruism, political beliefs, or an interest in public matters. Many authors have emphasized the importance of participatory experience (e.g., Kliček et al. 2008; Nascimento et al., 2020; Zheng, 2017). Respondents were first asked the question, "Have you participated in any of the following activities in the last 5

years?" Then, they were assigned each type of participation value on a three-point scale (1 – yes, 2 – no, 3 – irrelevant). We calculated their overall Citizens' Participatory Experience (CPE) value for each respondent by summing "yes" answers, obtaining the range 0–5. The low participatory experience of our respondents required us to adjust the CPE measure range to 0–3 (0 – no experience, 1 – one type, 2 – two types, 3 – more than two types), forming the Adjusted Citizens' Participatory Experience (ACPE).

Hypothesis 2. Citizens with more offline participatory experience are more likely to engage in e-participation.

Innovativeness of City (IC) is an original measure that, to our knowledge, has never been used to study the adoption of e-participation tools at the level of citizens. The logic of this measure lies in familiarity with an innovation, which is an influencing factor in diffusion of innovation theory (Rogers, 2003). When the familiarity of an innovation (e.g., an idea or product) increases, this substantially reduces the perception of risk by an adopter and facilitates adoption behavior (Newel & Swan 1995; Wejnert, 2002). The concept of familiarity is almost exclusively linked to a particular innovation. However, we suggest that e-participation tools share common features thanks to which we can expect the introduction of one to increase the familiarity of others. In practice, this expectation means that a greater range of tools offered by cities leads to a greater likelihood of citizen involvement.

We propose Innovativeness of City (IC) as a new measure. It includes the six most common e-participation tools used in the Czech Republic:

1) Tool to report urban issues – form, application, web, etc.
2) Online voting - decision-making in the municipality
3) Citizens' satisfaction questionnaire
4) Discussion forum on the municipality website
5) Tool for voluntary citizen sensing (e.g., noise, emissions, amount and type of animals)
6) Participatory budget for the municipality.

Respondents were first asked the question, "Does the municipality where you live use any of the following options to contact or communicate with citizens?" They then selected the specific e-participation tools used in their municipality. The next step was calculating the IC value for the city where the respondent lives as the sum of offered tools. IC has a range of 1-6; however, low values of IC demanded adjustment of the measuring range to 1-4 (1 –one tool, 2 –two tools, 3 –three tools, 4 –more than three tools), forming the Adjusted Innovativeness of City (AIC).

Hypothesis 3. Citizens living in a municipality that offers more e-participation tools are more likely to engage in e-participation.

The dependent variable is Experience with e-participation (Exp), which can take two values (adopter, non-adopter). Then, respondents were instructed to answer the following question only for those items they had selected in the IC measure: had they used these tools in the last 2 years? If they had used at least one tool once, they were included in the adopters group.All calculations were performed in TIBCO Statistica 12.0.

Data needed for the testing were gathered by the Czech National Panel, which is owned by the research agencies Nielsen Atmosphere, NMS Market Research, and STEM/MARK. The advantage of this approach to data collection is to ensure the quality of the questionnaire surveys, especially according to socio-demographic characteristics (gender, education, age) as well as other criteria (the ability to work with computers and access the Internet, as all questionnaires are distributed online). Moreover, it is possible to define additional criteria for the involvement in the study.

The questionnaire contained three control variables: gender, age, and education. The survey system thus screened respondents by these three characteristics, to make the demographics of the sample as similar as possible to those of the population. An additional criterion ensured that only residents of municipalities offering at least one e-participation tool could participate. The number of participants was set to 550, which respects the requirement for the sample size: the minimum for a 10,000,000 population is 400 respondents, to cover a ±5 precision level with a confidence level of 95%. (Yamane, 1967; Israel, 1992). After carefully reading all answers, the research team removed any untrustworthy responses that had taken too little time (less than 3 min) or included nonsense answers (NO to all questions) to increase the response reliability. The remaining 504 answers passed to further processing. Table 1 shows the demographics of the study sample, their classification into Adopter or Non-adopter groups, and a comparison of the study sample with the population of the Czech Republic.

Table 1
Demographic profile of respondents

Variable	Groups	Adopters (n = 231)		Non-adopters (n = 273)		Chi-square	Total (n = 504)		Population CZ (n = 10,6 M)
		No	%	No	%		No	%	%

Gender	Male	118	51.0	126	46.2	$\chi^2 = 1.217$ df = 1, p = 0.269	244	48.4	49.2
	Female	113	49.0	147	53.8		260	51.6	50.8
Age	18 - 29	32	13.9	54	19.8	$\chi^2 = 3.685$ df = 3, p = 0.298	86	17.1	15.6
	30 - 49	91	39.4	108	39.6		199	39.5	37.3
	50 - 64	55	23.8	58	21.2		113	22.4	23.0
	65 and over	53	22.9	53	19.4		106	21.0	24.1
Education	No education and primary education	23	9.9	38	13.9	$\chi^2 = 8.996$ df = 3, p = 0.029	61	12.1	13.7
	Secondary education without A-level examination	75	32.5	114	41.8		189	37.5	33.1
	Secondary education with A-level examination	94	40.7	88	32.2		182	36.1	34.0
	Higher education (university college)	39	16.9	33	12.1		72	14.3	19.2

3   Results

A systematic literature review revealed that most adoption and diffusion research papers do not specify their focus, whether it is a field of activity or a type of technology. Mostly, they refer to online or e-government services. Table 2 classifies 76 selected papers that deal with the implementation, diffusion, or adoption of e-participation/e-government tools and were available for download.

Table 2
Classification of adoption and diffusion research papers according to technology type

Technology type	Articles
E-participation as an implemented practice – adoption at citizens level	Carter & Bélanger, 2012; Choi & Song, 2020; Hu eta al., 2019; Hujran et al., 2020; Naranjo-Zolotov et al., 2019; Nascimento et al., 2020; Poikela et al., 2015; Sari et al., 2019
E-participation as an implemented practice – adoption at municipality level	Ahn, 2011; Li & Feeney, 2014; Zheng & Schachter, 2018
E-participation as an implemented practice – adoption at both levels	Afzalan, 2017
Social networks (media)	Wirtz et al., 2018; Bolívar, 2017; Stone & Can, 2020; Faber et al., 2020; Khan et al., 2020; Lidén & Larsson, 2016; Oliveira & Welch, 2013; Tju et al., 2018; Alotaibi et al., 2016; Setiawati & Pratiwi, 2015; Bolívar & Muñoz, 2018
E-government (online services) generally.	Nam, 2014; Puron-Cid, 2014; Kamal, 2013; Tsui, 2019; Al-Muwil et al., 2019; AlSayegh et al., 2019; Ofoeda et al., 2018; Abu-Shanab, 2017; Mahmood, 2016; Fan & Luo, 2014; Weerakkody, 2013; Lean et al., 2009; Sourbati, 2009; Carter & Bélanger, 2005; Fröhlich & Peters, 2017; Djani & Therikh, 2017; Twizeyimana, 2017; Piderit & Jojozi, 2016; Otieno & Omwenga, 2015; Singh, 2013; Rhongo et al., 2019; Moraes, 2016; Ahmed et al., 2015; Almahamid & McAdams, 2010; Luna-Reyes & Gil-Garcia, 2011; Yeh, 2017
Health services	Hoque et al., 2017; Lee et al., 2019; Shiferaw & Zolfo, 2012
Web pages	Nulhusna et al., 2017; Alomari et al., 2012; Gallego-Álvarez et al., 2010; Lee et al., 2020; Huang & Benyoucef, 2014; Cegarra-Navarro et al., 2012; Dečman, 2016
Transactions	Abunadi & Alqahtani, 2019; Roy & Upadhyay, 2017
Taxes	Pleger et al., 2020; Hale & McNeal, 2011; Abadi et al., 2017
M-government	Alotaibi et al., 2017; Garcia et al., 2018
Open data	Young, 2020; Kassen, 2018; Altayar, 2018; Fitriani et al., 2019
Cloud	Jones, 2019; Mohammed et al., 2017; Mohammed & Ibrahim, 2015; Alkhwaldi et al., 2019
E-diplomacy	Al-Muftah et al., 2018
E-participation review (all levels)	Naranjo-Zolotov et al., 2018; Steinbach et al., 2019

Nine papers corresponding to the definition of e-participation as an implemented practice (see Steinbach et al., 2020) explored adoption factors at the citizen level (see Appendix A and B). Most of these factors are tool-dependent and thus cannot be measured without previous knowledge and experience (e.g., Performance expectation, Effort expectancy, Social influence, Self-efficacy, Sense of accomplishment, Personal appearance, Recognition of others).

Based on our data, we found four groups of tool-independent factors that represent citizens' inherent characteristics. The first group covers the citizens' relationship to the community. All examples in this group (Sense of virtual community, Community commitment, Community ownership, Concern about the conditions of the municipality) influence adoption positively. The second group of factors is closely related to the first, but is more targeted at the participation activity. All of these (Attitude towards participation, Motivation to participate, Predisposition to citizen participation – willingness to participate, I want to help others, Found the theme important) influence adoption positively. The third group of factors focuses on citizens' relationship with technology innovation. Although personal innovativeness and general trust in technology have been highly studied in the context of technology adoption (Rad et al., 2018; Bélanger, & Carter, 2008; Rogers, 2003), only one factor has been explored in the e-participation adoption context (Internet trust).

The fourth group focuses on the trust of citizens in government. Trust in government is the only factor included that is related to the provider of the service. Its influence on e-participation is ambiguous. Whereas two papers found the influence of trust to be positive (Hu et al., 2019; Choi & Song, 2020), another revealed a negative influence (Nascimento et al., 2020). Both are understandable. If citizens trust their government, they believe that their participation will be valued, so they see meaning in that participation. On the other hand people who distrust governments are more active, as they want to change the situation and be included in the process of governing the municipality in which they reside.

Based on the literature review and the list of tool-independent factors, we decided to test three independent factors. The first, which is very often mentioned in the e-participation literature, considers the relationship with participation (Citizens' Participatory Experience). The second factor is underestimated in the same literature (Citizens' Technological Innovativeness), while the third has never been tested in the context of e-participation or e-government, to our knowledge (Innovativeness of City). The descriptive statistics and correlation matrix are shown in Table 3, which indicates that all variables significantly correlate with Experience (Exp). We also found that all variables correlate with themselves. We counted the variation inflation factor (VIF) to test multicollinearity. Levels below two proved there is no serious problem with multicollinearity, so all variables can be kept in the analysis.

Table 3
Correlation matrix (*p < 0.05, **p < 0.01)

Construct	Mean	SD	ACPE	CTI	AIC	VIF
ACPE	0.968	0.935				1.045
CTI	2.923	1.166	0.094*			1.036
AIC	1.837	0.947	0.138**	0.111*		1.128
Exp	0.458	0.499	0.181**	0.167**	0.323**	

The dependent variable, Experience with e-participation (Exp), was measured in a dichotomous form (Adopter/Non-adopter). To test our hypothesis, we used logistic regression (LR) analysis, which has several advantages over discriminant analysis (DFA). While LR accepts continuous as well as categorical predictors, DFA accepts only continuous (or dummy) predictors and no categorical ones. Moreover, DFA requires multivariate normally distributed independent variables (Dattalo, 1995; Hair et al. 2010; Tillmanns & Krafft, 2017). Table 4 shows the results of binomial logistic regression for our independent variables together with control variables. The model is statistically significant (Chi-square = 93.551, df = 10, p < 0.01), with an overall classification accuracy of 70%, as compared to 54.2% for the intercept-only model. According to Nagelkerke's R^2, the model explains 22.6% of the variance in Experience with e-participation (Exp). A Hosmer-Lemeshow test also supported the quality of the model, as the significance value (0.36) is higher than 0.05, meaning there is no difference between the model and survey data.

Table 4
Binomial logistic regression (n = 504; *p < 0.1, **p < 0.05, ***p < 0.01)

Variable	Groups	B	S.E.	Wald	Exp(B)
Intercept		-2.742	0.370	54.932	0.064

Citizens' Technological Innovativeness	CTI	0.291***	0.091	10.328	1.338
Adjusted Citizens' Participatory Experience	ACPE	0.388***	0.110	12.336	1.474
Adjusted Innovativeness of City	AIC	0.712***	0.112	40.511	2.036
Gender	Indicator = Female			0.670	
	Male	-0.088	0.108	0.670	0.952
Age	Indicator = 65 and over			14.743	
	18 - 29	-0.842***	0.234	12.994	0.430
	30 - 49	0.011	0.157	0.005	1.011
	50 - 64	0.455**	0.190	5.689	1.576
Education	Indicator = Higher education (university college)			6.630	
	No education and primary education	-0.133	0.241	0.304	0.875
	Secondary education without A-level examination	-0.326*	0.174	3.522	0.722
	Secondary education with A-level examination	0.255	0.166	2.357	1.290
Chi-square (df = 10, p < 0.01)	93.551				
-2Log-likelihood	601.637				
Nagelkerke's R^2	0.226				
Correctly classified Adopters (%)	61.5				
Correctly classified Non-adopters (%)	77.3				
Correctly classified overall (%)	70.0				

The data presented in Table 4 show the significance of all relationships. Hypothesis 1, which predicted that citizens' technological innovativeness would be positively related to e-participation, was confirmed ($\beta = 0.291$, $p < 0.01$). Hypothesis 2, which predicted that offline participatory experience would be positively related to e-participation, was also supported ($\beta = 0.388$, $p < 0.01$). Finally, Hypothesis 3, which predicted that the innovativeness of a city would be positively related to e-participation, was also supported ($\beta = 0.712$, $p < 0.01$).

Our results also provide information about the control variables and their relationship to e-participation experience. Gender turned out not to be significant in e-participation ($\beta = -0.088$, $p = 0.413$), which means that there is no direct relationship between gender and e-participation. This finding is consistent with Choi & Song (2020). On the other hand, these authors also proved age was not a significant variable. Based on our research, we have to contradict this statement. The data of respondents in our sample show a significant negative relationship between the group of young people ($\beta = -0.842$, $p < 0.01$) and e-participation, which means that people aged 65 and older are more likely to use e-participation tools than young people (18–29 years). A significant relationship also exists between the age group (50–64) and e-participation. People in this category are more likely to use e-participation tools ($\beta = 0.455$, $p < 0.05$) than those 65 and older. To summarize the effect of age on e-participation, we conclude that older people are more likely to be users but that this applies only to those who can use information technologies. Education is the last control variable we tested in our research. Unlike Choi & Song (2020), we found education to be only marginally significant at the level of Secondary education without an A-level examination ($\beta = -0.326$, $p < 0.1$). This group is less likely to use e-participation tools than people with higher education.

4   Discussion

Results showed that control variables had only a minor direct effect on the e-participation experience (Exp), unlike Citizens' Technological Innovativeness (CTI) and Adjusted Citizens' Participatory Experience (ACPE). However, control variables can affect both these measures and thus influence the e-participation experience indirectly. A detailed view of CTI could suggest who (in terms of gender, age, and education) should be addressed at the initial phase of diffusion, e.g., because they are tech-savvy and like to try new things. A similar approach can be used with the ACPE measure, which reveals the citizens who are more prone to participate. A chi-square test of independence revealed which control variables are related to ACPE and CTI.

According to ACPE, gender turned out to be insignificant (Chi-square = 5.60, df = 3, p = 0.13), education level was significantly relevant (Chi-square = 21.06, df = 9, p < 0.05), and age also showed significant relevance (Chi-

square = 42.27, df = 9, p < 0.01). According to CTI, age turned out to be insignificant (Chi-square = 16.49, df = 4, p = 0.17), whereas education was significantly related to CTI (Chi-square = 21.66, df = 4, p < 0.05), as was gender (Chi-square = 28.32, df = 4, p < 0.01). The effects of control variables on e-participation are summarized in table 5. Education has the same effect on both variables, whereas the effects of gender and age work in opposite direction, causing an ambiguous effect.

These results show there is no easy recommendation for practitioners deciding which group of the population to address as pioneers when introducing a new e-participation tool. According to Citizens' Technological Innovativeness (CTI), men are more confident in relation to technology. Given that this measure is subjective and Adjusted Citizens' Participatory Experience (ACPE) did not show higher engagement among men, we recommend addressing citizens regardless of gender. Higher education proved to be a good assumption for pioneers shortly after implementation, especially in the testing phase. Age is a more complex issue. Two groups out of four proved more active in ACPE than expected: 1) the youngest group (18–29) and 2) the oldest group (65 and over). We do not have a clear explanation for this phenomenon, so it can provide a basis for further research. One possible answer is that these groups are less likely to have families to take care of, so they have more time to care about public affairs.

Table 5
Effects of control variables on ACPE and CTI

	ACPE	CTI
Gender	Insignificant	Significant (p < .01)
Education	Significant (p < .05)	Significant (p < .05)
Age	Significant (p < .01)	Insignificant

The study also suggested a new variable that could influence the probability that citizens become active and use an e-participation tool, namely Innovativeness of City (IC), measured by the number of e-participation tools available in the city (max. 6 tools). This measure had to be adjusted (AIC) because only five cities offered all six tools and only six cities offered five of them. This sparse representation would have distorted the results of the analysis, so we lowered the scale of the measure to 1–4, with the fourth category including all cities with more than three tools. The AIC measure proved to be a significant variable in adoption behavior.

The number of tools offered by cities influences the adoption rate, which means more citizens using at least one tool. This finding shows that the use of e-participation tools is not restricted to a limited group of people. On the contrary, the group of users is growing with the implementation of an additional tool. Results show that the adoption rate is lower than 30% in cities with only one available tool. Adding the second tool leads to the increase of the adoption rate to 51%. Both tools are used by 19.28%, and one tool is used by 31.93% of citizens. Adding the third tool increases the adoption rate to more than 70%. In this case, all three tools are used by 20% of citizens, two by 27.69%, and one tool by 23.08%.

A further increase in the number of available e-participation tools seems less effective. Table 6 shows detailed results showing that the availability of three e-participation tools is the most significant factor in the increase of adoption rate. Future research should determine if this finding is an exceptional local case or common feature for cities in other countries. Particularly, it would be interesting to broaden this research to the former socialist countries because they shared similar development and values for tens of years.

Table 6
Usage of e-participation tools in terms of the number of tools available

AIC (Tools available)	How many tools citizens use				
	No tool	One tool	Two tools	Three tools	More than three tools
1	70.13%	29.87%			
2	48.80%	31.93%	19.28%		
3	29.23%	23.08%	27.69%	20.00%	
4	26.19%	21.43%	11.90%	14.29%	26.19%

The last part of the research concerned the frequency of using specific e-participation tools in the environment of Czech cities. This approach is unique in the field of e-participation research. Whereas many studies offer typology and description of e-participation tools (e.g., Linders, 2012; Wimmer et al., 2013), there is a scarcity of studies comparing the popularity and use of e-participation tools on a larger scale. To learn this, we explored respondents' data about the availability of e-participation tools in their cities of residence. Respondents were given these options: 1) Urban issues reporting tool - form, application, web, etc., 2) Online voting - decision-making in the municipality, 3) Citizens' satisfaction questionnaire, 4) Discussion forum on the municipality website, 5) Tool

for voluntary citizen sensing (e.g., noise, emissions, amount and type of animals), and 6) Participatory budget of the municipality.
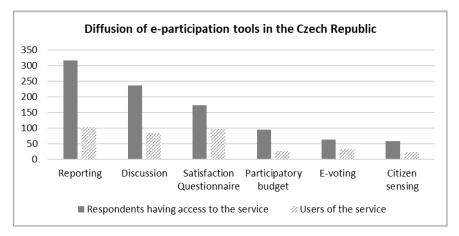

Fig. 3. Diffusion of e-participation tools in the Czech Republic

We evaluate the diffusion of e-participation tools from two points of view: those of municipalities and of citizens. Diffusion among municipalities represents the supply side and influences how many respondents have access to a service. Urban issue reporting tools, discussion forums, and satisfaction questionnaires are the tools most frequently provided by municipalities. Diffusion at the citizen level is measured by the real use of a particular tool. The most popular tools among citizens are the same as among municipalities, just in a different order (see Figure 3).

An exciting finding is the success rate (no. of users/no. of respondents having access to the service) of particular tools, which is a significant indicator. Due to this measure, cities can see if their investment into a specific tool was successful. For example, whereas satisfaction questionnaires have the highest success rate, 55.5%, the participatory budget has a success rate of only 27.4%.

5 Limits of the research

Our study has several limitations. First, we used data gathered from online questionnaires, which implies that our respondents are equipped with information technology and can use it efficiently. Many studies confirmed that facilitating conditions such as the availability of necessary technology, knowledge, and help from local government are important variables influencing one's intention to use new technology (e.g., Ajzen, 1991; Venkatesh et al., 2003; Naranjo-Zolotov et al., 2018). We must therefore assume that the adoption rate among the total population would be lower. On the other hand, E-government survey 2020 showed that 80.69% of the Czech population use the Internet. There are also 119.11 mobile cellular telephone subscriptions per 100 inhabitants, and the Human Capital Index is above the world and even European average. The technical and knowledge maturity of the Czech Republic justifies the use of an online survey as a means of data gathering.

The second limitation can be seen in the missing information about respondents' cities of residence. Because we do not know where respondents live, we cannot be sure whether their city does not offer a given tool or if the respondents just do not know about it. Knowledge about the existence of an e-participation tool is a necessary condition for its use. The lack of this piece of information causes another problem. It does not allow us to describe the Czech Republic's coverage by e-participation tools in this study.

6 Conclusion

E-participation is becoming a part of our lives, whether at the level of municipalities or of higher territorial units. E-participation brings new forms to the relationship between citizens and government, which stimulate the activity and engagement of citizens. E-participation also makes the government more open and transparent. However, the implementation of e-participation tools necessarily entails costs and uncertainty about the success of the implemented solution.

This article aimed to find variables influencing the success of e-participation tools that meet two conditions: 1) They are significant for the adoption of e-participation tools at the level of the citizen; 2) The data for these factors are accessible without a need to acquaint citizens with a particular e-participation tool.

Our research resulted in three variables: CPE, CTI, and IC. Through the literature review, we found a significant variable, namely one's relationship to the community and concerns about the conditions of the municipality (CPE). This captures the inclination to participate in an offline environment motivated by community commitment, altruism, political beliefs, or interest in public matters. We transformed this variable into the ACPE (Adjusted Citizens' Participatory Experience) measure due to low number of values in some categories. The second variable, CTI (Citizens' Technological Innovativeness), is commonly used in technology diffusion research (e.g. Rogers 2003; Moore, 1999) but not in e-participation research. This is why we decided to test it in our study. The third variable is our own proposal: Innovativeness of City (IC). This represents the supply side of the e-participation tools and measures how many tools a municipality offers. Although it tests the relationship with e-participation experience at the level of the citizen, it is not based on the characteristics of citizens, like the two previous measures. We assumed (hypothesis 3) that a greater range of tools being offered by cities increases the familiarity of e-participation and thus leads to a greater likelihood that citizens became adopters. We transformed this variable into the AIC (Adjusted Innovativeness of City) measure due to low number of values in some categories.

These results contribute to the extension of theoretical knowledge in the field of theories focused on adoption and diffusion of innovations by identification of new factors (variables) influencing adoption of innovations in the field of e-participation tools. On the other hand, control variables (gender, age, and education) had only a minor effect on adoption. Gender was insignificant, and education was only marginally significant at the level of Secondary education without an A-level examination. This group is less likely to use e-participation tools than people with higher education. In terms of age, we found a significant negative relationship between the group of young people and e-participation, which means that people aged 65 and older were more likely to use e-participation tools than young people (18–29 years). There is also a significant relationship between the age group (50–64) and e-participation. People in this category are more likely to use e-participation tools than those aged 65 and older.

The last part of this research investigated the indirect effect of control variables on e-participation adoption through ACPE and CTI. Unfortunately, we cannot clearly describe potential users from the demographic point of view based on these control variables. However, we can recommend city administrators focus on contacting current adopters of participation activities, if possible, because of the ACPE significance.

IC showed that an increase from zero to three e-participation tools brought an approximately 20% increase in adopters per each tool. A further increase in the number of e-participation tools shows only minimal impact. Therefore, we explored the data to determine which tools are most often available and most often used by citizens. The most popular tools are the same for cities as for citizens, just in a different order: urban issue reporting tools, discussion forums, and satisfaction questionnaires. Although our research revealed three important variables influencing the adoption of e-participation tools at the level of the citizen, there is space for further research. In particular, the supply side remains unexplored: the impact of marketing strategies, the identification of possible differences in success between small and big cities, or a possible connection with other e-government services.

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Appendix A

Article	Adoption factors - citizens	Adoption factors – municipality	Summary
Afzalan, 2017	1) Community capacity – Level of experience; Socioeconomic background; Attitude towards participation; Availability of technology infrastructure	1) Organization capacity - Management and control of the online participation (top-down, bottom-up); Organization collaboration and type; Planners' behavior and attitude; Tool incorporation (tightly, loosely) 2) Planning problem and participation goals – Time sensitivity, Scale, Informing citizens, Learning about citizens' ideas, Building consensus, Finding potential stakeholders 3) Norms and regulations – Regulations, Community norms 4) Tool capacity – Promoting and monitoring the participation, Efficiency, Conflict management, Atmosphere (comfortable environment)	Selection of e-participation tool at the level of municipality. "What considerations should planning organizations take into account when they are selecting online participatory tools?"

Appendix B

Article	Adoption factors - citizens	Summary
Carter & Bélanger, 2012	1) Accessibility » Convenience 2) Convenience » Relative advantage 3) Relative advantage » Intention to use I-voting 4) Internet trust » Intention to use I-voting	Impacts of both technological and political factors on intentions to use an Internet voting system. Relative advantage and trust of the Internet impact intentions to use Internet voting, while party mobilization and political interest impact propensity to vote. Further, it was found that perceived Internet accessibility impacts the perceived convenience of voting online, which in turn impacts the perceived relative advantage of online voting.
Choi & Song, 2020	1) Community commitment » Use 2) Community ownership » Use 3) Trust in government » Use 4) Subjective norm » Use 5) Perceived behavioral control » Use	Why some citizens engage in e-participation, while others do not. Study finds that citizens with a stronger social capital—a commitment to the community, ownership of the community, and trust in government—are more likely to engage in e-participation. However, the results do not show the significance of most TAM and TPB variables—perceived usefulness, perceived ease of use, and attitude toward e-participation. Only subjective norm and perceived behavioral control, core constructs of TPB, are significantly

		and positively related to citizens' engagement in e-participation.
Hu et al., 2019	1) (Performance expectation, Effort expectancy, Social influence) » Technology acceptance 2) (Trust of government, Trust of the platform) » Public trust 3) (Self-efficacy, Sense of accomplishment, Personal appearance, Recognition of others, External rewards) » Participate motivation 4) Technology acceptance » Public engaging intention 5) Public trust » Public engaging intention 6) Participate motivation » Public engaging intention	A structural model (i.e., PPTP) was constructed to describe public engaging behaviors. All factors proved to be significant. This study also introduced some management suggestions to help promote the effective implementation of EGS and the wide distribution of value co-creation concepts and activities.
Hujran et al., 2020	1) Perceived public value (Effectiveness, greater interaction) » Attitude 2) Perceived ease of use » Attitude 3) Enjoyment » Attitude 4) Attitude » Behavioral intention 5) Subjective norms » Behavioral intention 6) Perceived behavioral control » Behavioral intention	Findings indicated that Perceived public value (PPV), Perceived ease of use and Enjoyment jointly determine the attitudes of citizens toward e-democracy. Results also suggest that attitudes, Perceived behavioral control (PBC) and Subjective norms (SNs) have a significant effect on citizen's intention to use e-democracy. Finally, this research supported the role of enjoyment as the most significant determinant of citizen's attitude toward using e-democracy.
Naranjo-Zolotov et al., 2019	Sense of virtual community (Membership, Influence, Immersion) » Use	Data collected from 370 citizens who experienced an e-participation platform hosted by a European capital city. We found out that the direct association between the sense of virtual community and use was significant. Even though the direct association between the sense of virtual community and the continuous intention was non-significant, the indirect association sense of virtual community to use to continuous intention was statistically significant.
Nascimento et al., 2020	1) Perceived contribution » Intention to use 2) Concern about the conditions of the municipality » Intention to use 3) Facilitation in meeting demands - relative advantage » Intention to use 4) Predisposition to citizen participation - willingness to participate » Intention to use 5) Trust in government (negative) » Intention to use 6) Risk to privacy perceived (negative) » Intention to use 7) Strength of social ties with the family	This paper aimed to systematize the contextual factors that influence the intention to use citizens and government-initiated platforms, presenting them as non-functional requirements (NFRs), to facilitate their understanding to implementers. Citizen-initiated platforms (reporting, propose solutions). This study can support e-gov policies in the implementation of C2G platforms because several municipalities need assistance in taking actions to foster greater citizens' engagement.
Poikela et al., 2015	Motivation factors for participation: 1) I want to help others 2) Was bored 3) Found the theme important 4) Received benefits 5) Others expect me to Motivation for non-participation 1) Privacy risk 2) I was busy 3) Low incentives 4) Task technically challenging	Results of a field study tackling the issue of how privacy concern affects the adoption and use of a location-based mobile participation application, and what motivates the use of such applications. Privacy-concerned users are less likely to be motivated by a monetary benefit, but rather by the importance of the topic and that the intrinsic motivators that drive the privacy concerned users differ from those that drive the unconcerned. This study also shows that privacy concern might be an inhibiting factor in the adoption of a location-based mobile participation application.
Sari et al., 2019	Quality dimensions (requirements) on e-complaint service: 1) Citizen support (ease of use) 2) Security 3) Complaint handling 4) Transparency	The factor analysis with principal component analysis (PCA) is used to stable the dimension of ecomplaint service quality. The outcome of the final e-complaint scale consisting of 19 attributes under four dimensions (Citizen Support, Transparency, Security and Complaint Handling).