Information Systems Frontiers (2019) 21:621–634
https://doi.org/10.1007/s10796-019-09908-y

Transnational Digital Identity as an Instrument for Global Digital Citizenship: The Case of Estonia's E-Residency

Piia Tammpuu [1] · Anu Masso [1,2]

Published online: 4 April 2019

Abstract
Digital identity systems appear as part of the digital infrastructure that enables individuals to participate in society as digital citizens. This paper examines the implications of Estonia's e-residency, the transnational digital identity scheme implemented by the Estonian government in order to give non-residents of the country remote access to Estonia's digital infrastructure and e-services, for global digital citizenship. We explain the adoption of e-residency by analyzing how individual motives to apply for a digital identity are affected by both individual-level socio-demographic characteristics and macro-level characteristics measuring digital and economic development in applicant's country of origin. The findings suggest that individual motives to adopt e-residency vary depending on both the citizenship of applicants and the level of e-government development in the country of origin. Although attracting more citizens from digitally advanced countries, individual motives indicate that e-residency can compensate certain digital disadvantage to citizens of countries with lower levels of e-government development.

Keywords Digital identity · Digital citizenship · Virtual mobility · Digital inequality · E-government · E-residency

1 Introduction

Digital identity has been recognized as one of the key enablers of digital development and participation in modern social, political and economic life (OECD 2011; United Nations 2016; World Bank Group 2016) and a critical pillar of the digital economy (Al-Khouri 2014; European Commission 2015; OECD 2015; World Economic Forum 2018). The implications of digital identity are becoming particularly apparent as governments and businesses around the world move their services and transactions online (Sullivan 2016). Means for secure and trustworthy digital authentication, i.e. for verifying one's identity as a natural or a legal person in different online transactions, are needed in both the public and private sectors to provide and gain access to electronic information and services.

✉ Piia Tammpuu
piia.tammpuu@ut.ee

[1] Institute of Social Studies, University of Tartu, Lossi 36, 51003 Tartu, Estonia

[2] Ragnar Nurkse Department of Innovation and Governance, Tallinn University of Technology, Akadeemia tee 3, 12618 Tallinn, Estonia

Digital identity systems offering such secure means are crucial mechanisms of digital inclusion and enablement, and thus form an essential dimension of digital citizenship in shaping individual opportunities to participate in both the digital society and the economy (Sullivan 2016). However, existing literature on digital citizenship, which highlights the centrality of the digital infrastructure in social interactions taking place in digital environments (Hintz et al. 2019; Isin and Ruppert 2015; Mossberger et al. 2008; Vivienne et al. 2016), has not yet recognized the role of digital identity as part of that infrastructure.

Though digital identity and identity management management have been a growing field of academic research for a decade, the implications of digital identities and identity systems have mainly been studied and discussed in certain national (or subnational) contexts, even if from a comparative perspective (see, e.g., Goodstadt et al. 2015; Kubicek and Noack 2010; Lips 2010, 2013; Lips et al. 2009; Seltsikas and O'Keefe 2010; Sullivan 2016), while transnational or cross-border aspects have received only infrequent attention (see, e.g., Aavik and Krimmer 2016; Pimenidis and Savvas 2007; Sullivan 2018). Research has focused on technological and functional design, legal regulations and overall take-up of particular digital identity schemes. At the same time, only few studies can be found that examine individual motives behind the adoption of digital identities or identity cards (see, e.g., Belanche et al. 2014). There are no academic studies,

according to our knowledge, which consider social implications of a digital identity system arising from the adoption or the use of a digital identity in a transnational context.

This paper seeks to extend existing research on digital identity systems beyond territorially bound national (or subnational) contexts by exploring the social implications of Estonia's e-residency programme, the first transnational digital identity scheme implemented by the Estonian government, for global digital citizenship. The aim of "electronic residency" or "virtual residency" enabled by this programme is to give non-residents of the country, independent of their citizenship and place of residence, remote access to Estonia's well-advanced digital infrastructure and e-services via government-supported digital identity issued in the form of a smart identity card (the e-resident's ID). Without the requirement of (nor with the right to) physical residency in the country, the concept of e-residency challenges the traditional territorially bound concept of citizenship by providing an opportunity to establish membership to a digital nation and to act virtually independent of one's nationality and physical location via means of digital authentication offered by the e-resident's ID.

The aim of the current study is to examine the role of digital identity as essential to digital citizenship in giving access to online transactions and in shaping individual opportunities to participate in digital society. We explain the variations in individual motives to adopt Estonian e-residency by focusing both on individual-level socio-demographic characteristics and macro-level characteristics that measure digital and economic development in applicant's country of origin. We use multilevel modelling method (MLM) in our analysis, which enables to take into consideration both individual-level and macro-level variables for explaining the individual motives to adopt Estonian e-residency as a digital identity.

Considering the high variance between national digital identity systems in terms of their scope and functionality (Goodstadt et al. 2015; Kubicek and Noack 2010; Sullivan 2018; World Bank Group 2016, 2017), Estonian e-residency is argued to provide an advantage particularly to citizens and entrepreneurs from countries whose governments fail to have comparable digital infrastructure, instruments and services (Godoy and Heal 2016; Kotka et al. 2015). Furthermore, given Estonia's full membership in the European Union (EU), the e-resident's ID not only enables digital access and inclusion to Estonia's digital society but also to the EU at large, as the recently enforced European Regulation on Electronic Identification and Trust Services (eIDAS) shall ensure the mutual recognition of national electronic identification systems and trust services among the EU countries. In this respect, the transnational digital identity offered by the Estonian e-residency programme is assumed to be especially attractive to citizens and entrepreneurs outside the EU who do not have EU citizenship in order to gain digital entry to the emerging digital market of the EU (Godoy and Heal 2016).

However, the aforementioned aspects concerning the affordances and possible implications of the e-residency programme also raise a question of how digital identity systems relate to digital inequalities. This includes, for example, the aspects of who has (or does not) access to a digital identity under a pertinent scheme as well as who will actually adopt that digital identity and benefit from its functionality. As earlier studies on e-government adoption have shown, there is a risk that e-government initiatives may rather enhance the inequalities in opportunity, as those most in need of particular government services may have the least opportunity to them in digital form (Warf 2014a). Hence, the new technological solutions applied by governments may end up to serve those who are already in advanced position in terms of different capitals and access to various resources (Taipale 2013a). Similar concerns have been raised with respect to Estonian e-residency which, despite formal inclusiveness, may actually come to serve more privileged individuals and groups (Calzada 2018). In this study, we therefore seek to explore these assumptions by analyzing the overall adoption of e-residency and the ways in which individual motives to apply for the digital identity offered by the e-residency programme vary depending on applicant's citizenship and the level of e-government development in the applicant's country of origin.

The article is structured as follows. In the next section, we initially give an overview of recent research on digital identity and pertinent systems, focusing particularly on social implications related to transactional functions as essential to digital citizenship. Then we introduce the concept of Estonian e-residency and set research questions for our empirical analysis. After explaining the data and method for the study, we present the results of our analysis. Finally, we discuss the key conclusions of the study, along with some limitations of the current study and possibilities for further research.

2 Digital Identity Systems as Mechanisms of Digital Inclusion and Enablement

In the context of the current study, digital identity is understood and considered to be "a collection of electronically captured and stored identity attributes that uniquely describe a person within a given context and are used for electronic transactions"[1] (World Economic Forum 2018: 7). Such electronic transactions can range from an (information) enquiry to a contract and take place between an individual and a government department or agency or with a private sector entity, depending on the particular digital identity scheme (Sullivan 2016: 475). A digital identity can therefore be considered and defined also as a transaction identity whose functions extend

[1] We consider "electronic" identity (eID) synonymously with "digital" identity as defined here.

beyond identification of the individual (Sullivan 2011, 2016). Having a digital identity and being able to use it for electronic transactions of various kinds is thus a critical premise for participating in the digital society and the economy and acting as a digital citizen (Sullivan 2016). Digital identity systems can therefore be seen as part of the digital infrastructure that both enables and controls people's participation in the digital society as digital citizens (Hintz et al. 2019; Isin and Ruppert 2015; Mossberger et al. 2008; Vivienne et al. 2016).

Though most nations, both in developed and developing countries, have been developing their digital identity systems as part of their e-government initiatives, the scope and functionality of these systems is highly varied (Goodstadt et al. 2015; Kubicek and Noack 2010; Sullivan 2018; World Bank Group 2016, 2017). In developed high-income countries, the elaboration of digital identity systems has been linked to efforts to digitalize and improve public services delivery. By contrast, in developing low-income countries the primary aims of creating a digital identity system are still related to the purposes of identification, especially in cases where earlier physical identity systems have been incomplete or missing. Indeed, only a small percentage of developing countries have a multipurpose digital scheme which covers the entire population and provides access to a range of online services (World Bank Group 2016: 194–195). The variances between national digital identity systems thus reflect and are part of broader international disparities of e-government development among countries and regions (Warf 2014a, b; World Bank Group 2016; Zhao et al. 2014).

A more general limitation of existing government-supported digital identity schemes is that their applicability and validity are usually confined to certain territorially bound national (or subnational) contexts. Intensifying physical and informational mobility, however, necessitates the portability and cross-border recognition of digital identities generated under various identity systems. The portability of digital identities becomes thus an issue related to people's daily spatial mobility, in which forms of physical or corporeal become increasingly intertwined or substituted with forms of virtual mobility (Kellerman 2016; Taipale 2013b). Issues of legal compliance and technological interoperability of national digital identity systems have accordingly become part of policy agendas at both inter-state and regional levels (European Commission 2015; OECD 2015; World Economic Forum 2018) as well as a topic for academic research (Aavik and Krimmer 2016; Pimenidis and Savvas 2007; Sullivan 2018). A notable policy example here is the European Regulation on Electronic Identification and Trust Services (eIDAS), adopted in 2014 and enforced in 2018. The regulation requires EU countries to mutually recognize their notified electronic identification systems and trust services, for example such as digital signatures, so that citizens and businesses could take advantage of secure cross-border electronic interactions (Regulation (EU) No 910/ 2014).

In addition to a range of scope and functionality, government-supported digital identity schemes also vary in terms of adoption and usage. To explain disparate rates of e-government adoption, scholars have applied Rogers' (2003) theory of the diffusion of innovations, which suggests there are four reasons resulting in higher adoption rates. The innovations, first offer a clear relative advantage compared to present solutions and ideas. Secondly, they are compatible with existing values, past experiences and needs of potential adopters. Thirdly, they are not too complex to understand and use. Fourthly, they are triable and observable in terms of their promised effects. Drawing on these assumptions, researchers have argued that as long as there are other methods and means available for digital authentication, for example such as those offered by banks, government-supported digital identity systems do not necessarily provide sufficient additional value for citizens. By contrast, in cases where government-supported digital identities have been promoted as secure and efficient means for digital authentication for private sector services as well, for example Internet banking, adoption and usage rates may consequently be higher (Kubicek and Noack 2010). However, these conclusions have mainly been drawn based on a system analysis of certain national (or subnational) digital identity schemes and their affordances rather than by studying individual attitudes and motives behind adoption. The study by Belanche et al. (2014), an example of the few studies analyzing individual or community-level motives and attitudes towards the adoption of DigIDs or their cards (see also Martin and Rice 2010), has shown that perceived usefulness and ease of use, compared to other factors, are still the most relevant factors explaining the uptake (Belanche et al. 2014: 1222).

3 Estonia's E-Residency as a Transnational Digital Identity Scheme

Established on a well-functioning national digital identity system (Martens 2010; Vassil 2015), Estonia's e-residency is the first transnational digital identity scheme that extends a government-supported digital identity system beyond a territorially bound national society by providing a transnational digital identity in the form of a smart identity card (the e-resident's ID) to non-residents of the country independent of their nationality (citizenship) and place of residence.

The aim of enabling citizens of other countries, primarily EU, to use Estonia's e-services was first included in the national information and communication technology (ICT) strategy adopted in 2006, after Estonia's accession to the EU in 2004. The concept of e-residency or "virtual residency" was approved by the Estonian government in 2013 as part of the national Digital Agenda 2020, followed by a more detailed concept paper and implementation plan in 2014. The main idea behind the concept was to attract foreign entrepreneurs

and investors by giving them remote access to the electronic environment and services of the country, including the possibility of registering their businesses in Estonia and administrating them online at a distance. In addition, the policy documents also emphasized the opportunity to involve foreign specialists and professionals in the development of the Estonian economy, science, education or culture without expecting them to settle in Estonia. The policy conceptualization of the idea thus entailed different government agendas concerning digitalization, economic growth and competitiveness, digital migration and labor mobility as well as national reputation management and branding (Tammpuu and Masso 2018). However, the primary objective of the e-residency programme since its launch in December 2014 has been the expansion of Estonia's economic base, which is limited by the country's geography and a population of only 1.3 million inhabitants (Sullivan 2018).

The range of digital subjects covered by a government-supported digital identity scheme is usually delimited and based on other mechanisms of social or political inclusion such as citizenship or permanent residency in the country. By contrast, Estonia's e-residency is based on a different logic in which inclusion into the digital nation is disconnected from other territorially bound forms of membership and belonging. The legal regulation does not include any predefined exclusionary criteria for applying Estonian e-residency and the e-resident's ID is (at least formally) available to anyone interested. However, the issue of e-resident's ID card can be refused (mainly for security reasons) and the card can be revoked in case of misuse, based on the conditions regulated by law. A fee of 100 euros applies to all applications.

The functionality of the e-resident's ID is similar to that of the national ID card, which is a mandatory identity document for all Estonian citizens and permanent residents above 15 years old (Martens 2010; Vassil 2015). The e-resident's ID can be used, for example, to remotely establish a business in Estonia, manage a location-independent international business, open a bank account and use online banking services, as well as to take advantage of Estonia's public e-services and trust services such as digital signature. However, unlike the national ID card, the e-resident's ID can only be used for electronic transactions and not as a physical identity document. Also, as e-residency does not require (physical) residency in Estonia, it neither entails a right to physical entry or residency in the country nor the political right to electronic voting in the country's elections. E-residency thus advances an essentially national concept to a government-supported transnational digital identity that can be used across geographic borders for both private and public sector transactions (Sullivan and Burger 2017).

Considering the variations between digital identity systems and uneven development of e-government services among countries (Goodstadt et al. 2015; Kubicek and Noack 2010; Sullivan 2018; World Bank Group 2016, 2017), a transnational digital identity scheme such as Estonia's e-residency is an option that citizens and entrepreneurs in developing countries can use to overcome deficiencies in domestic digital infrastructures and policies (Godoy and Heal 2016). Furthermore, given Estonia's membership in the EU, the e-residency programme is being promoted as providing digital access not only to Estonia's digital society and e-services but also to the broader EU digital market, particularly in the context of the recently enforced European Regulation on Electronic Identification and Trust Services (eIDAS) (Godoy and Heal 2016). This aspect is particularly pertinent for citizens and entrepreneurs from non-EU countries and likewise for British citizens who may lose their status as EU citizens as a result of Brexit. As Estonian e-residency facilitates broader digital access to the EU digital market, it can be seen as an instrument for digitally enabled virtual mobility – an international "passport" to the virtual world (Sullivan and Burger 2017).

Within four years of the 2014 launching of the programme, circa 51,000 citizens from 166 countries had applied for Estonian e-residency of whom, about 49,000 have been issued with an e-resident's ID.[2] Digital identity programmes like Estonia's e-residency are hence argued to change traditional notions of residency that are based on fixed geographical location and will ultimately alter the notions of (im)migration and citizenship by opening the way for universal digital and digitally enabled de-territorial and transnational citizenship (Calzada 2018; Kotka et al. 2015; Sullivan 2018). The key dimensions and major practical and theoretical implications attributed to digital identity systems in general and to e-residency in particular are outlined in the Table below (see Table 1).

Yet, there is a question as to whether or not technological innovations such as e-residency will benefit those who could benefit most from such re-engineered systems of citizenship or merely augment the agency of those who are already (digitally) more privileged, including in terms of mobility (Calzada 2018). Although Estonia's e-residency programme may have a "compensation effect" for citizens and entrepreneurs from digitally less developed countries and regions, as some authors argue (Godoy and Heal 2016; Kotka et al. 2015), it may actually come to serve those who already have more digital opportunities, as earlier studies on e-government adoption suggest (Taipale 2013a; Warf 2014a). Hackl (2018) suggests new digital mobilities supported by digital technologies and infrastructures reduce or increase inequalities of opportunity through the forms of inclusion and exclusion they produce. While e-residency is formally inclusive, its availability and adoption may still be limited by certain contextual factors, including the level of digital development and the quality of digital infrastructure in the applicants' country of origin. As Helbig et al. (2009) suggest, aspects of the digital

[2] Up-to-date statistics about the applications of e-residency is published on the website https://app.cyfe.com/dashboards/195223/5587fe4e52036102283711615553

Table 1 Social implications attributed to digital identity systems in general and to e-residency in particular

Social implications		**Dimensions**		
Implications of digital identity systems	**Practical implications**	**Entitlement and access** *Who are entitled and have access to a digital identity under particular digital identity system/ scheme?*	**Scope and functionality** *For what purposes particular digital identity system/ scheme has been designed and in which usage contexts the digital identity can be employed?*	**Adoption and use** *Who will actually adopt the digital identity and benefit from particular digital identity system/ scheme?*
	Theoretical implications	**Digital inclusion**	**Digital enablement**	**Digital participation**
		Aforementioned dimensions as constitutive to digital citizenship		
Implications of e-residency	**Practical implications**	**Entitlement and access** *Formally inclusive, independent of applicant's nationality (citizenship) and place of residence*	**Scope and functionality** *A means for digital authentication in online transactions and for digital signature* *Location-independent access to public and private e-services, including online banking and an opportunity to register one's business to Estonia and manage it remotely*	**Adoption and use** *Global adoption driven by different individual motives and needs*
	Theoretical implications	**E-residency as constitutive to de-territorial transnational citizenship and digitally enabled virtual mobility and migration**		

divide, including differences in digital access, may both affect the demand of e-government services and limit the usefulness of certain government applications. Taipale (2013a) makes a similar argument in suggesting that it is the social and geographical contexts, other than individual-level factors such as knowledge or skills, that condition both the need for particular e-government services, as well as the user's capability to use the Internet as the medium employed for delivering electronic service.

4 Research Questions and Methodological Considerations

4.1 Research Questions

Taking into consideration the affordances of Estonia's e-residency for digital citizenship and digitally enabled virtual mobility and drawing on previous studies which suggest that socio-geographical contexts may shape both individual access to and a need for a digital identity, we set the following research questions for the analysis:

1. What is the spread of applicants' individual motives to apply for e-residency as a transnational digital identity across individual and country-level characteristics?

   And more specifically:

   1.1 How does the applicant's citizenship, compared to other individual-level characteristics, characterize the adoption of e-residency across motive types?
   1.2 How does the level of e-government development in the applicant's country of origin, compared to other macro-level characteristics, characterize the adoption of e-residency across motive types?

Table 2 Structure of the applications for Estonia's e-residency December 1, 2014 to December 31, 2017*

Individual level variables	Categories	Count	%
Gender	Male	22731	88.9
	Female	2829	11.1
Age	<30	6378	24.9
	31–40	9320	36.5
	41–50	6187	24.3
	51–60	2778	10.9
	>61	897	3.4
Citizenship	EU citizens	12865	50.3
	Non-EU citizens	12695	49.7
Region	Europe	16696	65.3
	Asia	5405	21.1
	Americas (North and South)	2263	8.8
	Africa	716	2.8
	Other	480	2
Year	2014**	41	0.2
	2015	5236	20.4
	2016	7002	27.4
	2017	13281	52
Total		25560	100

*Excluded applications ($N = 4319$): Declined ($n = 212$); Incomplete form ($n = 446$); Withdrawn by applicant ($n = 303$); Being processed on 31.12.2017 ($n = 74$); Motivation for application missing ($n = 3284$)

**2014 involves just a single month, as the programme was launched on December 1, 2014

4.2 Data and Method

To analyze and explain the adoption of e-residency through individual motives, we used administrative register-based data drawn from individual applications for e-residency ($N = 33{,}039$) submitted to the Estonian Police and Border Guard Board over a three-year period, starting from the launch of the programme in December 2014 to 31 December 2017. The original dataset includes information about the applicants' core motives and socio-demographic background data (gender, age and citizenship). The key criteria for applications to be included in the analysis were a description of motives and reasons for applying.[3] Failure to meet these two and other essential criteria led to 4319 applications being excluded (see Table 2 for details). The analyzed sample size ($n_i = 25{,}560$) represents 89% of all accepted applications during the study period. Applicants' countries of residence (total 149) were spread across all five continents. The number of individual applications has increased annually. As seen from the socio-demographic structure of the sample (Table 2), males are predominant among the applicants of e-residency (89%). Also younger age groups are relatively more represented compared to older age groups (above 50 years).

To analyze the variations in individual motives to apply for e-residency, we used a multilevel regression modelling method (MLM) that enables the separation of residual terms for individual and country levels of analysis, which provide adequate standard errors for the parameter estimates (Snijders and Bosker 2012). In this regard, the multilevel regression modelling enables to take into consideration both individual-level structural variables as well as country-level contextual characteristics in order to explain the variations in individual motives to adopt Estonian e-residency. This study, uses MLM for explanatory purposes within available individual-level variables drawn from the individual applications of e-residency with macro-level characteristics added to these data. To facilitate MLM, an additional criterion was applied to the country-level data of countries having more than 100 applicants (i.e. countries with 99 or fewer applicants were excluded from the MLM). This reduced the sample size to 23,463 applicants spread across 42 countries (see Appendix Table 5).

4.3 Variables in the Analysis

The study's dependent variable was the main motive for applying for Estonian e-residency as stated in each application. The online e-residency application form currently includes eight pre-defined standardized motives, which have been modified and added during the e-residency programme. In case of applications submitted in another form, the main motive has shortly been described in a free format in the registered application. For the standardization of differently described motives, original motives were re-coded into ten motive types (see Table 3). For the analysis, four main motive categories were extracted and categorized as dichotomous variables: (1) "business activity or interests related to Estonia"; (2) "fan of e-residency"; (3) "location-independent international business"; and (4) "other motives not related to business activity". These motives are coded and used in the analysis as dichotomous variables, where 1- "motive type mentioned", 0- "motive type not mentioned".

The most often mentioned motive for applying for Estonian e-residency has been the opportunity to run a location-independent business (45% of applicants), followed by the reason of having business interests or activities related to Estonia (25%). The total share of these two motive types thus indicates the overall predominance of business-related motives among applicants. The rest of applicants have mainly expressed either a non-instrumental interest in e-residency ("fans of e-residency") or an interest in using e-services and possibilities for digital authentication in general and not for business-related purposes. Although these, mainly pre-defined standardized motives do not provide detailed

[3] Since the beginning of the programme in December 2014, declined applications have formed ca 1% of all applications of e-residency.

Table 3 Motives for applying for Estonia's e-residency

Motivation types *Including sub-categories*	Count	%
1. Business activity or interests related to Estonia	**6419**	**25**
*Bringing business to Estonia**	*5985*	*23.42*
Having business interests or activity in Estonia	*258*	*1.01*
*Promoting the development of Estonian economy**	*176*	*0.69*
2. Fan of e-residency*	**3665**	**14**
3. Location independent international business*	**11389**	**45**
4. Other motives (not related to business)	**4087**	**16**
*Living in or visiting Estonia**	*978*	*3.83*
Professional interest towards e-residency	*11*	*0.04*
*Promoting the development of Estonian science, education or culture**	*222*	*0.87*
Using e-services in general	*159*	*0.62*
*Using the technology of secure authentication**	*2022*	*7.91*
*Other**	*695*	*2.72*
Total	**25560**	**100**

The bold entries mark the major four categories of motives as used in the further analysis

*The pre-defined standardized motives included in the online application form of e-residency; their phrasing and numbers have also changed over the course of the programme

information about specific individual needs, they still indicate overall dimensions of applicants' interests in e-residency, e.g. usage oriented vs not usage oriented motives, business-related vs non-business related motives, and motives specifically related to Estonia vs not specifically related to Estonia.

The main independent individual-level variable included to the regression model is citizenship, which is recoded into a dichotomous variable based on the country's belonging the EU (1 – "EU-citizens"; 2 – "non-EU-citizens"). The analysis considered citizenship as a measure of various mobility rights that are essentially related to an individual's formal citizenship status. Individuals with EU citizenship have the right to free movement within the EU and thus have access to the (Digital) Single Market of the EU. By contrast, citizens without EU citizenship have only limited access to both the EU as well as to the EU's Digital Single Market. Therefore, the individual motives to adopt e-residency as an instrument that enables digitally mediated virtual mobility and digital access to the EU presumably vary, depending on the applicant's citizenship status. The socio-demographic variables at the individual level elicited by the application form – gender and age, and the year of each application are the MLM's control variables (see Table 2).

There were also two macro-level control variables. The first concerns the level of e-government development in the applicants' country of origin (determined based on applicants' citizenship), which is measured through a composite index of the E-Government Development Index (EGDI) that is compiled and published by the United Nations (UN). The EGDI is a weighted average of normalized scores of the three most important dimensions of e-government: (i) the scope and quality of online services (Online Service Index, OSI); (ii) the status of the development of telecommunication infrastructure (Telecommunication Infrastructure Index, TII); and (iii) human capital (Human Capital Index, HCI) (United Nations 2016). The current study, used this variable in the analysis, in the form of four ordinal categories characterizing the level of e-government development in the country. The categories are taken from the UN's 2016 survey on e-government development. The four ranks were: 1 – "very high level"; 2 – "high level"; 3 – "medium level"; 4 – "low level".

The second macro-level variable concerns the income-level of the country as calculated based on gross national income (GNI) per capita according to the Atlas methodology by the World Bank. This variable was included to the model as a control variable. The income-level of the country was analyzed in the form of four ordinal categories (1 – "high-income economies"; 2 – "upper-middle-income economies"; 3 – "lower-middle-income economies"; 4 – "low-income economies") according to 2017 GNI per capita.[4]

Figure 1 presents the MLM and shows, as formulated in the research questions, the analysis focused on exploring the variation of individual motives to apply for Estonian e-residency. The MLM does this by taking into account both individual-level socio-demographic characteristics of applicants and the macro-level characteristics measuring the level of digital and economic development in the applicants' country of origin.

[4] In both macro-level variables, the fourth category indicating "low level of e-government development" and "low income" is missing in the sample used for the regression analysis, as there were more than 100 applicants from the countries characterized by these categories.

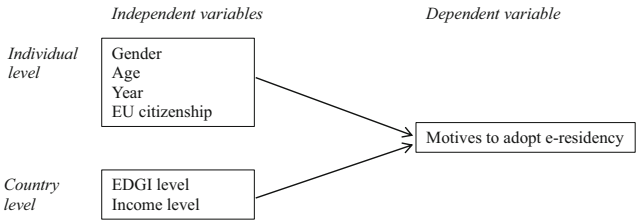

Fig. 1 Analytical framework for explaining digital identity adoption by motive types

5 Results

5.1 Adoption of E-Residency by Citizenship and Level of E-Government Development

Despite a global reach and broad geographical coverage, the adoption of e-residency is characterized by highly uneven geographical distribution (see Fig. 2). While 149 countries produced all those who applied in the study period, just 12 countries produced almost two-thirds (60%) of them. Since the launch of the programme in December 2014, most applicants have come from Finland and Russia,[5] both neighbors of Estonia, followed by Ukraine, United States, United Kingdom, Germany, Italy, India, and France. In regional terms, there are most applicants from Europe (65%), especially from Northern-Europe (23%), Eastern-Europe (18%) and Western-Europe (15%). The smallest share of applicants is from Africa (3%). As the majority of applicants come from Europe, e-residency seems to further intensify existing transnational linkages with countries located in the same region; a fact that can be explained, among other factors, by relative geographical proximity and historically established social, economic and political relations between the countries.

Regarding EU: non-EU citizenship, e-residency tends to attract citizens of the EU countries (50.3%) on a par with citizens of countries outside the EU (49.7%). As the former group also includes the British, whose status as EU citizens is threatened under Brexit, this balance may change in the future. We can also see that the proportion of non-EU citizens among applicants has gradually increased over the years, from 41% in 2015 to 53% in 2017.

However, in general we see that countries with very high or high levels of e-government development, as measured based on EGDI, or high levels of income produced the most applicants (see Fig. 3). At the same time, countries with medium levels of e-government development produced 9% and those with low levels of e-government development produced less than 1%. The distribution of applicants according to the level of e-government development in their citizenship country of origin has also remained rather persistent over the years. In this respect, the e-residency programme tends to mainly empower citizens who are already "digitally more empowered" by their own governments rather than those who are less empowered. In a similar way, most applicants (65%) come from wealthier high-income countries.

5.2 Explaining the Motives for Adopting Estonia's E-Residency

The motives for applying for e-residency are presented in Table 3 and the results of the four MLMs in Table 4. Each MLM includes one motive type as a dependent variable and the same micro-level independent variables and two macro-level independent variables as the other three.

The results indicate that citizenship is a statistically significant variable explaining the individual motives for joining the e-residency programme. However, the associations have different directions, as indicated by the opposite signs of the regression coefficient. Regarding the first motive type – "business activity or interests related to Estonia" – applicants with non-EU background are more frequently represented. On the other hand, among EU-citizen applicants who are foremost motivated to apply for e-residency due to being "fans of e-residency" are more prevalent. Citizenship is also the strongest explanatory variable, compared to other background variables, explaining these two motive types.

Besides citizenship as the main variable under consideration, we also included the other available micro-level control variables. Gender is also a statistically significant variable explaining the motives of applying for e-residency. However, in the case of the first three motive types – "business activity or interests related to Estonia", being a "fan of e-residency", and interested in "location-independent international business" – male applicants were most often represented (see negative sign of regression coefficients), whereas female applicants mostly expressed "other motives not directly related to business".

Compared to gender, age turned out to have somewhat weaker association coefficients and here the sign of the associations varies across the motive types. Whereas in the case of the first motive type characterized by "business activity or interests related to Estonia" and the fourth motive type expressing "other motives not directly related to business", the applicants are somewhat older, then in the case of other two motive types – being a "fan of e-residency" and interested in "location-independent international business" – younger applicants are more represented.

In addition, certain temporal dynamics are visible in the analysis. Motives concerning "business activity or interests related to Estonia" and "other motives not directly related to business" were somewhat more prevalent in the initial phase of the e-residency programme, whereas later motives like being a "fan of e-residency" and interested in "location-independent international business" were more often expressed. Such dynamics reflects, at least partly, the shifting focuses of the e-residency programme with respect to its aims and targets.

Of macro-level variables included in the regression analysis, the level of e-government development (EDGI-level) was

[5] The order of countries based on the number of applicants is slightly different in the sample used for the current study, especially regarding Russia, due to excluded applications that with omitted motives.

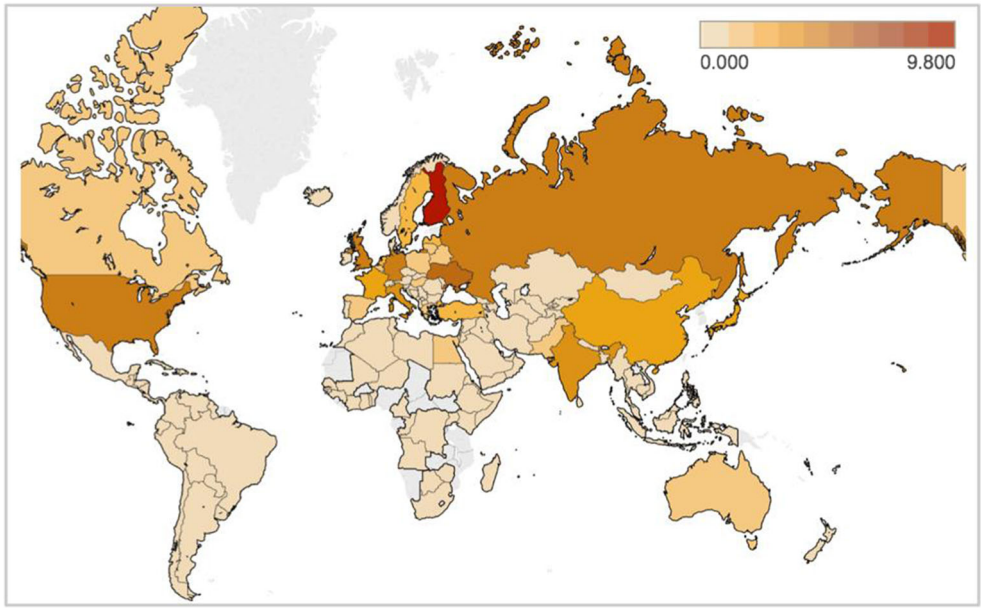

Fig. 2 Geographical distribution of e-residency applications in total (n = 25,560)

statistically significant for explaining the first two motive types: the applicants applying for e-residency because of having "business activity or interests related to Estonia" are more often from the countries with high or medium level of e-government development, whereas "fans of e-residency" are more often citizens of countries with very high level of e-government development. In this respect, the findings indicate that e-residency tends to provide a certain "compensation effect" particularly for citizens from countries with relatively lower level of e-government development, while citizens from

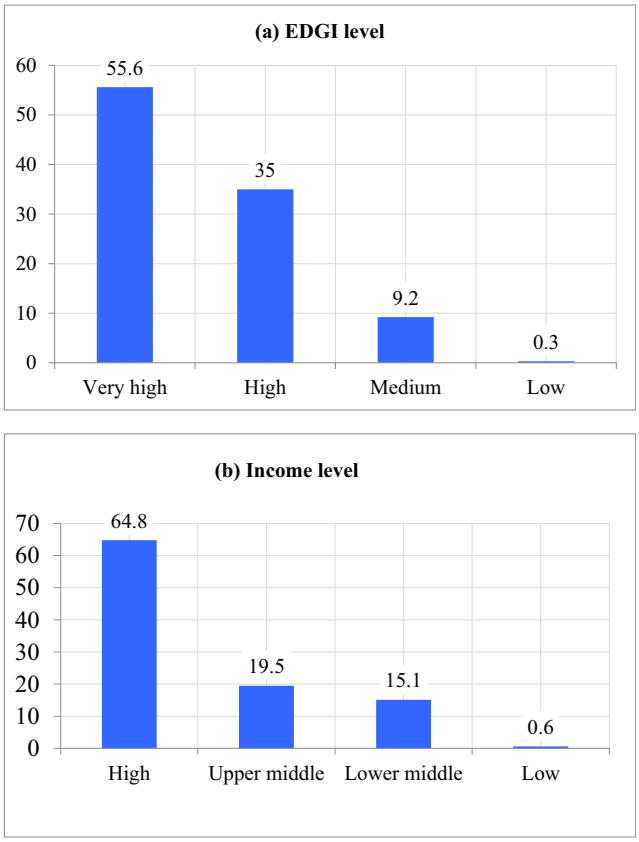

Fig. 3 Adoption of e-residency by (**a**) the level of e-government development (EDGI index) and (**b**) income level in the country of origin of the applicants (percent of accepted primary applications in 2014–2017)

Table 4 Multilevel linear regression models for explaining the adoption of e-residency by motive types

		Model 1: Business activity or interests related to Estonia B (S.E)	Model 2: Fan of E-residency B (S.E)	Model 3: Location independent international business B (S.E)	Model 4: Other motives B (S.E)
Micro-level variables	Intercept	20.980** (7.147)	-7.927 (5.764)	-119.380*** (8.103)	107.327*** (6.001)
	Gender	-.022* (.009)	-.026*** (.007)	-.047*** (.010)	.095*** (.008)
	Age	.012*** (.001)	-.008***(.001)	-.022*** (.001)	.017***(.001)
	EU citizenship	-.055*** (.007)	.072*** (.006)	-.014 (.008)	-.004 (.006)
	Year of application	-.010*** (.004)	.004 (.003)	.060*** (.004)	-.053*** (.003)
Macro-level variables	EDGI level	.032** (.008)	-.030***(.006)	.004 (.009)	-.006 (.007)
	Income level	.041*** (.008)	-.069***(.007)	.038*** (.009)	-.009 (.007)
	-2 Log Likelihood	27229.640	17135.449	33122.136	19026.748
	Between-country variance	5.003	4.512	6.988	2.285
	Within-country variance	.180	.117	.234	.133

*Only countries where the number of e-residency applications is >100 (42 countries, 23,463 individuals) are included in the multilevel regression analysis

** Parameters are unstandardized regression coefficients; standard errors (S.E.) in parentheses. * p < .05; **p < .01; ***p <. 001, (two-tailed)

countries with relatively higher level of e-government development express rather non-instrumental interest in the concept of e-residency. In a similar way, the relationship with the country's income-level indicates that applicants from lower income-level countries have somewhat more often expressed business-related motives by reporting "business activity or interests related to Estonia" or being interested in "location-independent international business".

Thus, as the regression analysis demonstrates, despite a strong correlation between the two macro-level variables included in the regression analysis (r = .834, $p < .001$), their significance as explanatory variables varies across different motive types.

6 Discussion

In contemporary digital society, digital identity systems are important mechanisms of digital inclusion and enablement which shape individual opportunities to participate in social and economic life as digital citizens. Estonian e-residency is the first transnational digital identity scheme that extends the range of digital subjects entitled to a government-supported digital identity beyond nationals or residents of a nation-state and expands the applicability of such DigID from national to international and transnational contexts (Sullivan 2018).

However, as our analysis has revealed, despite the formal, legally established inclusiveness of the concept, the global adoption of Estonian e-residency is structured and highly differentiated not only in terms of socio-demographic factors such as gender and age but also in terms of socio-geographic context, which question the universal global access and applicability of the concept. As the vast majority of applicants of e-residency are citizens of countries with relatively higher levels of digital and economic development, the e-residency programme tends to further increase the digital opportunities of citizens and entrepreneurs who are digitally better positioned by their own national governments rather than advance those with less digital opportunities, as suggested by some authors (Godoy and Heal 2016; Kotka et al. 2015). The global but highly uneven geographic distribution of e-residents thus reflects, but also contributes to the uneven geographies of digital access and enablement which characterize the contemporary information geographies at large (Graham et al. 2015). The findings of the current study are therefore in accordance with conclusions drawn from earlier research on e-government adoption, which suggest that instead of working as efficient mechanisms of (digital) inclusion, new technologies may rather contribute to the reproduction of existing digital inequalities and divides (Taipale 2013a; Warf 2014a).

While e-residency is also expected to give more advantage to citizens from non-EU countries by offering a digital access to the Digital Single Market of the EU (Godoy and Heal 2016), the e-residency programme has attracted EU citizens on an equal footing with citizens from non-EU countries so far – although, the share of citizens from non-EU countries has been on the rise. The attractiveness of Estonian e-residency to EU citizens can be explained, among other possible factors, by historically developed social, economic and political relations between the countries in the region, which are intertwined with various kinds of online transactions that can be supported by the affordances of e-residency. However, as the share of non-EU citizens has constantly increased among the applicants of Estonian e-residency and surpassed the number of EU citizens for the first time in 2017, the e-residency programme may have a clearer advantage for non-EU citizens, particularly in the context of the emerging of Digital Single Market of the EU.

However, as existing studies on e-government adoption suggest, the socio-geographic context and the differences in the levels of digital and economic development between applicants' countries of origin not only condition the access but also the need for certain e-government solutions (Taipale 2013a). As our analysis has shown, the level of e-government and economic development in applicant's country of origin affects the overall adoption of e-residency as well as the individual motives to apply for the transnational DigID offered by the e-residency programme. In case of citizens from digitally less developed countries, the adoption is more frequently driven by instrumental, usage-related needs, which highlights the potential of e-residency to compensate certain digital disadvantage related to a lower level of e-government development, whereas in case of applicants from digitally more developed countries the motives rather indicate a more general, non-instrumental interest in e-residency.

The concept of Estonian e-residency thus explicates the potentials as well as limitations of a transnational digital identity for global digital citizenship. As our analysis indicates, a digital identity may imply different significance and enforce a different kind of digital citizenship for different social groups, depending on their particular needs for a digital identity. Due to the overall aims of the programme, which mainly focus on economic gains, and the primary functionality attributed to the e-resident's ID, e-residency mainly enforces a certain type of economic digital citizenship (cf. Sullivan 2018). But this may also limit the potential applicability as well as adoption of e-residency by certain social groups. For example, as the current adoption of e-residency reveals, the applicants of e-residency are predominantly male and there is only a small share of female applicants. Such structural differences, in turn, come to contribute to further socially structured digital divides and disparities across dimensions of digital inclusion, enablement and participation that are constitutive to digital citizenship.

However, due to the short temporal span of the programme, we can suggest only initial implications of e-residency for global digital citizenship and digitally enabled virtual mobility. Therefore, it has to be studied further whether and how transnational and multifunctional digital identity schemes such as the Estonian e-residency can alter existing global inequalities in digital opportunities and offer a model of globally inclusive digital citizenship.

7 Conclusions

The aim of this study was to explore the preliminary implications of Estonian e-residency, the first transnational digital identity scheme implemented by the Estonian government, particularly for digital citizenship and digitally enabled virtual mobility. More specifically, we sought to examine the ways in which both individual-level socio-demographic and country-level socio-economic variables that measure digital and economic disparities between applicants' countries of origin explain the variations in individual motives to adopt the digital identity offered by the Estonian e-residency programme, using a multilevel modelling regression method.

As the results of the analysis proved, the variations in individual motives are not only explained by socio-demographic factors such as gender, age or citizenship but also by the country-level factors such as the level of e-government and economic development in the country of origin. Our analysis revealed that applicants without EU citizenship decide to adopt e-residency more frequently for reasons that relate to business interests or activity related specifically to Estonia. We assume that this may be due to Estonia's membership in the EU, which makes the Estonian economic and digital environment particularly attractive to citizens and entrepreneurs outside the EU, particularly in the context of the emerging Digital Single Market of the EU. While citizens from countries with very high level of e-government development express more frequently a non-instrumental and a more general interest in e-residency, the motives of citizens from countries with relatively lower levels of e-government development rather relate to the instrumental advantages of the Estonian e-residency programme. In a similar way, business-related incentives tend to be more important for citizens from countries with relatively lower income-levels. In this respect, the overall level of digital and economic development in the country tends to shape individual needs for digital instruments such as the transnational digital identity offered by the e-residency programme.

However, as the vast majority of applicants of e-residency is steadily from countries with higher levels of e-government development, the e-residency programme mainly tends to serve citizens and entrepreneurs who, at least in principle, have a relatively better access to various e-government affordances compared to citizens from countries with less advanced e-government. Nevertheless, we can conclude based on our findings that despite providing more frequently an advantage to citizens from wealthier and digitally more developed countries, the individual motives for joining the e-residency programme still indicate that the transnational digital identity can compensate certain digital disadvantage in case of citizens and entrepreneurs from countries with relatively lower levels of e-government and economic development. Hence, we can see that individual motives to apply for Estonian e-residency relate to broader structures of digital access and enablement.

8 Limitations and Future Research

The limitations of the current study mainly relate to the administrative register-based data used for the empirical analysis. The limited individual-level data and the pre-defined standardized motives included in the individual application form of e-residency provide only partial insights into the needs and incentives underlying the individual motives to apply for Estonian e-residency, which sets limits for the analytical and methodological research

design. Due to the highly uneven geographical distribution, certain countries and regions, particularly with lower levels of digital and economic development, remained underrepresented and excluded from more in-depth explanatory analysis due to the very limited number of cases. Therefore, the current trends of application allow only partial evaluation of the policy implications of the e-residency programme so far.

Despite the aforementioned limitations, the current study encourages to use administrative register-based data also for future research. Combined with other (administrative) data describing the actual use of the e-resident ID-s (the "digital footprints" of e-residents), the information included in the individual applications would make possible to analyze the differentiated use of e-residency as shaped both by individual factors and different social, economic, and digital contexts. In addition, a qualitative analysis of e-residents' individual motives to apply for Estonian e-residency would make possible a more in-depth study of the different dimensions of digital citizenship and mobile residency as enabled by the transnational digital identity offered by the Estonian e-residency programme.

Appendix 1

Table 5 Individual motives to adopt e-residency and country-level explanatory variables by countries

Country	Motive 1: Business activity or interests related to Estonia	Motive 2: Fan of e-residency	Motive 3: Location independent business	Motive 4: Other motives	EDGI level*	Income level **	N
Australia	12%	19%	55%	14%	1	1	305
Austria	21%	18%	48%	13%	1	1	181
Bangladesh	38%	16%	40%	6%	3	3	152
Belarus	33%	3%	51%	14%	2	2	279
Belgium	23%	19%	48%	10%	1	1	302
Brazil	23%	10%	57%	10%	2	2	167
Canada	15%	20%	51%	14%	1	1	327
China	24%	28%	35%	13%	2	2	928
Czech Republic	19%	22%	49%	10%	2	1	195
Denmark	32%	13%	38%	17%	1	1	189
Egypt	28%	9%	41%	23%	3	3	279
Finland	41%	6%	26%	27%	1	1	2500
France	17%	19%	52%	12%	1	1	1002
Germany	19%	17%	53%	11%	1	1	1433
Greece	16%	12%	64%	9%	2	1	362
Hungary	15%	17%	56%	12%	2	1	301
India	31%	9%	51%	10%	3	3	1021
Iran	37%	1%	55%	7%	3	2	158
Ireland	13%	22%	36%	29%	1	1	107
Israel	28%	11%	52%	9%	1	1	157
Italy	23%	16%	46%	15%	1	1	1140
Japan	21%	30%	38%	11%	1	1	856
Korea	11%	35%	47%	8%	1	1	275
Latvia	46%	3%	26%	26%	2	1	630
Lithuania	38%	9%	31%	23%	1	1	340
Netherlands	14%	31%	36%	19%	1	1	606
Norway	35%	9%	33%	23%	1	1	163
Pakistan	40%	6%	43%	11%	3	3	267
Poland	24%	12%	48%	17%	2	1	428
Portugal	18%	11%	61%	10%	2	1	167
Romania	16%	17%	53%	14%	2	2	177
Russia	34%	4%	40%	22%	2	2	1442
Serbia	8%	8%	77%	8%	2	2	103
Singapore	13%	31%	42%	15%	1	1	117
Slovak Republic	12%	30%	49%	10%	2	1	148
Spain	20%	18%	52%	10%	1	1	447
Sweden	30%	11%	36%	24%	1	1	504
Switzerland	13%	27%	46%	15%	1	1	171
Turkey	19%	5%	68%	8%	2	2	731
Ukraine	28%	4%	56%	12%	2	3	1500
United Kingdom	17%	22%	42%	18%	1	1	1445
United States	17%	24%	37%	23%	1	1	1461

*1- very high, 2- high, 3- medium, 4- low

**1- high, 2- upper middle, 3- lower middle, 4- low

Acknowledgements The preparation of this article was supported by the grants from the Estonian Research Council (PUT1624, IUT 20-38) and by the developmental programme ASTRA of Tallinn University of Technology for years 2016-2022 (2014-2020.4.01.16-0032). The authors would like to thank Estonian Police and Border Guard Board for the cooperation in issuing the data for this research.

References

Aavik, G., & Krimmer, R. (2016). Integrating digital migrants: Solutions for cross-border identification from e-residency to eIDAS. A case study from Estonia. In H. Scholl et al. (Eds.), *Electronic Government. EGOV 2016. Lecture Notes in Computer Science*, 9820. https://doi.org/10.1007/978-3-319-44421-5_12.

Al-Khouri, A. M. (2014). Digital identity: Transforming GCC economies. *Innovation, 16*(2), 184–194.

Belanche, D., Casaló, L. V., & Flavián, C. (2014). The role of place identity in smart card adoption. *Public Management Review, 16*(8), 1205–1228.

Calzada, I. (2018). "Algorithmic nations": Seeing like a city-regional and techno-political conceptual assemblage. *Regional Studies, Regional Science, 5*(1), 267–289.

European Commission (2015). A Digital Single Market Strategy for Europe. COM (2015) 192. Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2015%3A192%3AFIN. Accessed 12 February 2019.

Godoy, D.G.S., & Heal, A. (2016). Trade in the digital age: Can e-residency be an enabler for Asia-Pacific developing countries? Trade Insights Issue No 17. United Nations Economic and Social Commission for Asia and the Pacific. United Nations Trade, Investment and Innovation Division. https://www.unescap.org/publications/trade-digital-age-can-e-residency-be-enabler-asia-pacific-developing-countries-escap. Accessed 12 February 2019.

Goodstadt, L. F., Connolly, R., & Bannister, F. (2015). The Hong Kong e-identity card: Examining the reasons for its success when other cards continue to struggle. *Information Systems Management, 32*(1), 72–80.

Graham, M., De Sabbata, S., & Zook, M. A. (2015). Towards a study of information geographies: (Im)mutable augmentations and a mapping of the geographies of information. *Geo: Geography and Environment, 2*, 88–105.

Hackl, A. (2018). Mobility equity in a globalized world: Reducing inequalities in the sustainable development agenda. *World Development, 112*, 150–162.

Helbig, N., Gil-Garcia, J. R., & Ferro, E. (2009). Understanding the complexity of electronic government: Implications from the digital divide literature. *Government Information Quarterly, 26*, 89–97.

Hintz, A., Dencik, L., & Wahl-Jorgensen, K. (2019). *Digital citizenship in a datafied society*. Cambridge: Polity Press.

Isin, E., & Ruppert, E. (2015). *Being digital citizens*. London: Rowman & Littlefield International.

Kellerman, A. (2016). *Daily spatial mobilities: physical and virtual*. London: Routledge.

Kotka, T., Ivan Vargas Alvarez del Castillo, C., & Korjus, K. (2015). Estonian e-residency: redefining the nation-state in the digital era. Cyber Studies Programme Working Paper Series 3: 2015. University of Oxford. https://www.politics.ox.ac.uk/materials/publications/14883/workingpaperno3kotkavargaskorjus.pdf. Accessed 12 February 2019.

Kubicek, H., & Noack, T. (2010). Different countries-different paths extended comparison of the introduction of eIDs in eight European countries. *Identity in the Information Society, 3*(1), 235–245.

Lips, M. (2010). Rethinking citizen – government relationships in the age of digital identity: Insights from research. *Information Polity, 15*, 273–289.

Lips, A. M. B. (2013). Reconstructing, attributing and fixating citizen identities in digital-era government. *Media, Culture & Society, 35*(1), 61–70.

Lips, A. M. B., Taylor, J. A., & Organ, J. (2009). Identity management, administrative sorting and citizenship in new modes of government. *Information, Communication & Society, 12*(5), 715–734.

Martens, T. (2010). Electronic identity management in Estonia between market and state governance. *Identity in the Information Society, 3*(1), 213–233.

Martin, N. J., & Rice, J. L. (2010). Building better government IT: understanding community beliefs and attitudes toward smart card technologies. *Behaviour & Information Technology, 29*(4), 433–444.

Mossberger, K., Tolbert, C. J., & McNeal, R. S. (2008). *Digital citizenship: The internet, society, and participation*. Cambridge: MIT Press.

OECD (2011). Digital identity management: Enabling innovation and trust in the internet economy. OECD Publishing: OECD. http://www.oecd.org/sti/ieconomy/49338380.pdf. Accessed 12 February 2019.

OECD (2015). Developments in digital identity. DSTI/ICCP/REG (2015)12. Directorate for Science, Technology and Innovation Committee on Digital Economy Policy, OECD. https://one.oecd.org/document/DSTI/ICCP/REG(2015)12/en/pdf. Accessed 12 February 2019.

Pimenidis, E., & Savvas, I. (2007). E-identification technologies for e-government interoperability in the EU. *International Journal of Electronic Security and Digital Forensics, 1*(2), 169–179.

Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC. Official Journal of the European Union 257, 28.8.2014: 73–114. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0910&rid=6 . Accessed 12 February 2019.

Rogers, E. M. (2003). *Diffusion of innovations*. New York: Free Press.

Seltsikas, P., & O'Keefe, R. M. (2010). Expectations and outcomes in electronic identity management: the role of trust and public value. *European Journal of Information Systems, 19*, 93–103.

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. London: Sage.

Sullivan, C. (2011). *Digital identity: An emergent legal concept*. University of Adelaide: University of Adelaide Press.

Sullivan, C. (2016). Digital citizenship and the right to digital identity under international law. *Computer Law & Security Review, 32*, 474–481.

Sullivan, C. (2018). Digital identity – from emergent legal concept to new reality. *Computer Law & Security Review, 34*, 723–731.

Sullivan, C., & Burger, E. (2017). E-residency and blockchain. *Computer Law & Security Review, 33*, 470–481.

Taipale, S. (2013a). The use of e-government services and the Internet: The role of socio-demographic, economic and geographical predictors. *Telecommunications Policy, 37*, 413–422.

Taipale, S. (2013b). Mobilities in Finland's information society strategies from 1995 to 2006. *Mobilities, 8*(2), 293–311.

Tammpuu, P., & Masso, A. (2018). "Welcome to the virtual state": Estonian e-residency and the digitalized state as a commodity. *European Journal of Cultural Studies, 21*(5), 543–560.

United Nations (2016). E-government survey 2016: E-government in support of sustainable government. New York: United Nations Department of Economic and Social Affairs. https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2016-Survey/Executive%20Summary.pdf. Accessed 12 February 2019.

Vassil, K. (2015). Estonian e-government ecosystem: Foundation, applications, outcomes. Washington DC: The World Bank Group. http://pubdocs.worldbank.org/en/165711456838073531/WDR16-BP-Estonian-eGov-ecosystem-Vassil.pdf. Accessed 12 February 2019.

Vivienne, S., McCosker, A., & Johns, A. (2016). Digital citizenship as fluid interface. Between control, contest and culture. In A. McCosker, S. Vivienne, & A. Johns (Eds.), *Negotiating digital citizenship: Control, contest and culture* (pp. 1–17). London: Rowman & Littlefield International.

Warf, B. (2014a). Asian geographies of e-government. *Eurasian Geography and Economics, 55*(1), 94–110.

Warf, B. (2014b). Geographies of e-government in Latin America and the Caribbean. *Journal of Latin American Geography, 13*(1), 169–185.

World Bank Group. (2016). *World development report 2016: Digital dividends*. Washington DC: The World Bank Group http://www.worldbank.org/en/publication/wdr2016. Accessed 12 February 2019.

World Bank Group (2017). ID4D identification for development. 2017 annual report. Washington DC: The World Bank Group. http://pubdocs.worldbank.org/en/561391513609113984/2017-ID4D-Annual-Report.pdf. Accessed 12 February 2019.

World Economic Forum (2018). White paper on digital identity on the threshold of a digital identity revolution. http://www3.weforum.org/docs/White_Paper_Digital_Identity_Threshold_Digital_Identity_Revolution_report_2018.pdf. Accessed 12 February 2019.

Zhao, F., Collier, A., & Deng, H. (2014). A multidimensional and integrative approach to study global digital divide and e-government development. *Information Technology & People, 27*(1), 38–62.

Piia Tammpuu is a PhD Candidate at the Institute of Social Studies, University of Tartu, Estonia. Her research focuses on digitally supported modes of transnationalism and mobility, and related transformation of citizenship.

Anu Masso is an Associate Professor at Ragnar Nurkse Department of Innovation and Governance, Tallinn University of Technology, Estonia, and a Senior Researcher at the Institute of Social Studies, University of Tartu, Estonia. Her current research focuses on the interrelated fields of big data and spatial mobilities, like developing measurements and estimating bias of social dynamics of large-scale socio-cultural phenomena, and examining socio-cultural consequences of digital transformations in general and big data in particular.