MSc Programme in Urban Management and Development

Rotterdam, the Netherlands
August, 2022

Thesis title: Understanding Digital Divide in Municipal Services

Name: Nadine Burbar
Supervisor: Somesh Sharma
Specialisation: Strategic Urban Planning and Policy SUPP
Country: Palestine, State of
Report number: 1610
UMD 18

IHS
Making cities work

Institute for Housing and
Urban Development Studies of
Erasmus University Rotterdam

Summary

Cities are adopting a "smart" paradigm in their urban development; technology is integrated into every part of daily life functions. While municipal services are a civic service, a means to suppress social inequalities, the digital transformation of services is nevertheless making these inequalities exacerbate. The rapid digitalization pace in our world is eluding larger groups, those digitally disadvantaged by technology (Robinson et al., 2015). The extent to which municipal services are accessed through the internet tends to increase the divide between citizens who can access these services and those who are without access. Research has established those at the high-end of the digital divide: middle-aged and higher-educated, tend to have better chances to appropriate technology much more than those at the lower end of digital divide: elderly, poor, lower-educated, and migrants (van Dijk et al., 2015). In Digital Municipal Services as well, there is a divide among users, some are advantaging from new technological innovations in municipal services while others are being pushed behind. Our research investigates the level of inclusion in digital municipal services 'DMS', and undercovers the main user characteristics that determine the level of access to appropriate DMS. Socio-demographic characteristics are established in literature to inhibit access to ICT, such as age, gender, education, income, as well as ethnicity. However, our research concluded, that in Digital municipal services, age, education, and ethnicity are the main determining characteristics to access. We discovered through quantitative research methods, the characteristics that determine access to DMS, moreover, we explained through qualitative methods the perception of citizens, and how digital divide is experienced by groups with lower levels of access to DMS. The re-innovation of services inhibits users with lower digital skills to use DMS. New innovations are creating new uncertainties and need to learn ever-changing technology. Groups with lower education attainment, income, older, and migration backgrounds experience digital divide in municipal services the most. These groups have lower access due to different disparities in motivation, material, skill, and use access. Older groups have a lower attitude towards technology and prefer in-person interaction, they also, have a lower complex digital skills level to handle activities online as municipal services. Education and income determine users' perceived usefulness of digital services, and thus their attitudes to appropriate it. Groups with migration backgrounds tend to have a lower attitude towards digital services due to language barrier however acquired digital skills do not suffice, without the local language, is the main barrier to access and use the services, yet, these groups have a higher attitude to improve their skills than native groups, they have higher interest to integrate into society and to better their living conditions.

Keywords

Acknowledgments

"Every finish line is the beginning of a new race"

Firstly, I avail myself of this opportunity to thank my supervisor, professor Somesh Sharma, for his endless mentorship, space to grow, and support until I reached the finish line. As well as my thesis second reader Dr. Jan Fransen, for welcoming me to the thesis circle and his expertise.

Secondly, to all my friends who cheered me along in this race. Thanks for the mental support! Good memories, and new recipes that made home feel less faraway!

My greatest gratitude for my family, for ceaseless love and support - My mom, for not missing any of the last 322 days to be the first person to check on me.

Finally, to all interviewees who took a genuine time to share their experience and knowledge, and put me one step closer to completing my thesis.

This thesis wouldn't have been possible without your contribution!

Rotterdam, August 7th, 2022

Nadine Burbar

Abbreviations

DigID	Digital Identification
DMS	Digital Municipal Services
ICT	Information and Communications Technology
NITA	National Telecommunications and Information Administration
RDM	Rotterdam Municipality

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Background information and problem statement

In a busy life rushing after advancement and keeping up with the latest technology, we present a moment to investigate what is happening behind the scenes of digitalization - an action known as the amalgamation of technology across every daily life aspect that can be digitized (Gray & Rumpe, 2015). Our world is relying on digital tools for prosperity and connectivity, the last two decades have witnessed a dramatic and unprecedented growth in ICTs where the 'Information technology revolution' encapsulated a rapid change (Kenisten & Kumar, 2003) bringing rise to the information society. Yet, one backdrop of this revolution that has helped innovation in every industry, is that the information revolution is not human-oriented (Silvano, 2022). The advancement is happening at a rapid pace and forgoes human needs, leaving existing inequalities to exasperate. By observing the digital divide through the socio-economic lens, the links resting between digital divide and social exclusion rise to the surface. In conjunction with social, economic, psychological, and cultural conditions of individuals. The offline exclusionary factors of individuals correspond to their online exclusion factors (Helsper, 2012).

In the last two decades, urban development has been linked to digital innovation in city management (Kolotouchkina et al., 2022) cities are comprising a "smart city" approach to transforming against 21st-century challenges; urban growth, poverty, environmental degradation, etc. (Albino et al., 2015). Governments and public agencies, including municipalities, are embracing the "smartness" notion in their urban planning and development policies (Ballas, 2013). Governments of the 21st century are adopting digital agendas, encouraging the digitalization process as much as the COVID-19 pandemic did. Eluding larger groups of people with economic and social disadvantages (Robinson et al., 2015). While digitization policies are taking place, smart city policies are rather deemed to be focused on technology rather than people (Silvano, 2022), the 'smart' new paradigm of urban development spikes serious concerns about digital divide in making services inclusive to everyone (Kolotouchkina et al., 2022). The same case for digital or smart municipal services, that are part of this digitally-driven urban development. The provision of public (municipal) services is inevitably a means to suppress social inequalities, the digital transformation of municipal services is yet making these inequalities exacerbate (Silvano, 2022). The extent to which municipal services are accessed through the internet tends to increase the divide between citizens who can access these services and those who are without access, and this problem will exacerbate with mainstreaming of online public services (Sorj, 2008; van Dijk et al., 2015). In digital municipal services, there is only one provider, the municipality, which provides citizens with one option. E-Municipal services are unlike e-commercial services, they follow rules and regulations of the institution and the corresponding departments, which makes them more complex and sophisticated to translate to ICT. The Supply-oriented service (municipality) neglects the demand-side (Citizens), particularly disadvantaged groups. Those at the high-end of the digital divide: middle-aged and higher-educated, tend to have better chances to appropriate the digital municipal services much more than those at the lower-end of digital divide: elderly, poor, lower-educated, migrants (van Dijk et al., 2015). The offline disparities are being reconfigured in e-government and public agencies' digital services.

1.2 Relevance of the research topic

The research investigates the digital divide and its implication for online inclusion in digital municipal services. In the last two decades, several scholars have tried to conceptualize the digital divide phenomena and its impact on the future. Van Deursen and Van Dijk (2011) anticipated it will remain and exacerbate into the future. This research is contributing to the digital divide and online inclusion realm. At one point, some scholars have stated the shortcoming of digital divide research being mainly descriptive (De Haan, 2004; Van Dijk, 2006) engrossed in recording the availability of IT, and if the gaps in usage and access are shrinking or widening. Moreover, some available research provided a nuanced overview of digital divide, yet the dimension of online inclusion was often from a uni-dimensional perspective, providing a focus on specific frameworks, either psychological or socioeconomic (Helsper, 2012). Although there have been explicit attempts to study digital divide and online inclusion from a multidimensional perspective, there have been very limited studies of digital divide in municipal services. Some models were covering digital divide in e-government, but municipalities were rather barely represented. Up-today, little research has studied the role of digital policies at the local scale, where our research takes place to address this gap, by contributing to research on the topic of online inclusion in public services, and providing insights to public agencies on decision-making for digital policies and programs.

1.3 Research Objectives

The research objective is to investigate the critical determinants of digital divide in digital municipal services, by explicating the extent of access to appropriate digital services against the digital divide drivers, namely, age, gender, education, income, and ethnicity and their association with access variables. This research points out the determinants to access digital municipal services by different groups of society in Rotterdam, those with different characteristics. It postulates a deeper understanding of determinants of digital divide implicating disparities in accessing digital municipal services.

1.4 Research questions

Overall research question: To what extent do user personal characteristics determine level of inclusion in digital municipal services in Rotterdam?

Specific research question(s):
1. What are the main personal characteristics that determine level of access to appropriate digital municipal services?
2. How do groups with lower level of access experience digital divide in municipal services?

1.5 Research Scope

Our research investigates digital divide in municipal services through adopting existing models of online inclusion and personal characteristics, namely, age, gender, education, income, and ethnicity, associated in literature with digital divide. Our study takes place in The Netherlands. We studied digital municipal services offered by the Municipality of Rotterdam, through a study population in Charlois district with a focus on Carnisse; a neighborhood inhabited by 11849 persons (Rotterdam Municipality, 2022), utilizing surveys to understand the personal characteristics associated with users' level of access to DMS, and interviews to profoundly understand the experience of digitally excluded groups.

Chapter 2: State of the art of the theories

The landmark of our world today is shaped by technology, a turning point of living standards between humans in light of the rise of 'information society', throughout disruptive technologies restructuring the conventional society (Webster, 2013). The literature recognized the internet and personal computers (PCs) as intertwined examples of the digital revolution and the creation of a service society (Cruz-Jesus et al. 2015; Webster,2013). Where the empirical research expressed the capability to appropriate and use the internet is considered a requisite to integrate into contemporary society (Zhang, 2013). While the internet was thought to expand access to quality services (i.e., health, education, and labor, participation in political discussion, and government access) (DiMaggio et al., 2004), the internet access still unheeded and evaded some groups, who over the years, were pushed into isolation and marginalization, due to the unequal access of technology and internet (Bucea et al., 2020).

2.1 Definition of digital divide

The digital divide was born in the late 19990s when only 5% of the world's population was included in the 'Information age' who accessing the web (Keniston, 2003). The term digital divide first appeared in National Telecommunications and Information Administration NITA report as the divide among individuals 'who are able to access new technologies and those individuals who cannot' (NITA, 1999). The disparities in ICT were referred to as 'digital divide' (Bucea et al., 2020), which was considered the newest type of divide, leading digital divide research to come about (Tkachenko et al., 2021). Plentiful digital divide research focused on the first-order effects of those who can access technology, others focused on the second-order effects of 'good use' inequalities between individuals who are able to access and use technology (Dewan & Riggins, 2005). Our research takes part in the second-order effect, studying the disparities between users of digital public (municipal) services.

As novel phenomena, digital divide is still in theoretical justification infancy, in an absence of a universal definition (Bucea et al., 2020; Tkachenko et al., 2021). However, scholars such as Bucea et al. (2020) considered the definition of the Organization for Economic Co-operating and Development (OECD) more appropriate for this phenomena. The OECD defined digital divide by referring to different socio-economic levels of individuals, businesses, and geographical areas regarding their opportunities to access and use ICT tools to perform myriad activities (OECD, 2001). The impreciseness of digital divide definition is attributed not to it being a unique concept, but to the technology itself which has changed significantly in terms of using internet (Gunkel, 2003) fluctuating from access to frequency, purpose, and intensity of internet use (Araque et al.,2013). Later, the binary divide of 'have and have not' became outdated and belittled (Warschauer, 2003), and a focus on the usage of ICT and level of proficiency became pertinent to measure digitalization (Dewan & Riggins, 2005). DeHaan (2004) considered the reduction of the phenomena of 'have or have-not' access to the internet or technology to be one of the common shortcomings of digital divide research, it discards the progress in comprehending communication and social change impact. Warschauer (2004) raised concerns about this bipolar relationship in the dichotomies of having and have-not, and Van Dijk (2005) forewarned about its negative consequences. Van Dijk analyzed disparities in ICT and affirmed that the physical access gap is narrowing, expressly in developing countries (2006). Traditionally, measuring differences within digital divide was based on the main indicators of ownership of devices and use of internet (Rye, 2008), however, the rates of use of the internet and ownership of devices reached almost 100%, nevertheless, the improvement

in accessibility does not imply that problems are solved, the problem is deepening and growing (van Dijk, 2012), and a need for new indicators and a more complex understanding of the problem arose (Gunkel, 2003; van Dijk, 2006). Disparities in capability and abilities to access and make good use of ICT known as the "Knowledge divide" brought a new hurdle and new forms of inequalities (Robinson et al., 2015). According to Selwyn (2010), the competence of managing technology has relevance to individuals' societal needs, as well as reinforcement socially, economically, culturally, and politically. Helsper addressed the new challenge, he studied the links between digital and social exclusion (2012), while Warschauer (2003) argued that internet access has to do with not the internet as such, but with the contexts that shape it, he argued that the subsisting inequality is not digital but social.

Various researchers contributed to defining the digital divide phenomena. Dichotomies in respect of two scientific typologies; the first-order and second-order effect of digital divide. Under the first order, NITA (1999) defined the phenomena of those who do have or do not have access to the internet. Digital divide was based on the main indicators of ownership of devices and use of internet (Rye, 2008). Critiques of this definition called forward the reduction of the phenomena to 'have and have-not' (Warschauer, 2003; van Dijk 2006). Acknowledging that technology is in constant change (Gunkel, 2003) and thus a shift on the disparities in terms of frequency of use and benefit (Araque et al.,2013) shaped the second-order effect, that focuses on the disparities in 'good use' of ICT among social groups (Selwyn, 2010; Helsper, 2012; Robinson et al., 2015).

2.1.1 Drivers of Digital Divide

Technology can be a catalyst to derive deep divides in a society that negatively impacts sustainability and economic prosperity, vulnerable groups' behavior should be understood and guided to benefit from digitalization (S.R Park et al. 2015). Socio-demographic characteristics are associated with online behavior according to Van Deursen et al. (2015). Below we present five demographic segments (gender, age, education, and income) mentioned in literature to be of significance in contemporary society (Bucea et al., 2020; Helsper, 2012; DenHaan, 2004; van Deursen et al., 2015; van Dijk, 2005; van Dijk, 2012), as well as race and ethnicity (AlMuwil et al., 2019; Robinson et al., 2015).

Primarily, **_gender_**, research has long found a disparity between the two gender's use of the internet. Men were found to use it more actively than women. Men were considered to have a higher positive attitude towards technology (Whitley, 1997). In many developed countries, the physical access gender gap has diminished, but men still are found to use internet and technology more than women due to prior exposure to technology related to work purposes (Cooper, 2006; Meraz, 2008). Some recent studies concluded differences in internet activities between women and men (Meraz, 2008; van Deursen & van Dijk, 2014). Secondly, **_age_** is a strong driver of internet use. The adult and old age groups have been recognized to experience a lower attitude towards the internet (Huet, 2002). The digital divide is also an age matter, as expressed by United Nations (2012). This age use gap is referred to as the 'generational rifts', between those who are labeled as digital natives, and others, elder, labeled as digital immigrants, and therefore, have the need to adapt to ICT (Ballano et al. 2014). Research by Friemel (2016) draws that "_with every additional year of age, the likelihood of Internet usage decreases by 8% in five-year differences when considering a range of 65–90 years or more_" (p.328). Thirdly, **_education_** is another important and consistent driver of the digital divide (DiMaggio et al., 2004; van Dijk, 2005), and is justified by the complexity of ICT (Bucea et al., 2020), agreed van Deursen et al., (2015) who also considered education attainment as a core predictor of users' activities in using the internet and the type of activities they engage

with. People with less education attainment have less access to material and exposure to content (van Dijk, 2005).

Research and international organizations considered level of *income* as a prominent determinant of the digital divide. A positive relationship is recognized between the level of income and adoption level of internet and technology (Bucea et al., 2020; Livingstone & Helsper, 2007; van Dijk, 2005) people with higher income levels were considered by DiMaggio et al., (2004) to have better ability to use the internet effectively and productively. Lastly, in a multicultural society, *race and ethnicity* are "*characterized by the existing of different social groups that hold different positions in the stratification system, particularly ethnic and racial minorities*" (Robinson et al.,2015, p. 573). The disparities in the use of technology by social groups have relevance to the reduction and magnification of social disadvantages (Chen, 2013).

Aggregated literature established different characteristics associated with digital divide that influences access to ICT. The studies build consensus on these characteristics. Gender digital disparity prevails in socio-economic inequalities between both genders (Meraz, 2008; van Deursen & van Dijk, 2014). Age, influences individuals' attitudes towards technology and internet (Huet, 2002). And education attainment is a prominent factor that influences individuals' ability to handle technology and type of activities online (DiMaggio et al., 2004; van Dijk, 2005; van Deursen et al., 2015). Income is a determinant of digital divide in form of ICT adoption and the ability to perform productively online (Bucea et al., 2020; DiMaggio et al., 2004; Livingstone & Helsper, 2007; van Dijk, 2005). Ethnicity introduces diversions in technology advantages among social groups stemming from different social values (Chen, 2013; Robinson et al., 2015).

2.1.2 Reconceptualizing digital divide and inclusion

In studying the first-order and second-order effects of digital divide, several research efforts were conducted to reconceptualize the phenomena and its effect on individuals and households. The binary concept of the digital divide was replenished with multi-dimensional concepts introduced to the information society realm (DenHaan, 2004). For effective adoption of IT, a three-dimensional access type was introduced (DenHaan & Huysmans, 2003; Marsh, 2001; van Dijk, 1999): motivation, possession, and digital skills. *Motivation* signifies the perceptions and attitudes toward the internet and technology and interest in using them. *Possession* refers to the availability of material properties for accessing technology. And Digital *skills* stand for the extent to which users can handle technology. The three independent aspects of access, motivation, possession, and skills, were confronted by the controversy about how these types of access relate (DenHaan, 2004). The controversy stems from debates around the drivers of digital divide and their influences on the relations between the aspects of access.

Social inclusion emerged in policy discourses in Europe in the 1970s, as part of the response to economic restructuring rising from the global economic integration, affecting labor, social policies, and migration flow (Labonte et al., 2011). A clear definition of social inclusion or exclusion is still unpresented in literature (Al-Jaghoub & Westrup, 2008). Power & Wilson described social exclusion as "*the inability of our society to keep all groups and individuals within reach of what we expect as a society….[or] to realize their full potential*" (2000, p.1). As for the social inclusion concept, compared to social exclusion which has a theoretical framework on the process in which society members can be marginalized, there is less theoretical agreement on social inclusion (Labonte et al., 2011). Some defined social inclusion as a proactive approach where all groups of people are valued and live with dignity and fulfill their basic needs (Freiler, 2002 as in Labonte et al., 2011). The COVID-19 crisis has

accelerated the pace of digital transformation, worsening the threats to social inclusion, the rapid technological change is entailing a two-dimensional perspective between the government and citizens to bridge the digital divide to assure everyone can benefit equally from accessing technology, offline as online (United Nations, 2021). Digital inequalities are continuously associated with gender, income, race, and all aspects of offline inequalities. Even in developed contexts, the disparities in access to and use of digital technology still elude disadvantaged groups (Robinson et al., 2015). DiMaggio & Garip (2012) argue that digital inequalities can reinforce the existing social disparities, or even, aggravate them as pre-existing differences in human capital can influence online equalities. Different scholars debated the fundamental values of social inclusion. Stewart (2002) defined these values to be encapsulated in material well-being, participation in productive life, education attainment, health, and social participation in terms of club membership or social networks. Shookner outlined five values intended to enhance social inclusion: "(1) Social justice (fair distribution of inclusion and resources), (2) Valuing diversity (recognition and respect; valuing all contributions), (3) Opportunities for choice, (4) Entitlement to rights and services, and (5) collective work" (2000, pp. 2-3). In our research, we will focus on the rights of equal services, as we investigate the accessibility to digital technology from a service provision perspective and its impact on social inclusion.

In a knowledge society, e-inclusion has been defined, broadly, as social inclusion (Yu et al. 2018). The literature has established the relations between offline (social) inequalities and online (social) exclusion (De Haan, 2004; Helsper, 2012; Robinson et al., 2015; van Deursen & van Dijk, 2014; Warschauer; 2004) in our research referred to as 'digital divide'. Those who are with a higher-level engagement with digital technology enjoy the advantages over those disadvantaged (Robinson et al.,2015). In digital divide debates, Waschaeur (2003) argued that for marginalized groups the purpose of ICT use is not to eliminate the digital divide but to accelerate the process of social inclusion. Manzoor & Virmarlund mentioned digital technologies for social inclusion (2018, p.1):

> "*Digital technology has been described as a facilitator for social inclusion because it allows for the delivery of real-time services that can enable individuals to learn, work, travel, socialize, shop, and interact with the community without being subject to physical barriers. Digital technologies have also been identified as one of the most important factors that can contribute to reducing existing social gaps and can be used to encourage and support social inclusion and increase people's quality of life*".

Along with others, Kaplan (2005) argues that online-inclusion is about social inclusion in an information society. As our research explicates inclusion in digital municipal services, we will refer to online inclusion as synonymous with social inclusion. The Literature recognized for e-public services (e-municipal services) to be inclusive, the e-services must be able to extend to all society segments and meet the needs of those digitally disadvantaged, otherwise, the growth of the online population would elude groups and individuals (AlMuwil et al., 2019). To establish inclusion in digital municipal services, we need to draw the lines of existing literature frameworks on online inclusion. There have been several efforts to conceptualize online inclusion. The study of the adoption and usage of ICT is the most mature research in the area of information systems (AlMuwil et al., 2019). According to Venkatesh et al. (2003), researchers are encountered with choosing a "favored model" amongst a multitude of models, and somehow ignore the contribution of other unfavored models. Furthermore, an absent link has been recognized between studies of online inclusion and e-public services adoption fields, mainly from the perception of inhabitants (AlMuwil et al., 2019). Undeniably, some attempts have been indented to conceptualize online inclusion (for

example, Becker et al., 2008, Bentivegna & Guerrieri, 2010; Helsper, 2008). However, van Dijk (2006) argued that there is a privation of theorization in online inclusion research. It was maintained at socio-demographic descriptive level, and he called for in-depth research to investigate the psychological, cultural, and social causes of inequality of access. There have been theoretical and empirical challenges to studying e-government and e-inclusion fields together, these fields are shifting towards a more complex understanding of their phenomenon (Helbig et al. 2009). Some researchers established particular theories and models to examine online inclusion, we present a summary of these frameworks in Table 1. These frameworks are focused on online inclusion, and present a useful evaluation of the influence of e-services on the general population, however, they fail to present a clear evaluation of disadvantaged groups' needs (Cullen et al., 2007). Our research thus, aims to adopt some of the concepts and components of available models, to contribute to the understanding of groups who are less advantaged by the digitalization of municipal services. Van Dijk (1999) was the first scholar to indicate the multidimensionality of digital divide. Bradbrook & Fisher (2004) studied e-inclusion through fivefold criteria they called "the 5 Cs" of e-inclusion, Connection, Capability, Content, Confidence, and Continuity. On the contrary, van Dijk (2005) theorized access in a four steps model, motivation, material, skills, and usage. He argued that adoption of technology begins with significant attractiveness of the innovation and individuals' motivations for adoption, which in his "successive types of access" model referred to as first stage of appropriation to technology. DenHaan (2004) conceptualized the digital divide in a multifaceted model, he has criticized the existing research to be focused on the binary relationship of 'having and have-not', he presented a multidimensional model constituted of 7 components, namely, personal characteristics, resources, access to ICT, the context of opportunities, participation in society, and the technological properties. On the other hand, Helsper (2008) has focused her research on digital resources, and categorized online inclusion into four components, access to ICT, skills, attitudes, and the extent of engagement with ICT. Bentivegna & Guerrieri (2010) aimed to footprint the ICT evolvement and to record the level of e-inclusion advancement, they developed an e-inclusion index as a multi-dimensional approach to understanding the link between ICT advancement and e-inclusion. The e-inclusion index has focused on the economic impacts.

Table 1 Frameworks adopted for e-inclusion

	Author(s)	Theory	Depiction
1.	Bradbrook & Fisher (2004)	The 5's of Inclusion	The model explains the complexity of e-inclusion and identifies five components that trigger online-inclusion: - Connectivity: referring to access to ICT - Capability: referring to digital skills - Content: the content to perform online activities - Continuity
2.	Bentivegna & Guerrieri (2010)	E-inclusion Index	The index measures the progress in ICT, and captures and monitors the advancement of e-inclusion by structuring index e-inclusion into three components: - Access: affordability, availability, and quality of internet - Usage: skills, autonomy, and intensity of using internet - Impact: impact of internet in several fields: e-Government, e-Health, e-Education, e-Economics, e-Culture, and Communications
3.	DenHaan (2004)	Multidimensional Conceptual model for explaining inequalities in Information Society	Presents a multifaceted model to include the multidimensional access to ICT, cause and consequences of access, to overcome the binary relationship of digital divide concept. The model identifies the below components in access to information society: - Personal characteristics: age, sex, race, intelligence, personality - Resources: material, social, cognitive, time

			- Access: incorporated Van Dijk (2005) model: motivation, material, skill, use - Context of Opportunities: Labor market, household and education situations - Participation in society: market, social networks, culture, politics, institutions - Technology properties: IT can influence ICT diffusion, price and complexity of IT innovations
4.	Helsper (2008)	Framework of Digital Resources	The model articulated the determinants of exclusion that obstruct individuals in their daily life, such as income, or other determinants as individuals' choice to not use ICT even if they have the ability to. This model looks into resources from four criteria: - Access to ICT - Skills - Attitude towards ICT - The extent of engagement with ICT
5.	Van Dijk (2005)	Successive Access to Digital Technologies	The model conceptualized access to technology in a fourfold unit that encompasses four barriers: - Motivation access: to use ICT, interest, and attitude - Material access: such as computers, internet connections, and locations to use them. - Skills access: education, digital skills, use of ICT, social support - Usage access: use patterns, frequency, uneven use opportunities between societies

Some researchers have adopted these concepts and models or merged them with other theories such as the Uses and Gratification theory, to develop a multifaceted perspective of ICT and digital inclusion or exclusion in e-government research (see example, Becker, 2008; AlMuwil et al., 2019). In their research, they noticed the tendency for individuals to adopt e-commerce services more likely than e-government. Both Becker and AlMuwil et al. referred to trust as an inhibitor to ease the paths for individuals to adopt e-government. Van Dijk et al. (2015) similarly, attributed trust to lower levels of attitudes toward adopting e-government services.

Portrayed from available literature, we aim to adopt some concepts of the existing models to evaluate inclusion in digital municipal services. This research draws on the established key inhibitors of e-inclusion, namely, demographic inhibitors, age, gender, income, education, and ethnicity, and the themes that have emerged in the literature from studying individuals' behaviors in daily-life situations while adopting e-government services, such as access ability, attitude, skills, use opportunities. Our research framework adopts the components of access to appropriate digital municipal services through motivation, material, skills, and use, which are co-occurring in the theories and models presented previously in table 1. Bradbrook & Fisher (2004), Van Dijk (2005), DenHaan (2004), Helsper (2008), and Bentivegna & Guerrieri (2010), established their models on criteria for online inclusion that builds on individuals' access to ICT. Expressing that this relationship is configured by attitude towards technology, and having the physical material, ability to handle digital technology and its content, and the ability to have usage autonomy and efficacy, to maintain this ability when technology changes. In e-government context, the content of technology and trust have a high significance in evaluating e-inclusion (AlMuwil et al., 2019). Research on e-inclusion in e-government has shown that there is a gap between e-commerce and e-government adoption. Individuals find e-commerce easier to learn and use, and showed a lower interest and level of trust in e-government services (AlMuwil et al., 2019). Fuchs (2009) recognized this lack of interest as "motivational access". Thus, we will adopt trust and content aspects into our framework under the 'motivation access' component in our research. Concerning the selected

models, we consider the 'Successive Access in the appropriation of Digital Technology Model' by van Dijk (2005) to be a guiding model for our study of online inclusion, as it attributes to the overarching criteria of online inclusion developed in literature by other authors. Van Dijk's model encompasses access and usage aspects. Nonetheless, we will not regard this model with its horizontal nature, each stage of access in this model is theorized to occur before the other. But since our research focuses on digital municipal services, we are not only regarding the technology itself but a social provision service behind it, that is supplied by a 'one and only' legal authority. The reasoning of inclusion or exclusion can thus be cross-cutting, and not horizontal.

2.1.2.1 Successive Access model

Van Dijk was one of the first academics and researchers to investigate the digital divide from a multi-dimensional aspect (van Dijk, 2006; AlMuwil et al. 2020). Van Dijk (2005) incorporated four types of accessibility through the model for successive access to digital technology. He conceptualized access to technology in a fourfold unit that encompasses four barriers, depicted in Figure1, 1) motivation access 2) material access 3) digital skills access, and 4) use access patterns. He argued that the success of each access stage is necessary for the next one to be achieved. The first condition is *motivation* to use digital technology. By acquiring motivation access, the challenge is to have the *material* to access technology; such as computers, internet connections, and locations to use them. Then if the user has the motivation and physical properties to use technology, the next step is to have the necessary *skills* to use it, such as skills linked to using computers or handling the content. The last step is the *use* of digital technology for certain purposes, whereas time and quality of use determine the use outcome. Van Dijk argues the success of each stage is dependent on resources' availability and user characteristics. He related the consequences of the use of technology by social participation, which in our research will refer to as social inclusion. The model has been argued to have advantages as it encompasses the extremes between 'have and have-not' as it emphasizes the situations where technology is present, and others argued (Rey, 2008) that this model is taking into consideration the users' relation to technology individualistically, with less emphasis on the geographical location, such as rural or urban. Nicolas (2003) added geographic capital that included the physical characteristics of the locations and their technological actions, and firms' policies.
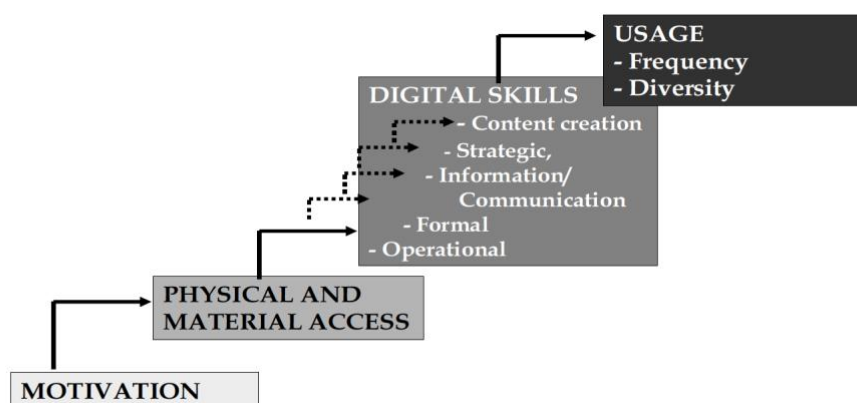
Figure 1 Four Successive Access in appropriation of Digital Technology, (Van Dijk, 2012, p. 61)

The literature has established the relations between offline (social) inequalities and online (social) exclusion (De Haan, 2004; Helsper, 2012; Robinson et al., 2015; van Deursen & van Dijk, 2014; Warschauer; 2004) With the emergence of knowledge society, e-inclusion has been defined, broadly, as social inclusion (Yu et al. 2018). Those who are with a higher-level engagement with digital technology enjoy the advantages over those disadvantaged (Robinson

et al.,2015). In digital divide debates, Waschaeur (2003) argued that for marginalized groups the purpose of ICT use is not to eliminate the digital divide but to accelerate the process of social inclusion. Many models and frameworks were established to investigate the socio-demographic determinants and their association with access components, these models revolved around components of attitude, skills, physical material, and technology (Bentivegna & Guerrieri, 2010; Bradbrook & Fisher, 2004; DenHaan, 2004; Helsper, 2008; van Dijk, 2005). Some investigated the digital divide from a multi-dimensional aspect. Van Dijk (2005) incorporated four types of accessibility through the model for successive access to digital technology. He conceptualized access to technology in a fourfold unit that encompasses four barriers, i) motivation access ii) material access iii) digital skills access, and iiii) use access patterns. He argued that the success of each access stage is necessary for the next one to be achieved.

2.2 Digital divide in municipal services

In the information age, digitalization has been identified as a process of every aspect of daily life being integrated with technology (Gray & Rumpe, 2015). The introduction of Digital Agendas, such as the EU Digital Agenda, stimulated the transition to digital public services and the introduction of e-government models, such as in the UK in the mid-1990s (AlMuwil et al., 2019) and the Netherlands Digital Government Agenda. According to European E-Government Action Plan 2010-2016, public services online delivery is a critical step to accelerate the government's digital transformation. Correspondingly, it has been vital to understand how society, organizations, policies, and ICT can fit together in an environment that is transforming digitally (AlMuwil et al., 2019).

E-governments services are "*online public services delivered by a government or semi-government (partnership) organization to citizens following the laws and regulations of a nation-state describing rights and duties*" (van Dijk et al., 2015, p.1). Similar to technology's impact on daily life aspects, the literature gave the notion that public services have had integration with technology in almost all of its functional aspects, administrative, provision of services, and communication general activity (Silvano, 2022). This recent development has been considered to bring information and services in a standard and cost-effective manner to the general public (Wang & Shih, 2008) and to facilitate the interactions between public administrations, citizens, and businesses (Silvano, 2022). However, Sorj (2008) explained that the extent to which public services are accessed through the internet tends to increase the divide between citizens who can access these services and those who are without access, and warned that the problem will exasperate with the mainstreaming of online public services. In relevance to e-government development, Wang & Shih (2008) contributed the problem of the digital divide to the difference in individuals' capacities to use new technologies, there is a risk to exclude some groups who have insufficient access and knowledge of technology, their representation will be eliminated, whereas the privileged others will be over-represented. Although e-government is instrumental for reducing inefficiency and bureaucracies, the universalization of internet access is not happening equally in the world, for instance, it will be a long process for developing countries, and it is argued to necessarily maintain offline substitutes of communications between public administrations and citizens (Sorj, 2008). The public services provision is based on the principle of social justice, which aims to overcome social disparities, nonetheless, the digitization of public services adds the risk of aggravating public services inequalities (Silvano, 2022). Over the last decades, literature has identified factors that influence citizens' appropriation of e-government namely, lack of skills, trust, cost, access, and disinterest (AlMuwil et al., 2019; Cruz-Jesus et al. 2017; Helsper 2008; Becker et al. 2008; van Dijk et al., 2015).

In the last twenty years, public services have evolved from conventional one-way operations to a communicative process involving the citizen in a two-way interaction between public agencies and citizens. It has been shifting from a supply and technical orientation side to a demand-side and social one. The primary aspect of e-public services is the challenge to reach every citizen. Some lack the necessary skills, attitudes, and material to access it (van Dijk et al., 2015). Some citizens are satisfied with the traditional way of service delivery and do not wish to convert to using a full digital service supply. A digital default policy pushes this group away from attaining services. Some groups prefer to visit the municipality's service desk because it is easier for them to request a service in person than virtually as some public services are rather complicated. After all, they follow the laws and regulations of the entity (van Dijk et al., 2015) so it is not conceivable that citizens would want an oral explanation. Transforming services to digital functions produces challenges for several groups of people. Nevertheless, while some countries are closing the access gap, some countries are still behind, with a majority of the population having no access to e-public services. Within developed countries as well, some groups face challenges to access e-public services, such as seniors, the poor, migrants with ethnic minorities, and low educated, including disabled persons (van Dijk et al.,2015). Some policy advisors call to maintain physical channels of interaction between citizens and government and to keep the traditional service delivery (AlMuwil et al., 2019). Having access to e-public services requires availability of certain digital skills. Van Deursen (2010) and van Deursen and van Dijk (2011) highlighted the skills barriers that deprive citizens from accessing e-public services. They identified that citizens need to have the skills to handle digital media, so-called 'button knowledge'. And formal skills, namely, navigation, browsing, finding the way to e-public platforms, and the skills related to content. These skills normally better formulated within the younger generation, and higher educated citizens, more than seniors, poor, and lower educated. In the context of the e-public service another barrier arises, citizens may need these skill sets are mostly needed to access other platforms and services, but for e-public services, citizens need to compass citizenship competencies. They should have knowledge about their national rights (van Dijk et al., 2015). Citizens with lower education and younger, have less knowledge about these rights. Higher education, middle-aged, and senior citizens perform better in these strategic skills on internet.

2.3 Conceptual framework

We adopted components of online inclusion models, and established our independent variables, the personal characteristics influencing access to digital technology, age, gender, education, income, race and ethnicity (AlMuwil et al., 2019; Bucea et al., 2020; Helsper, 2012; DeHaan, 2004; van Deursen et al., 2015; van Dijk, 2012; Robinson et al., 2015). to understand their influence on online inclusion, our dependent variable, through the components of van Dijk (2005) Successive Access model; the levels of motivation, material, skills, and usage access.
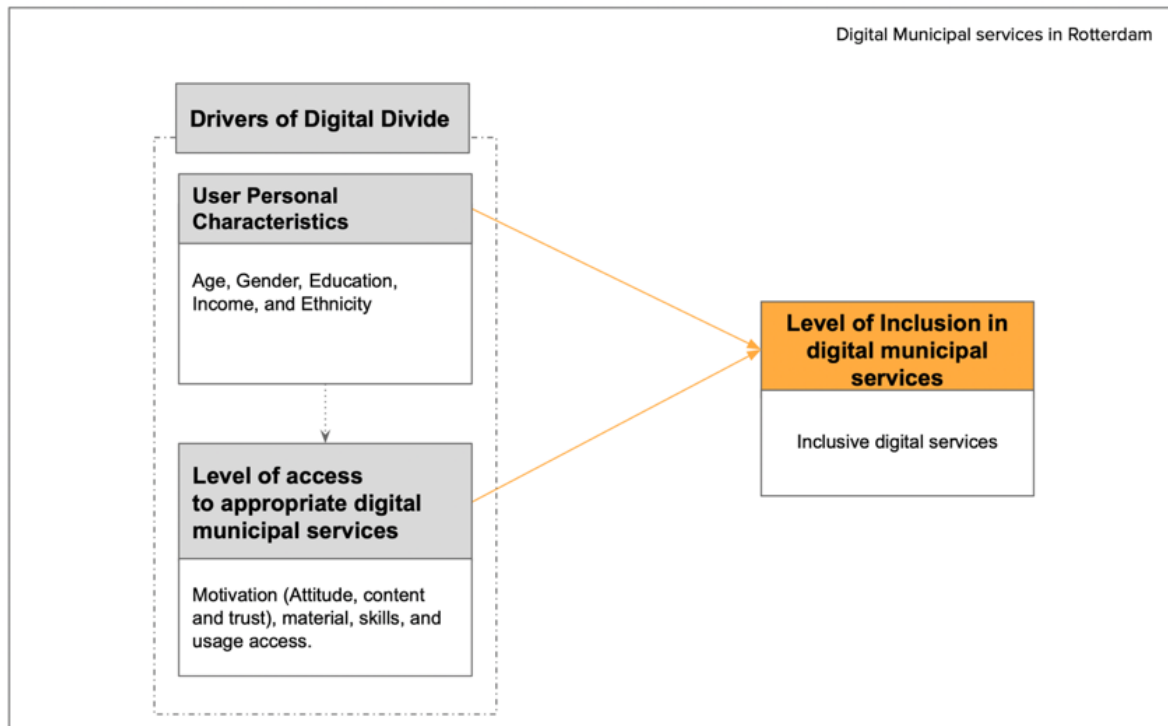

Figure 2 Inclusion in Digital Municipal Services, Author

Chapter 3: Research Design and Methods

Our research was designed as an inductive to explain digital divide in DMS. The research captures observation of digital divide through drivers of digital divide, personal characteristics, and level of access to DMS, explains the observation in accessing DMS by recognizing DMS access patterns among our sample, to develop an understanding of how different personal characteristics of users, such as age, gender, education, income, and or ethnicity, determine level of inclusion in DMS. To carry out our research design, a mix-method research approach was undertaken. Our study area in Charlois District, with a focus on Carnisse neighborhood, in The Netherlands. Qualitatively, through conduction of a survey on a random sample, generating a data-set to run logistic regression for our dependent and independent variables, to observe the personal characteristics that have a significant association with level of access to DMS. Through qualitative methods, semi-structured interviews, we explain our observations on how digital divide is perceived by users who have a lower level of access to DMS.

3.1 Research Techniques and Instruments

3.1.1 Research question

Overall research question: To what extent do users' personal characteristics determine level of inclusion in digital municipal services in Rotterdam?

Specific research question(s): To answer our overall question, the below questions will be investigated:

1. *What are the main personal characteristics that determine level of access to appropriate digital municipal services?*
2. *How do groups with lower levels of access experience digital divide in municipal services?*

Our research explains to which extent users have access to appropriate digital or smart municipal services through adopting the components of online inclusion as established in literature, for follow the model of van Dijk (2005), each stage in the model is investigated to explain the level of inclusion:

- **Motivation Access**
  The research explains to what extent users have a positive or negative attitude toward digital municipal services and how they perceive it in easing their attainment of public services, their perception of content, and their trust level in the municipality's online services.

- **Material Access**
  to explain the access and availability of physical material, to know whether users have the necessary material to access digital municipal services sufficiently.

- **Skill Access**
  Several skill types need to be investigated to explain how they facilitate the accessibility to digital municipal services. Van Deursen (2010) and van Deursen & van Dijk (2011) established different skills necessary to access technology explained in our research. Operational skills to handle digital technology, informational skills, to navigating and internet browsing skills to access information i.e., DMS and content-related skills.

- **Use Access**
  The usage of municipal services is investigated by explaining how users perceive their skills to benefit from DMS. Whether they have the willingness to improve their ability to better benefit from accessing DMS, their satisfaction with online service, the required help to use DMS, and frequency of use of e-government platforms, i.e., DigID, to understand their use pattern.

Furthermore, the level of inclusion is explained in conjunction with digital divide derivers: the extent to which users have access to appropriate digital municipal services is associated with their socio-demographic characteristics (Bucea et al., 2015; De Haan, 2004; Helsper, 2012; van Deursen et al., 2015; van Dijk, 2005; van Dijk, 2012):

(1) Gender
(2) Age
(3) Education
(4) Income
(5) Ethnicity

3.1.2 Study Sample

Our literature review showed disparities in digital services are attributed to demographical inhibitors. Higher educated and middle-income individuals have more advantages than lower education, poor, elder, and migrants. The research sample is selected for a neighborhood(s) in Rotterdam that encompasses the diverse demographical characteristics mentioned. Our target sample is Charlois District with a focus on Carnisse. A neighborhood in the south part of Rotterdam city, is inhabited by 11,849 persons (Rotterdam Municipality, 2022). In regards to determined size of sample, Yamane (1967) formula to calculate the size of our sample (N) was used, for the selected neighborhood, by following the formula: $n = \frac{N}{(1+N*e^2)}$. The sample size (N), as the total population, and (e) as the marginal error, calculating 10% marginal error. Accordingly, the sample size was determined:

$$n = 11849 \, / \, (1+ \, 11849 \, *0.1*0.1)$$

$$n = 99.16 \approx 100$$

The logistic regression analysis was intended for the quantitative part of this research, thus the sample had to meet the basic assumptions of our model, a random population with a minimum age of 18 years old. Also, as our survey is a paper-based method, we took into consideration that some answers would be incomplete, and therefore, more data was collected exceeding 100. Collected survey was 186. Variables of personal characteristics and access variables had a minimum of 100 observations, which meets our sample size, with an average age of 39.4 for males and 38.5 for females, and with slightly more females than males. As for the second part of our research methods, the qualitative sample, we conducted semi-structured interviews with 11 residents, of different group ages, gender, education levels, a migration background.

3.1.3 Research methods

The research concepts, variables, and indicators illustrated in Table 2 investigated by conducting a mixed-method research approach. Involving the collection of both quantitative and qualitative data through the following techniques:

- **Phase 1: Primary data collection**

1. Quantitative data
   a. Survey: through the research variables were investigated to provide data about the level of inclusion in digital municipal services. Socio-demographic inhibitors' variables. Paper-based survey collection was applied. Through a random population in the Charlois District, with a focus on Carnisse. The collected data was generated from the random population in the study area of residents and the passing population where survey was conducted.
      i. The survey has the purpose to point out the main characteristics of groups with lower levels of inclusion in DMS by analyzing characteristics associated with access variables.
      ii. 1/5 Likert scale approach was selected to assess the levels of access to DMS through statements intended to gauge level of access for motivation, material, skills, and use (see table 3).

2. Qualitative data
   a. *Semi-structured interviews* with a set of open-ended and closed questions. A random sample was drawn of different socio-demographic groups, selected for interviews to study on a deeper level individuals' experience and perception of DMS following the model we selected in our research. The interview questions revolved around variables of inclusion in digital municipal services from citizens' perspectives (see annex 2). Moreover, interviews with digital policy-makers at Rotterdam Municipality were conducted to establish the inclusivity of the digitalization policy from the supplier-perceptive (municipality). Data were transcribed and inputted to Atlas.ti program, and coded according to study variables.

- **Secondary data collection**

- *Desk Research* about the digital policy in the Netherlands
- *Descriptive statistics* from the Rotterdam Municipality portal about selected study area

3.2 Operationalization: variables and indicator

The table below summarizes from the literature the relevant concepts, variables, and indicators in which data collection was carried out to answer our research's main and sub-questions.

Table 2 Operationalization of Level of Inclusion in DMS, Author

Concept	Variable	Measurement unit	Indicator	Source
Level of access in DMS	Motivation access	Likert scale	- Level of awareness about services - Attitude towards digital services - Preference for online or in-person service - Trust in government platforms	Survey & Interviews
	Material access	Likert scale	- Have the necessary resources to appropriate e-municipal services	Survey & Interviews
	Skills access	Likert scale	- Perceived ease of use - Perceived ease of interaction - willingness to improve skills	Survey & Interviews
	Usage access	Likert scale	- Perceived ease of use - Perceived usefulness: - Gets the required help to use e-municipal services/ not - Use the e-municipal services frequently as possible / not	Survey & Interviews
	Digital Policy	Content	- Policy takes into consideration citizens needs based on their different socio-demographic characteristics, motivation and skills sets.	Literature & Semi-structured interviews with policy makers
Personal Characteristics	Gender	Nominal	M/F/O	Survey
	Age	Nominal-Absolute	Years of age	Survey
	Education	Ordinal (4 categories)	Educational level: Primary; Secondary; Undergraduate; Postgraduate	Survey
	Income	Ordinal (10 categories)	<1,350; 1,350-1,859; 1,851-2,359; 2351-2850; 2851-3350; 3351-3850; 3581-4350; 4351-4580; 4851-5350; >5350	Survey
	Ethnicity	Nominal	Native / non-Native	Survey

3.3 Validity and reliability

To ensure internal reliability; effective operationalization of variables into quantified data per study variable, we ensured a minimum of 100 independent observations for each studied variable, in accordance with the formula used to determine our sample size. Moreover, triangulation of data by meeting the minimum number of surveys, and semi-structured interviews, in addition to secondary

data, helps in enhancing the reliability and validity of the study. Furthermore, the design of the survey was conducted in a manner to ensure reliability, firstly, the survey consolidated existing methods, surveys, developed by other scholars such as Helsper et al. (2021), and academic institutions, such as the University of Twente (2022) published survey methods on measuring digital divide. Moreover, the survey was formulated by a group of 5 students from multi-disciplinary specializations, who worked on the digital divide research in Rotterdam each with a different focus, and that allowed our survey process to be peer-reviewed, ensuring reliability of our research instrument. Additionally, for more reliability of collected data, the printed-survey approach was selected, surveys were handed to residents at the selected study area after explaining our study purpose, to ensure their motivation of providing valid responses, on the contrary of online questionnaires that might reach potential respondents with low willingness and motivation to participate in the research (Van Thiel, 2014). Consequently, we were able to generate data from interested respondents, and thus the collected data is more valid. As well as data from interviews, participants showed interest in sharing their experience. Research instruments were tested before actual data collection. The survey was organized and tested to provide a logical flow and to be answered in no more than 10 minutes. Due to diversity of study population, the survey was in four languages; Dutch, English, Turkish, and Polish. The translated language was reviewed by a native person of each language. An interview guide was developed, pilot interviews were conducted beforehand with peers and strangers, and reviewed according to generated feedback. Our research independent variables, age, education, and ethnicity showed high statistical significance, a statistical validity of association with change in access variables. This statistical significance in our empirical study reaffirms those established in literature. Our research demonstrates external validity to generalize results to other municipal services in an analogous context.

3.4 Data Analysis methods

Survey collected data was cleaned and inputted into Stata program. In order to apply our research model, statistical analysis was conducted through logistic regression. Since our survey variables were mainly categorical, we firstly used Stata to create binary variables:

- Access variables on Likert scale 1/5 were converted to groups with ≤3 as 0 and groups with >3 as 1
- Access variables Yes/No were converted as 0 for No and 1 for yes
- Personal characteristics variables:
    - Gender: Male 0, and Female 1
    - Education: 5 categories of education, converted into 3 categories, 1 as basic education, 2 as undergraduate, and 3 as graduate
    - Income: 10 categories of income brackets were converted into, 0 as below or on minimum average income, and 1 higher than minimum average income
    - Migration background: non-native Dutch as 0 and native Dutch as 1

The variables were applied to a logistic regression model to gauge the level of association between the independent variables and dependent variables. The significance level between dependent and independent variables was recognized by the p-value of 0.01, 0.05, and 0.1.

Interview data were transcribed into a word-processed document, and inserted into Atlas.ti program, for coding according to our research variables, and further content analysis of the expressions and experiences indicated by interviewees, which also corresponds to our statistical analysis. All interviewees were identified by their initial and background status.

3.5 Limitations

The challenges faced throughout this study were mainly, the type of survey variables being ordinal, categorical variables, limiting the selected statistical analysis approach. The survey was collected in 4 languages due to the diversity of population; language was a challenge during data collection to freely and elaborately express the purpose of the study or to communicate with non-English speakers. As some respondents were not fully proficient in Dutch or English, a probability for some survey questions to be misinterpreted occurs, and also had some respondents take more time to answer the surveys, and to conduct the interview.

Chapter 4: Results, Analysis, and Discussions

Digital or smart Municipal Services "DMS", are part of digitally-driven urban development, the 'smart' new paradigm of urban development that in the last two decades has spiked serious concerns about digital divide in making services inclusive to everyone (Kolotouchkina et al., 2022). The provision of public (municipal) services is inevitably a means to suppress social inequalities, the digital transformation of municipal services is yet making these inequalities exacerbate (Silvano, 2022). The extent to which municipal services are accessed through the internet tends to increase the divide between citizens who can access these services and those who are without access, and this problem will exasperate with mainstreaming of online public services (Sorj, 2008; van Dijk et al., 2015). DMS are unlike e-commercial services, they follow rules and regulations of the institution and corresponding departments, which makes them more complex and sophisticated to translate to ICT. The Supply-oriented service neglects the demand side (Citizens), particularly disadvantaged groups. Those at the high-end of the digital divide: middle-aged and higher-educated, tend to have better chances to appropriate the digital municipal services than those at the lower end of digital divide: elderly, poor, lower-educated, migrants (van Dijk et al., 2015). The offline disparities are being reconfigured in e-government and public agencies' digital services (Robison et al., 2015). In this regard, our research presents an exclusive insight into digital divide in digital municipal services. We answer our overall and sub-research questions (section 1.4) in this chapter, our research data addresses how the digitalization of DMS is limiting some groups from accessing the services, we understand who are these groups by analyzing the characteristics of digitally excluded groups and their level of access to DMS, and we explore further how they experience this limitation through in-depth analysis of qualitative research methods, to answer how the digital divide persists through DMS. We looked into level of access to DMS through the access variables illustrated in (Table3). You will read in the next section the main findings drawn from collected data.

Table 3 Variables of Level of access in DMS, Author

Variable	Measuring	Survey 1/5 Likert scale; or YES/NO	Access Stage (van Dijk, 2012)
V1	Level of awareness about DMS	Most municipal services are offered online	Motivation access
V2	Perceived usefulness	I Find online municipal services useful in my daily life	Motivation access
V3	Level of trust: Safety of sharing information	I feel safe sharing my information online with municipality	Motivation access
V4	Preference over offline services	I prefer online services to in-person services	Motivation access
V5	Material availability	Yes/No: I have at least one device at home Yes/No: I have connection to internet in the last 30 days	Material access
V6	Ease of interaction	My interaction with DMS is clear and understandable	Skill access
V7	Willingness to improve ability	I would like to improve ability to access online municipal services	Use access
V8	Use pattern	Yes/No: I have DigID I have used DigID in the last 12 months	Use access

4.1 Representativeness of study sample

To understand the digital divide in digital municipal services, our research followed the Successive Access to appropriate digital technologies stages (van Dijk, 2006) and the variables that research has established to contribute to citizens' appropriation of e-government, or public, services, such as trust and content relatability. Accordingly, our research explains the digital divide in digital municipal services by investigating citizens' appropriation level of digital services of Rotterdam Municipality in the Netherlands. Our research was designed to target the population in the south part of Rotterdam, which shows a larger percentage of diversity in age, gender, education, and ethnicity. The first part of the research methodology is to get insights into digital exclusion through surveying citizens in the targeted neighborhoods. 100% of the surveys were distributed in person, 186 respondents were generated, and the survey contained various aspects (Annex 1). 179 respondents provided their gender, 79 male and 101 female between the age of 18 and 99. As described in our research methodology, the survey aimed to investigate digital exclusion through a fourfold aspect of access; motivation, material, skills, and use, against the drivers of the digital divide; age, gender, income, education, and ethnicity. The survey assessed level of access to appropriate digital technology through a 1/5 Likert scale for 8 variables (Table 3). The lens of access and demographics has helped us to observe how digital divide endures among citizens in DMS. We hereunder present the associated socio-demographical inhibitors to DMS and the observed disparities between citizens.

4.2 User characteristics determinants to access DMS

To highpoint the characteristics that influence level of access to DMS. We ran a probit regression; accordingly, we first tested the following assumptions of our model:

Assumption #1: Dependent variables should be categorical: our model's dependent variables are categorical. Access variables all have a group of 0 and 1 which confirms that all dependent variables are categorical (see Annex 3).

Assumption #2: Next, we test the assumption for observation independence: each variable response confirms different respondents in the sample. There was no repetition in data per respondent, and there is no repetition of survey code.

Assumption #3: Data shows no multicollinearity: our model has no multicollinearity. None of the personal characteristics' variables are highly correlated, the correlation of personal characteristics is lower than 0.5 across all variables (see Annex 3), which confirms that there is no issue of multinuclearity in our research model.

Presented in Table 4 output of marginal effects (dy/dx) between personal characteristics (X) and access variables (Y). Fittingly, we present in the coming subsections the main personal characteristics that determine digital divide in DMS. Our analysis presents the variables with statistical significance level at 0.01, 0.05, and a minimum level of 0.1, and by holding other factors constant.

Table 4 Probit regression results of personal characteristics and variables of access, Author

	Awareness	Preceived Usefulness	Saftey sharing information	Preference of services	Material access	Ease of interaction	Willingness to improve	DigID access
	(V1)	(V2)	(V3)	(V4)	(V5)	(V6)	(V7)	(V8)
Age	-0.00421	-0.00810***	-0.00549*	-0.00408	-0.000861	-0.00634**	-0.00435	-0.000597
	(-1.47)	(-2.72)	(-1.90)	(-1.26)	(-0.59)	(-1.96)	(-1.30)	(-0.38)
Gender	-0.0339	0.0805	-0.0111	0.121	0.0184	0.121	0.0437	-0.0113
	(-0.45)	(0.98)	(-0.12)	(1.42)	(0.37)	(1.44)	(0.50)	(-0.23)
1.Education	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2.Education	0.319***	0.253**	0.151	0.238**	-0.00395	0.140	0.156	0.0748
	(2.93)	(2.14)	(1.25)	(2.24)	(-0.08)	(1.15)	(1.34)	(1.46)
3.Education	0.360***	0.273**	0.120	0.175	0	0.00946	-0.0694	0.0721
	(2.83)	(2.15)	(0.93)	(1.57)	(.)	(0.07)	(-0.58)	(1.02)
Income	-0.146	-0.0472	0.0121	0.0355	0.0700	0.0431	-0.143	0.0997*
	(-1.60)	(-0.51)	(0.13)	(0.38)	(1.33)	(0.46)	(-1.53)	(1.92)
Migrant_ Status	-0.0998	-0.181*	-0.0176	0.265***	-0.0687	-0.246***	0.271***	-0.0774*
	(-1.25)	(-1.89)	(-0.17)	(2.75)	(-1.57)	(-2.66)	(2.76)	(-1.92)
N	117	122	125	122	100	122	119	139

t-statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01

4.2.1 Age

As established in literature, digital divide is considered an age matter (Huet, 2002) and a strong driver for appropriating digital technology among generations; the digital natives and the digital immigrants (Ballano et al. 2014). Older groups have a lower attitude toward technology (Huet, 2002; Helsper, 2007; van Dijk, 2006), circumstantially, the older groups have a lower attitude towards appropriating digital municipal services. In the first stage of access, motivation access is observed to be negatively associated with additional score points of age. On an average, in a 10 years threshold, probability to perceive the usefulness of DMS decreases by 8% score points for older groups. We can also observe a lower trust level in DMS among older groups; the probability of sharing information with the municipality online, decreases by 5% score points, compared to being 10 years younger. Trust is an important factor in e-public services, citizens with lower interest and trust tend to appropriate e-public services less (AlMuwil et al., 2019), this lack of trust is referred to as motivational access (Fuchs, 2009), hence, the older groups who have lower interest and trust levels in digital services are observed with lower access levels to DMS. Conversely, all groups have material access to digital devices and internet, however, we notice a lower pattern of preference for online services associated negatively with age. Preference for in-person municipal services can be referenced to the overall lower attitude towards technology among older groups. Equally, they favor in-person interaction. Older groups are observed in literature to have a lower digital skill level, which can

hinder accessing DMS. Groups with lower skill levels cannot equally benefit from DMS as younger and more skilled groups. On average, being 10 years older, probability of perceived easiness of use decreases by 6% score points, showing a pattern of facing more difficulty in using DMS than younger groups. Known as a 'generational rift', digital natives and digital immigrants (Bucea et al., 2020), the older groups need to adapt and acquire digital skills, while younger groups are digital natives. Older groups might have operational skills to operate a computer or access internet, but they have less informational and strategic skills to use techniques to search and identify the right information (van Dijk, 2005). Reaching DMS information online and managing it, is more of a complex activity that older groups are less fluent at, presumably, limiting their ability to access and use DMS.

> "*We have a voice, and we have brains, we are not machines, the best way to help people is to talk*"
>
> *(I. Retired Dutch, personal communication, June 17, 2022)*

> "*Why would I need to use conventional services if technology can provide the alternative?*"
>
> *(A. 27-year-old Working migrant, personal communication, June 14, 2022)*

4.2.2 Gender

In digital inclusion research, scholars have expressed disparities between the two genders, men were found to use the internet more often, or for more advanced purposes than females (Cooper, 2006; Meraz, 2008; van Deursen & van Dijk, 2014). Men were found to have a higher attitude toward technology (Whitley, 1997). Nonetheless, in our research, digital inclusion in municipal services has slightly different findings in terms of gender and access to digital services. Our sample has an equal representation of men and women, with a few more women than men. Although men were considered in literature to be more advanced in appropriating technology, in our analysis, gender shows no statistical significance for accessing DMS. In literature, men were considered to have an advantage over women in access to ICT due to associated superiority in workstyle and education. Notwithstanding, our model does capture education and income levels, the data has shown no statistical significance for any pattern in appropriating DMS by the two genders. To understand this observation, we conducted in-depth interviews with both genders to look into their experience in accessing DMS which we elaborate on in section 4.3.

> "*I am a man with passion, I do not like to hide behind technology*"
> (C. Retired male immigrant, personal communication, June 12, 2022)

> "*At the beginning, it was difficult to know how to start communicating with the municipality, what should I do to get online?*"
> (J. Female non-working migrant, personal communication, June 20, 2022)

4.2.3 Education

The level of activities online in literature has not only been reasoned to gender but also to level of education. Education attainment is a core predictor of users' activities on internet and the type of activities they engage in (van Deursen et al., 2015). A similar observation reoccurred in our analysis. We looked into 3 levels of education, basic, undergraduate, and graduate education. Education level has a significant association with access to DMS (Table 4). For motivation access, in comparison with basic education, on average with an additional degree, people with undergraduate degrees (Education 2) have 32% more probability score points to be aware of DMS. And graduate education groups (Education 3), have a probability of being more aware of DMS by 36% score points. Moreover, education is noticed to have a significance in citizens' perception of digital technology, the more a person has educational attainment, the more probably to positively perceive the usefulness of digital services. On average, the probability of perceived usefulness of DMS by having an education degree increases by 27% score points, among the highest education groups. DMS motivation access is positively associated with education, as we see in Table 4, with an additional degree of education, from basic to undergraduate, on average, the probability of having a preference towards online services over in-person increases by 24% score points. This trend in our model can be attributed to two reasons, (1) more respondents have responded to have graduate degrees, and (2) higher educated groups have older age, thus lowering the probability to favor in-person services. In the second stage of access, material access is statistically insignificant, all respondents have access to the internet and at least one device. In the third stage, education showed a statistically insignificant relationship with skills to access DMS, the perceived easiness of use was not statistically associated with education level, as well as in the fourth stage of usage access, willingness to improve ability to use DMS. According to Table 4, education has more significance on citizens' motivation access.

4.2.4 Income

Income is recognized as a prominent determinant of digital divide. Researchers found a positive relationship between the level of income and the adoption level of internet and technology (Bucea et al., 2020; Livingstone & Helsper, 2007; van Dijk, 2005) groups with higher income levels were considered by DiMaggio et al., (2004) to possess better ability to use internet effectively and productively. In the context of our research model, income has no statistical significance on motivational, material, or skills access, on the other hand, in usage access, the model shows. On average, for an additional income bracket, the probability of using DigID increases by 10% score points. We can see a pattern among groups who have more income to be more engaged in usage of digital services, such as e-government gateway DigID than lower income groups. Lower-income groups have fewer opportunities to use internet and technology productively (DiMaggio et al., 2004) citizens who have lower income have less opportunity to use DMS as they tend to use internet for less advanced and productive purposes than higher-income groups. We only see a statistical significance in access to DigID. Furthermore, the statistical insignificance between income and access variables (V1-V7) can also be reasoned to data limitation. Available data on income was collected through an ordinal scale of 10 categories, we asked respondents to indicate "what is your average household gross monthly income?", taking into consideration that not all respondents were fully proficient in English, nor Dutch, or with different levels of education, this question might have been misinterpreted, some respondents might have answered this question as average individual gross monthly income, the data showed a distribution of respondents in lower and highest brackets of income, between basic income bracket €13850-€1850 and highest bracket >€5350. We converted this

variable to binary, as 0 basic salaries, and 1 above basic salary. Due to possible misinterpretation of the question, the data collected might not provide statistical significance. However, we investigated if income is a driver of digital divide in DMS through interviews. Further elaborated in section 4.3.

"*It is difficult for me to use the digital services, even if I try and make a mistake, I don't know how to explain it in order to ask for help*"
(R. Working Immigrant, personal communication, June 19, 2022)

4.2.5 Ethnicity

Our sample registered 26 different nationalities. In a multicultural society, social groups share needs and values, particularly ethnic and racial minorities (Robinson et al.,2015). Differences in use of technology by social groups have attribution to reduction and magnification of social disparities (Chen, 2013). Our model analyzes native and non-native groups' level of access to DMS. Having a migrant background has a significant association with level of access to DMS (Table 4). In motivation access, compared to being Dutch, on average, having a migration background, the probability of perceiving DMS useful decreases by 18% score points. The perception of DMS differs between natives and nonnatives, as they could differ in their lifestyles, values, and needs. On the other hand, having a migration background, the probability to prefer online services over in-person services increases by 26% score points. Citizens who have a migration background can have a lower level of the Dutch language, which lowers their motivation to use in-person services due to communication barriers. Municipal services are normally in the country's native language. Choosing to access the service online can help migrants with a lower level of Dutch to use online tools such as translation, to understand the service with less language barrier. In the second access stage, material access is also non-significant as all respondents have access to internet and at least one device. In skill access, we observe that on average, being with a migration background, the probability to find DMS easy to use decreases by 25% score points. This observation can be complementary to a language barrier, as groups with migration backgrounds have lower Dutch language could be limiting. Conversely, for the fourth access stage, usage, groups with migration backgrounds tend to have more willingness to improve their ability to use DMS. Compared to being native Dutch, on average, being with a migration background, the probability to have the willingness to improve the ability to access DMS increases by 27% score points. Citizens with migration backgrounds show a pattern of higher interest in improving their ability than native groups. Additionally, having a migration background the probability of using DigID decreases by 8% score points. Non-native groups have a lower possibility to benefit from digital services through using e-government platforms DigID than native groups. Unsurprisingly, non-native groups find DMS to be difficult to use, and thus lower their possibility to appropriate and benefit from it.

"*My Dutch language is sufficient, yet the language of the municipality is difficult, when I use the services online there is no one who explains what is required*"

(N. first-generation migrant, personal communication, June 26, 2022)

"*I am a native Dutch; I sometimes don't understand what the city writes to us*"

(J, Retired Dutch, personal communication, June 18, 2022)

4.3 Citizen-perspective of DMS

Through the survey, we investigated different groups of citizens with variations in levels of access to appropriate DMS. In this section, we provide deeper insights into how these disparities are experienced by digitally divided groups. Eleven residents were interviewed from different age groups, gender, economic, and migration backgrounds, to explicate how they experience exclusion and what is their perception of their access to DMS. Table 5 illustrates an overview of the interviewees.

Table 5 Overview of interviewed citizens in Rotterdam, Author

Interviewee	Gender	Age	Migration Status
Interviewee **T**	M	80	Retired Native
Interviewee **J**	M	75	Retired Native
Interviewee **I**	F	73	Retired Native
Interviewee **C**	M	68	Retired migrant
Interviewee **A**	M	63	Refugee
Interviewee **R**	M	50	Working migrant
Interviewee **O**	F	42	Second generation working migrant
Interviewee **J**	F	43	Non-working migrant
Interviewee **N**	M	41	Non-working migrant
Interviewee **H**	F	38	Working migrant
Interviewee **A**	F	27	Student and Working migrant

We recced throughout semi-structured interviews (see annex 2) the nodes and ties of level of inclusion in DMS, to understand interviewees' experience and perception of DMS. On average, interviews with digitally divided groups lasted 22 minutes. Figure 3 depicts a cluster of impressions and words mentioned by interviewees when we ran interviews' content on Atlas.ti program. The bigger and bolder words, the more often citizens articulated during the interviews. Citizens expressed digital divide through the words: language, problem, information, services, time, phone, internet, devices, website, and help. We see how these words, actually, build on each other. Citizens reach out to the municipality and try to look for the services online, if they have the material (**smartphone, laptop, computer, tablet**) to do so, then they encounter different **challenges**, **language**, **information** availability, difficulty in interacting with services' **online content**. A feeling of unease with **sharing** personal **information**, they are not fully comprehending how to manage the municipality's portal and **website**. When **problems** occur, citizens seek **help**, they revert to the municipality to inquire for help, or they look around in social organizations or centers in their **neighborhood**. Some look for help in **libraries** as well, or in **theaters**, thus, it takes more time to have their **needs** addressed. The experience with DMS is unique to every individual, yet, after eleven in-depth interviews, somehow, we were able to notice a pattern among groups of different ages, income, gender, and economic or migrant backgrounds. Some responses became repetitive in terms of challenges experience, perception of DMS, and how to handle DMS, our sample, therefore, was saturated. On the other hand, we conducted three in-depth interviews with public servants from the Municipality of Rotterdam "RDM", who engage in digital policy-making and implementation, to study how DMS policy is contributing to level of inclusion in DMS. In the forthcoming section, we present an elaborated analysis of these interviews.

Figure 3 Word cloud cluster of interviews with digitally divided citizens, ATLAS.ti

4.3.1.1 Motivation access:

In Rotterdam, almost every citizen is aware of the municipality's services offered online. they might not know all the detailed services, but they have the minimum awareness level of their availability. The city of Rotterdam has been working on transforming its services to digital or smart services for more than 15 years. During this period, the city has been aware of the disparity of use among citizens depending on citizens' digital skills levels. The municipality has tried to take into consideration the divergence in skills level among citizens, yet, the municipality recognizes that it is a 'wicked problem' (B. RDM, personal communication, June 29, 2022). The DRM in Rotterdam was led by a city's vision for becoming pioneering in smart services, which in turn, drive and accelerate the municipal digital transformation and service re-innovation processes. Nonetheless, on the demand-side of the process, citizens are directly affected by these decisions, especially the less advantaged groups who bear the consequences of new innovations that can create new inequalities. While the city is transforming into a smart city, citizens of Rotterdam are grouped as those at the higher spectrum of the digital divide; those with higher educated, skilled, and often middle or younger age, who are pursuing the 'new smart' city paradigm in their attainment of public services. While others are on the lower spectrum, those with lower-education attainment, skills level, elder, and with migration background, who are struggling to keep up with this transformation, or even lack the motivation and attitude to use the city's digital services. Citizens on the lower spectrum vary in their characteristics. The older groups, the digital migrants, normally above the age of 60, have lower attitudes toward online services, they prefer human interaction, to communicate their wants verbally "*we have a voice, and we have brains, we are not machines, the best way to help people is to talk*" (I, Retired Dutch, personal communication, June 17, 2022). The older groups believe that taking out the human factor in interaction between the municipality and citizens has been introducing an imbalance among society members, "*the problem is that we stopped talking, how can a computer understand what I want*" (C. Retired migrant, personal communication, June 14, 2022).

4.3.1.2 Material access:

Our recent study reasserts the material access gap has shrunk to almost the minimum. 95% of citizens have access to at least one device, such as a mobile, laptop, or tablet, or have internet access where they live. Most citizens at the lower end of DMS have access to digital material and use their devices and internet daily. The elder groups perceive owning a device expensive to maintain as it can crash, more difficult to fix, and more expensive to own. Generally, the older groups perceive a lower attitude toward appropriating digital technologies for activities in their daily life. But that's not the ultimate fact, the majority of the older generation are not anti-technology, on the contrary, they access the internet, technology, and social media daily for different purposes, mostly entertainment and watching the news (van Dijk, 2011). For example, regularly, the older groups use their digital device i.e., tablets, to watch TV programs and channels, "I have a subscription for TV channels on my tablet, this is what I need my device for" (J. Retired Native Dutch, personal communication, June 14, 2022). The middle and young-aged groups use their smartphone most often to look for digital municipal services over the internet, they use keywords of the service they are looking for and insert them into the search engine. On the other hand, the older group does not favor using smartphones to look for services, "*I can't do it [look for DMS] with a smartphone because the screen is too small (…) and I've got an iPad, but when I do something or it doesn't do anything I don't know what to do*" (I. Retired Native, personal communication, June 17, 2022).

On average, the groups over the age of 80 do not own any device. The municipality works toward increasing the material access level, it has a registry of residents with lower income, education, or less advantaged backgrounds. The municipality has 33% of this population registered in its system, while 7% of this population is recognized to have no means to connect digitally with the Municipality (M. S, RDM, personal communication, June 27, 2022). The groups at the lower end of DMS tend to browse the internet to look for the municipality's numbers or to look for a contact to call and request help, "*citizens who cannot access our services online, are commonly capable to reach our website and look for a phone number*" (E.RDM, personal communication, June 24, 2022). As well as the younger generation who share the struggle, "*I try to solve everything I want by myself, but at the end, I reach out by phone*" (J. Non-working migrant, personal communication, June 20, 2022). Availability of offline alternatives is important to support groups with a lower level of access. However, phone (call-center) support has its limitations. Citizens have to wait on phone line for a longer period to be administered to the right personnel from the municipality, which sometimes can take more than half an hour. Also, citizens referred they feel about the information given over the phone is not fully corresponding to their inquiries, most of the time, they have to schedule an appointment and go in person to the citizen service center.

4.3.1.3 Skills access:

After citizens have acquired the motivation to appropriate DMS, and have the material to access it, one would need to have the digital ability to learn and manage DMS as to benefit from it. Skills required to access DMS can be associated with one's experience with similar software, or have the social network to observe others who use it, or the ability to learn how to use it independently. Other material access, such as laptops, smartphones, computers, or the internet, do not necessarily mean they require the same skills level, to access DMS. Those who use digital devices do not necessarily acquire the required skills to access DMS. When we compare citizens' ability to access other means of media, such as for entertainment and work activities, most of them have a minimal level of operational skills with digital devices. In the context of

DMS, users need unconventional skills to appropriate DMS. The DMS is more complex in its nature because they follow rules and regulations of the public entity and the processes followed across its departments. In this regard, we addressed from literature the different types of digital skills that enable citizens to access e-service. And we investigated how these skills influence the level of inclusion in DMS. Besides *operational skills*, digital skills consist of *information skills*, one with the ability to search, select, and process information (van Dijk, 2005), which is important for accessing DMS, they require knowledge of the municipality's service and its terms. DMS content plays an important role for citizens to reach and process the right information. Also, *strategic skills*, are the capability of citizens to use the available sources for certain objectives for their benefit to improve their life situation. In our recent research, the digital skills divides were perpetuated in two main areas, the perception of DMS content by users, and the perceived ease of interaction with DMS.

The divides in accessing DMS are related to services content, not all citizens have the adequate level of informational skills to handle DMS. Both genders, female and male, face challenges to access DMS. Not only does age influence citizens' ability to learn to manage content. Generally, groups with lower-level of operational skills and information skills face difficulty to learn to use DMS. The frequency of the use is an important aspect. Citizens use the internet daily which helps them to maintain their skills level to manage it every day, but in the case of DMS, the exposure level is low, and citizens do not need to inquire about a public service every day, thus, the probability to gain a 'learning by doing' skill is small. "*They can tell me once what to do, but later when I need to do it again, by myself, I will not now, again*" (A, working-migrant, personal communication June 19, 2022). Language is another challenge of DMS content. There is a consensus among respondents about DMS language difficulty level. Native Dutch expressed the same struggle. Citizens in Rotterdam consider DMS content language very difficult. The municipality uses 'technical' terms that are not commonly used by internet users. Citizens are not regularly exposed to the terms used in public sector and its formal communication style. Unfamiliarity creates anxiety levels and fear of learning. Citizens cannot manage uncertainty online or offline. They face the same experience when receiving a letter from the municipality on their door. It could be a simple notice, for example, a notice about closing a street for construction, but the language difficulty creates fear of uncertainty. "(…) *this gives me so much stress, I feel anxious when I receive a letter from the municipality and do not know what to do*" (N. non-working immigrant, personal communication, June 26, 2022). Citizens have to investigate the purpose of the communication. This experience contributes to their overall perception of communication with the municipality. With more dependency on digital communication, citizens believe that citizen-and-municipality communication is becoming more difficult. For citizens to have the digital skills to access DMS, they are challenged to overcome the language barrier and acquire the information skills to take benefit from the services. Overcoming the language barrier is not the ultimate solution. The information skills divides have a deeper foundation in society. A multicultural city like Rotterdam with more than 170 different spoken languages (E.M, RDM, personal communication, June 24, 2022). A big segment of the society has a non-Dutch mother tongue, especially the first generation of migrants who have to interact with DMS. These groups have a lower level of English and an intermediate level of Dutch, and expressed facing difficulty to find the right words to look for DMS over the internet, and ability to handle the information flow in the DMS interface because of the complexity of the language, "*It is not enough to look translation on my mobile if I don't know what these words stand for*" (H. First-generation working migrant, personal communication, June 29, 2022). However, having a sufficient level of Dutch is less likely to eliminate the difficulty of DMS content when citizens are not fully acknowledged of public services terminologies, rules, rights, and procedures. Furthermore,

content is experienced by how services are designed. DMS are uniquely supplied by the municipality as service provider, unlike for-profit services that have many competitors, which gives users the liberty to switch between providers that suit them better. Citizens only interact with one DMS provider and cannot change if they face any barriers. On the contrary, they look for external help. As technology changes worldwide, at a fast pace, DMS changes as well, and thus, "*the Municipality looks for ways to continuously enhance its service experience*" (E.M, RDM, personal communication, June 24, 2022). With the re-innovation of services, access challenges for lower-skilled citizens persist. They are unable to build a learning experience to use DMS when it changes from time to time, they look for help again, to learn how to use it.

The longstanding digital skills divide is about users' ability to operate and benefit from the internet, computers, or any devices (Warschauer, 2004; van Dijk, 2005) and less mentioned about the digital divide that occurs because of the incapability of the system to keep up with technological development. Digital divide research only focuses on internet users, the research has less established the divide from the supply-side, in DMS context, the municipality. The municipality is very dependent on its personnel, who as well have different levels of digital skills, influenced by the same factors, age, gender, education level, and attitude towards internet, as well as the type of proficiency and experience with technology. The innovation in municipal services creates inequalities among personnel who have lower skills and attitudes towards new digital services, thus, they are unable to deliver the necessary help to citizens "*we need to come to a balance between the municipality's personnel who work directly with citizens and developer who design the digital services, we need the developers to see what the personnel see*" (E.M, RDM, personal communication, June 24, 2022). And on the same hand, citizens need to be engaged in how the services should be developed "*The people who build the service only talk with computers, they need to talk to us citizens to know what we want*" (I, Retired Dutch, personal communication, June 17, 2022).

4.3.1.4 Usage access:

The full appropriation of DMS is in usage by those who have the motivation, need, material, and skill levels to use it and benefit. These preconditions are not necessarily sufficient for citizens to appropriate DMS. Some might have the motivation, the tools, and digital skills, but they lack the language or lack trust to use the service. Citizens who have a low level of access to DMS, have a low-frequency rate to use DMS in general. They look for alternatives. The older age group and middle age group look for help in their neighborhood, they contact the social organization and request in-person help. For instance, first-generation migrants have the support of a social organization for 2 years upon their arrival, during that period, they refer to them for help with accessing the municipality's services, explaining the information, and taking advice on what to do. Other citizens seek other intermediate services.

4.4 Discussions

In the study of digital divide in municipal services we look at two-sided phenomena, the demand-side of services, the citizens, and the supply-side of digital services, the municipality. This relationship is unique in its context, it studies a service offered by an exclusive supplier of a civic service that intrinsically is to elevate social justice (Silvano, 2022). According to literature, personal characteristics such as age, gender, education, income, and ethnicity are the influential to determine digital divide (Bucea et al., 2015; Helsper, 2012; De Haan, 2004; van Deursen et al., 2015; van Dijk, 2005; van Dijk, 2012, Robinson et al., 2015, AlMuwil et al., 2019). However, from these characteristics, in the empirical work performed in this research, age, education, and migration background showed to be the most influential and statistically significant. The excluded person is more likely to be older, have a lower education level, and have a migrant background. For the case of DMS in Rotterdam, Gender and income were not found to be statistically significant in the regressions. Gender was neither found significant determinant of digital divide in interviews, both experienced digital divide equally. Nonetheless, income was significant among older people because it limits the conditions of material accessibility. Older or retired groups have limited income, they consider owning a smartphone, laptop, or computer expensive, and costly to maintain, and a smartphone is not applicable to use for DMS because of display challenges on a small screen. Income is an issue as well for the older group in looking for external help as it entails extra costs for accessibility to intermediate services.

From the components of access (motivation, material, skills, use), material access was not found to be an issue in Rotterdam, as almost all participants declared having at least one device, and internet, regardless of their personal characteristics differences. In regard to age, consistent with literature, older groups were found to be less motivated to use DMS, reflected in less perceived usefulness, and diminished safety of using digital services. Older people are also found to perceive bigger barriers to interacting with DMS due to a lack of digital skills. People who are older have been found to have lower attitudes towards technology, usually preferring in-person interactions (Huet, 2002; Bucea et al., 2020). Older people prefer human interaction, which reinforces their preference for in-person services, and therefore its exclusion in terms of being digitally divided. For older groups who only have income from social services, acquiring material access is expensive, and even when owning a device, it is not necessarily in conditions to provide a comfortable experience of usage. This shows how merely having or not having material access is not a very fit indicator for usage. Many participants also commented that DMS content often changed, not allowing them to get familiar with the service, which they already have reduced skills to make use of. The rapid pace of new technology emergencies and adoption in DMS is restricting some groups from accessing it. Learning to use a complex service such as DMS entitles sophisticated skills and a user learning journey, and requires a longer period for lower-skilled groups to learn it and adopt it. The municipality aims to stay on track with technological development and thus the DMS is in continuous change and development to adopt the newest technology. On the other hand, users with lower motivation and skills access levels are unable to build knowledge on how to use it, the constant change in services enforces a skill divides loop. Digitally divided groups thus need to pass the four stages of access with every new update on the technology. This case raises the question of whether the cost of technology becomes greater than maintaining in-person services. An interaction that allows a people-to-people approach is favored, as the challenge is incurring errors in the communication is less than in interacting with a digital medium that is designed in a standard way.

In terms of education, people with lower educational attainment were found less likely to be aware of the variety of DMS and to perceive DMS as less useful. Scholars attribute this to education being associated with the performance of more sophisticated activities online (DiMaggio et al., 2004; van Deursen et al., 2015; Bucea et al., 2020). People with lower educational attainment were also found to have less preference for digital services over in-person services, because DMS is complex content, therefore they may have greater difficulties in making use of them. Education level per se was not found to restrict users from usage of digital devices. Most interviewees including people of lower educational attainment use digital services on a daily basis to perform work tasks. However, the level of education can be related to restricting the types of activities they can or not do on the internet. DMS was described to be complex to use, or difficult, which is why people with lower education perceived more difficulty in interaction. Finally, migrant background was found to be significant also across various variables. Often attributed to the fact that migrants tend to be marginalized (Robinson et al., 2015; van Deursen et al., 2015) They are less likely to perceive the usefulness of DMS than non-migrants, However, they prefer digital services to in-person, probably because of language barriers at engaging with staff from municipality, and less awareness on how to reach out or where to go to be assisted. People of migrant background were also found to encounter bigger difficulties of interaction, but higher willingness to improve their digital skills. This can be attributed to an intrinsic motivation to integrate into the receiving society, for which they need to make use of these

DMS. From the interviews, it was observed that because DMS is only offered in Dutch, language and content-related skills are the main barrier to usage. For more recently settled migrants, sorting out the processes of the municipality and bureaucracy with which they were unfamiliar also represent a barrier. Because some migrants expressed not understanding the information given in in-person services or perceiving in-person attention as bad quality service, it could explain why they prefer digital service, in which they can rely on longer established migrants and networks for help or use other applications as a translator to navigate the information, despite of the difficulty that language represents for them. DMS was perceived to be difficult to use because content and service are frequently changing, and language-wise is not available to the variety of users found in multi-diverse contexts such as Rotterdam. From the interviews with municipal officers, it could be inferred that not enough work has been allocated to collecting feedback from users during the design and prior launch of the DMS. Also, that sometimes municipal hierarchy distorts the design of the services, which without feedback from the users may result in the service not being user-friendly to lower-skilled groups. Given that the Municipality is the only supplier for these services, it is important that the difficulties of a variety of users are acknowledged, as people unable to use these services cannot opt for other digital alternatives.

Chapter 5: Conclusions

Municipal services are a civic service, a means to suppress social inequalities, yet, the digital transformation of municipal services is nevertheless making inequalities exacerbate (Silvano, 2022). The rapid digitalization pace in our world is eluding larger groups, those digitally disadvantaged by technology (Robinson et al., 2015). The extent to which municipal services are accessed through the internet tends to rise divides between citizens; who can access services and those without access. Aggregated literature established divides emerging among those at the higher end of digital divide: middle-aged and higher-educated, tend to have better chances to appropriate technology much more than those at the lower end of digital divide: elderly, poor, lower-educated, and migrants (van Dijk et al., 2015). In digital municipal services, some are benefiting from technological innovations in municipal services, while others are being pushed behind.

There are several personal characteristics identified in literature to determine digital divide, such as age, gender, education, income, and ethnicity (AlMuwil et al., 2019; Bucea et al., 2015; Helsper, 2012; DeHaan, 2004; Robinson et al., 2015van Deursen et al., 2015; van Dijk, 2005; van Dijk, 2012). However, in the context of DMS, age, education, and migration background show a highly significant association with digital divide. **Age** has a protruding influence on users' level of attitudes toward DMS. In the first stage of access, motivation, older users have a tendency to prefer personal communication with the Municipality, regardless of services' availability online. Older groups have less perceived usefulness and lower interest and trust levels in adopting DMS', and higher value for 'human interaction'. **Education** attainment influences citizens' level of motivation access, the more education a person has, the more motivation to appropriate DMS. Although the material gap is relatively small, owning a device does not automatically grant access to services. DMS requires sophisticated digital skills due to its complex nature. The main aspect of skill divides in DMS is the content-related skills, specifically in Rotterdam, skills related to language due to its multicultural context. **Ethnicity,** as well, having a migration background reinforces difficulty in engaging with sophisticated content. Users with migration backgrounds do not necessarily lack the informational skills to use digital technology, rather they lack the language skill to use it independently. Non-native groups have lower usage patterns for e-government platform, DigID. Conclusively, non-native users have more willingness to improve their ability to use and benefit from DMS, a prospect of interest in integrating into local society, while natives do not share this pre-interest.

Besides the language barrier, users are challenged by the continuous change in technology and innovation in DMS, limiting lower-skilled groups from acquiring the "know-how" to appropriate DMS, given the constant change and fast pace of technology emergence and advancement in service. This vicious cycle eludes some groups from accessing DMS, a focus on technology rather than the user 'human', reinforce disparities between social groups. The DMS policy does overlook the prevailing disparities among users, this problem exasperates with the mainstreaming of digital services, especially in a multicultural society such as Rotterdam city. The existing research on digital divide focuses on individuals' ability to access, use, and benefit from ICT, our research, however, explored a new dimension, the digital divide occurring at the stimulus of an exclusive service-supplier of a civic service, that influences individuals' digital inclusion. DMS is provided only by the municipality, it is of more importance that the service is easy to use for a variety of people, considering possession of different social values, speak of diverse languages, and different levels of skills, this can only be accomplished with a more participatory design and feedback from users.

5.3 Further research

Municipality have a role to provide civic services for all residents around the world, thus, it is curial for future research to take digital divide in municipal services in other locations and on a broader scope, through both quantitative and qualitative approaches that allow investigation and understanding of the phenomena further than description. Migration status has shown a highly significant association with access to DMS, which gives an insight that different values from different cultures and backgrounds could have an influence on appropriating DMS, thus, further research is recommended to tackle the intersectionality aspect of migration and access to DMS, also further research is needed to investigate other factors such as social, cultural, economic, physiological factors and their association with digital divide in municipal services. Moreover, as our research indicates digital divide pertains to the supply-side of DMS, further research is recommended on digital divide from the municipalities-perspective. Finally, since our had an inductive approach, it thus serves as a starting point for future deductive study of digital divide in DMS.

5.4 Recommendation for policy

Our research highlighted the occurring divides in digital municipal services, for policymakers to ensure delivery of equitable civic services, some recommendations can be drawn accordingly:

Establish a digital inclusion scale in DMS to ensure service inclusivity. municipal services are crucial to all residents, the municipality should establish methodologically a digital inclusion scale in which it can define the levels of residents' access to services, and accordingly identify the needed support and service type for these groups. To identify indicators of inclusion in DMS through a participatory and multidisciplinary approach, including and not limited to academics, municipal personnel, citizens, social experts, and software development.

Undertake a participatory approach in service development, focusing on citizens rather than technology. Consolidating all groups of society to ensure service adaptability to various skill levels, especially for marginalized groups, elderly, less educated, and migrant groups. Strengthen the integration of migrants in DMS through intersectional DMS policy.

Enhance and streamline the communication process with citizens, with consideration of marginalized groups, and an assessment of language on municipal communication mediums. Through a top-down approach within the municipality to re-engineer digital services design process to consolidate front-office municipal personnel, to correspond to daily life interactions with citizens, and ensure better service experience to all groups. Finally, investment in alternative services and continuous training to migrants on accessing information. And to raise awareness of the elderly, lower educated, and migrants through training programs about the digital services and means to communicate with the municipality.

Bibliography

Albino, V., Berardi, U., Dangelico, M.R. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. Journal of Urban Technology, 22(1), 3-21

Al-Jaghoub, S., Westrup, C. (2008). Reassessing social inclusion and digital divides. Journal of Information, Communication & Ethics in Society. 7 2/3, 2009 pp. 146-158. DOI 10.1108/14779960910955864.

Al-Muwil, A., Weerakkody, V., El-haddadeh, R., Dwivedi, Y. (2019). Balancing digital-by-default with inclusion: A study case of the factors influencing E-inclusion in the UK. Information Systems Frontiers (2019) 21:635–659. https://doi.org/10.1007/s10796-019-09914-0

Araque, J. C., Maiden, R. P., Bravo, N., Estrada, I., Evans, R., Hubchik, K., Kirby, K., & Reddy, M. (2013). Computer usage and access in low-income urban communities. Computers in Human Behavior, 29(4), 1393–1401. https://doi.org/10.1016/j.chb.2013.01.032.

Ballas, D. (2013). What makes cities happy?. Cities, 32(1), 39–50. https://doi.org/10.1016/j.cities.2013.04.009

Ballano, S., Uribe, A. C., & Munté-Ramos, R.-À. (2014). Young users and the digital divide: Readers, participants, or creators on the internet? Communication & Society, 27(4), 147–155. https://doi.org/10.15581/003.27.4.147-155.

Becker, J., Niehaves, B. and Bergener, P. (2008). 'Digital Divide in e-Government: The e-Inclusion Gap Model' in Electronic Government. 7th International Conference, EGOV 2008, Turin, Italy, August 31–September 5, 2008. Proceedings Springer Berlin /Heidelberg.

Bucea, A.E., Cruz-Jesus, F., Oliveira, T., Coelho, P.S. (2020). Assessing the role of age, education, gender, and income on the digital divide: Evidence for the European Union. Information Systems Frontiers (2021) 23:1007–1021. https://doi.org/10.1007/s10796-020-10012-9

Chen, W. (2013). Communication and ties in American networks. Social Science Computer Review, 31,404–423.

Cooper, J. 2006. The digital divide: The special case of gender. Journal of Computer Assisted Learning 22 (5):320-34.

Cruz-Jesus, F., Oliveira, T., & Bacao, F. (2012). Digital divide across the European Union. Information & Management, 49(6), 278 291.https://doi.org/10.1016/j.im.2012.09.003.

Cullen J., Hadjivassiliou K. and Junge K. (2007). Status of eInclusion measurement, analysis and approaches for improvement.

De Haan, J. (2004). A multifaceted dynamic model of the digital divide. IT&Society, 1: 7 2004, pp. 66-88.

Dewan, S., & Frederick, J. R. (2005). The digital divide: Current and future research directions. Journal of the Association for Information Systems, 6(12), 298–336. [https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=bc0de81b-c4f8-4b79-89b9-ace753037bf0%40redis]

DiMaggio, P., Hargittai, E., & Neuman, W. R. (2001). Social implications of the Internet. Annual Review of Sociology, 27, 307-336.

DiMaggio, P., & Garip, F. (2012). Network effects and social inequality. Annual Review of Sociology, 38, 93–118.

Friemel, T. N. (2016). The digital divide has grown old: Determinants of a digital divide among seniors. New Media & Society, 18(2), 313–331. https://doi.org/10.1177/1461444814538648.

Fuchs, C. (2009). The role of income inequality in a multivariate cross-national analysis of the digital divide. Social Science Computer Review, 27(1), 41–58.

Gray, J., Rumpe, B. (2015). Models for digitalization

Grove, B. (2008). Mental Capital and Wellbeing: Making the most of ourselves in the 21st century. State-of-Science Review: SR-B9 commissioned as part of the UK Government's Foresight Project

Gunkel, D. J. (2003). Second thoughts: Toward a critique of the digital divide. New Media & Society, 5(4), 499–522. https://doi.org/10. 1177/146144480354003

Helbig, N., Ramón Gil-García, J., & Ferro, E. (2009). Understanding the complexity of electronic government: Implications from the digital divide literature. Government Information Quarterly, 26(1), 89–97.

Helsper, E. (2008). Digital Inclusion: An Analysis of Social Disadvantage and the Information Society. Oxford: Oxford Internet Institute (OII).

Helsper, E. (2012). A corresponding fields model for the links between social and digital exclusion. Communication theory, 22 (4). pp. 403-426. ISSN 1050-3293 DOI: 10.1111/j.1468-2885.2012.01416.x.

Helsper, E.J., Schneider, L.S., van Deursen, A.J.A.M. & van Laar, E. (2021). The youth Digital Skills Indicator: Report on the conceptualisation and development of the ySKILLS digital skills measure.

Kaplan, D. (2005). E-Inclusion: New challenges and policy recommendations. Brussels

Keniston, K., Kumar, D. (2003). The Four Digital Divides. Sage, Delhi.

Kolotouchkina, O., Barroso, C.Ll., Sanchez. J. L.M. (2022). Smart cities, the digital divide, and people with disabilities. The International Journal of Urban Policy and Planning, Cities 123 (2022) 103613

Labonté, R., Hadi, A., Kauffmann, X.E. (2011). Indicators of Social Exclusion and Inclusion: A critical and comparative analysis of the Literature. EI Exchange working paper series.

Livingstone, S., and E. J. Helsper. (2007). Gradations in digital inclusion: Children, young people and the digital divide. New Media & Society 9 (4):671–96.

Manzoor, M., Vimarlund, V. (2018). Digital Technologies for social inclusion for individuals with disabilities. Health and Technology (2018) 8:377–390. https://doi.org/10.1007/s12553-018-0239-1

Meraz, S. (2008). Women and technology: How socialization created a gender gap. In Women, men, and news. Divided and disconnected in the new media landscape, ed. S. M. P. Pointdexter, and A. M. Weiss, 110–29. New York, NY: Routledge.

National Telecommunications and Information Administration (NTIA) (1999) Falling through the Net: Defining the Digital Divide. Washington, DC: US Department of Commerce. http://www.ntia.doc.gov/ntiahome/fttn99/contents.html

Nicholas, K. (2003). Geo-policy barriers and rural Internet access: The regulatory role in construction the digital divide. The Information Society, 19, 287–295.

OECD. (2001). Understanding the digital divide (Vol. 6). https://doi.org/10.1093/ilj/6.1.52

Power, A., & Wilson, W. J. (2000). Social exclusion and the future of cities, Centre for Analysis of social exclusion. London: London School of Economics

Robinson, L., Cotten, S. R., Ono, H., Quan-Haase, A., Mesch, G., Chen, W., Schulz, J., Hale, T. M., & Stern, M. J. (2015). Digital inequalities and why they matter. Information Communication and Society, 18(5), 569-582. https://doi.org/10.1080/1369118X.2015.1012532

Rotterdam Municipality. (2022). 2022 Wijkprofiel Rotterdam. https://wijkprofiel.rotterdam.nl/nl/2022/rotterdam/charlois/carnisse

Rye, S.A. (2008). Exploring the gap of the digital divide. GeoJournal (2008) 71:171–184 DOI 10.1007/s10708-008-9154-8

Selwyn, N. (2010). Degrees of digital division: Reconsidering digital inequalities and contemporary higher education. RUSC [Revista de Universidad y Sociedad del Conocimiento], 7 N1, 33–42. https://doi.org/10.7238/issn.1698-580X.

Shookner, M. (2002). An Inclusion Lens: Workbook for Looking at Social and Economic Exclusion and Inclusion, Ottawa, Health Canada. [http://www.oaith.ca/assets/files/Publications/inclusion_lens.pdf]

Silvano, C. (2022). Efficiency and digital divide within online public services: The smart mobility case. Ceridap. ISSN 2723-9195, https://doi.org/10.13130/2723-9195/2022-1-22

Sorj, B. (2008). Confronting inequality in the information society [online]. Rio de Janeiro: Centro Edelstein de Pesquisa Social, 2008. The Dimensions of the Digital Divide. pp. 44-57. ISBN 978-85-99662-48-9

Stewart, K. (2002). Measuring Well-Being and Exclusion in Europe's Regions, Centre for Analysis of Social Exclusion, CASE paper 53, London: London School of Economics.

Tkachenko, K.I., Zolkin A.L., Lomakin, D.E., Pakhomova, A.I., Pomazanov, V.V. (2021). Phenomena of digital divide and ways of its bridging. E3S Web of Conferences 311, 06009 (2021). https://doi.org/10.1051/e3sconf/202131106009

United Nations. (2021). Policy Brief N (92). Leveraging digital technologies for social inclusion. Department of Economics and Social Affairs. [https://www.un.org/development/desa/dpad/publication/un-desa-policy-brief-92-leveraging-digital-technologies-for-social-inclusion/]

University of Twente (2022). Survey and Methods. https://www.utwente.nl/nl/centrumdigitaleinclusie/Digitale%20Inclusie/

van Deursen, A. J. A. M., and J. A. G. M. van Dijk. (2014). The digital divide shifts to differences in usage. New media & Society 16:507–26.

van Dijk, J. A. G. M. (2005). The deepening divide: Inequality in the information society. London: Sage.

van Dijk, J. A. G. M. (2006). Digital divide research, achievements and shortcomings. Poetics, 34(4–5), 221–235. https://doi.org/10.1016/j. poetic.2006.05.004.

van Dijk, J. A. G. M. (2012). The evolution of the digital divide: The digital divide turns to inequality of skills and usage. Digital Enlightenment Yearbook, 2012, 57–75.

van Dijk, J. A. G. M., and K. Hacker. (2003). The digital divide as a complex and dynamic phenomenon. The Information Society 19 (4):315–26.

van Dijk, J., Ebbers, W. & van de Wijngaert, L. (2015). e-Government. The International Encyclopedia of Digital Communication and Society. 9999: 1–10. DOI: 10.1002/9781118767771.wbiedcs109.

Van Thiel, S. (2014). Research methods in public administration and public management: An introduction. Routledge.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27, 425–478.

Wang, Y., Shih, Y. (2008). Why do people use information kiosks? A validation of the Unified Theory of Acceptance and Use of Technology. Government Information Quarterly 26 (2009) 158–165. DOI:10.1016/j.giq.2008.07.001

Warschauer, M. (2003). Dissecting the "digital divide": A case study in Egypt. The Information Society, 19(4), 297–304. https://doi.org/10.1080/01972240309490.

Warschauer, M. (2004). Technology and social inclusion: Rethinking the digital divide. Cambridge, MA: MIT Press.

Webster, F. (2013). Theories of the information society. London: Routledge.

Yamane, T. (1967). Satistics, An introductory Analysis. New York

Yu, B.A. N., Lorri, M.M.,&Fan, Z. (2018). E-inclusion or digital divide: An integrated model of digital inequality. Journal of Documentation, 74(3), 552–574.

Zhang, X. (2013). Income disparity and digital divide: The internet consumption model and cross-country empirical research. Telecommunications Policy, 37(6–7), 515–529. https://doi.org/10.1016/j.telpol.2012.12.011.

Annex 1: Research Instruments

Annex 1: Survey

DIGITAL DIVIDE QUESTIONNAIRE

Today, many sources of information and various services are available online. This increasing digitalization affects different people in different ways. This survey is part of a larger research project about personal skills and usage of digital devices (such as computers and smartphones), the internet, and online services, as well as their benefits and limitations.

Below you will be asked to give your perception of various topics related to our research. With your answers, we will analyze who the digitalization of information and services affects and how it affects them. Some questions will be simple to answer, others you might be more uncertain about. Please answer to the best of your ability; we want to capture your main feelings and opinions.

Thank you for your help with this important project!

1. SOCIAL PERCEPTIONS

For the following statements, please rate your agreement from 1 (strongly disagree) to 5 (strongly agree).							
SOCIAL INCLUSION	1	2	3	4	5	N/A	Don't know
I consistently participate in my community (e.g., volunteering, cultural festivals, neighborhood meetings, etc.).							
I feel that my social needs, problems, and circumstances are considered by the municipality.							
PERCEPTION OF STEREOTYPES	1	2	3	4	5	N/A	Don't know
There are stereotypes about different kinds of people based on their identity (gender, ethnicity, etc.).							
I personally experience bias or discrimination because of my identity (gender, ethnicity, etc.) in my daily life.							
I personally experience bias or discrimination because of my identity (gender, ethnicity, etc.) in work or education.							
There are stereotypes about digital usage (of computers, smartphones, the internet) and abilities specifically related to a person's **gender**.							
I personally experience bias or discrimination regarding my digital usage and abilities because of my **gender.**							
There are stereotypes about digital usage (of computers, smartphones, the internet) and abilities specifically related to a person's **ethnicity**.							
I personally experience bias or discrimination regarding my digital usage and abilities because of my **ethnicity.**							

2. MATERIAL ACCESS

What types of devices do you have access to at home? (Check all that apply).

☐ Desktop computer   ☐ Laptop
☐ Smartphone   ☐ Tablet
☐ Other   ☐ None

If applicable, how many of each device do you have at home?

☐ Desktop computer   ☐ Laptop
☐ Smartphone   ☐ Tablet

Do you have reliable access to an internet connection at home?

☐ Yes   ☐ No

In the past 30 days, where have you used the Internet? (Check all that apply).

☐ At home
☐ At work, school, or university
☐ While traveling (e.g., on a bus, tram, or train)
☐ Somewhere else (e.g., library, internet café, at another person's house)

3. DIGITAL USAGE

I have an e-mail address.

☐ Yes   ☐ No

How often do you use the internet?

☐ Never   ☐ Less   ☐ Once a   ☐ 4-6 days   ☐ Daily
  2-3   ☐ than week   days a   a week
once a   week
week

How often do you use online software or applications (Word, Excel)?

☐ Never   ☐ Less   ☐ Once a   ☐ 4-6 days   ☐ Daily
  2-3   ☐ than week   days a   a week
once a   week week
week

In the past 12 months, for what purposes have you used the internet? (Check all that apply).

☐ Music/video streaming services   ☐ News (e.g., articles, videos)
☐ Gaming   ☐ Finding/applying to jobs
☐ Leisure internet searches (e.g., blogs, travel)   ☐ Online shopping
☐ Practical internet searches (e.g., recipes,   ☐ Reading product reviews childcare,
        healthcare)   ☐ Social network sites
☐ Online courses or training   ☐ Sharing photos/videos
                                          ☐ Other: _____

4. SKILLS

For the following statements, please check yes or no according to your personal abilities.		
OPERATIONAL SKILLS	Yes	No
I know how to connect to a WIFI network.		
I know how to look for information online using a search engine.		
I know how to install apps on a mobile device such as a phone or tablet.		
I know how to download files and retrieve them once saved or stored.		
I know how to attach files to an email.		
I know how to complete online forms.		
I know how to avoid computer viruses.		

To what extent are the following statements true of you? Please answer from 1 (not at all true of me) to 5 (very true).							
INFORMATION SEEKING SKILLS	1	2	3	4	5	N/A	Don't know
I find it easy to decide the best keywords to use in online searches.							
I find it easy to use and navigate most websites.							
SOFTWARE/CONTENT CREATION SKILLS	1	2	3	4	5	N/A	Don't know
I know how to change the settings of a digital device or application.							
I know how to find, download, install, and configure applications.							
I know how to produce or edit content using a word processor (e.g., Word).							
I know how to produce or edit spreadsheets (e.g., using Excel).							
I know how to use basic formulas in a spreadsheet.							
I know how to create digital presentations (e.g., using PowerPoint, Canva).							
I know how to produce or edit simple digital content like images, memes, videos, and/or audio files.							
I know how to use specific software for design, calculation and/or simulation (e.g., Photoshop, AutoCAD, Aicon, etc.).							
SAFETY & SECURITY SKILLS	1	2	3	4	5	N/A	Don't know
I check if the information and websites I access online are trustworthy.							
I know which information I should and should not share online.							

| I feel safe sharing my information online for services such as the municipality online portal or subscription websites. | | | | | | | |

PROBLEM-SOLVING SKILLS	1	2	3	4	5	N/A	Don't know
My ability to solve routine problems with my devices (e.g., close program, restart computer, reinstall/update program, check internet connection) is:							
My ability to find support and assistance when a technical problem occurs or when using a new device, program, or application is:							
PERCEPTION OF DIGITAL INCLUSION	1	2	3	4	5	N/A	Don't know
Compared to others, my personal skill level using digital devices and/or the internet is							
My personal level of stress or anxiety about using digital devices and/or the internet is:							

For the following two statements, please rate your agreement from 1 (strongly disagree) to 5 (strongly agree).

MOTIVATION/ATTITUDES	1	2	3	4	5	N/A	Don't know
Having access to the internet and digital devices has improved my life.							
My knowledge has increased because of the Internet (e.g., looking up information, talking to others online).							

5. FINANCE

For the following statements, please evaluate your personal usage frequency.

DIGITAL FINANCIAL USAGE	Never	Rarely	Sometimes	Frequently	Always	N/A	Don't know
I use a digital bank account.							
I pay with a card or QR code (cashless).							
I use a digital financial app (e.g., Tikkie, Revolut, Bux).							
I use digital financial investments (e.g., stocks, cryptocurrencies).							

For the following statements, please check yes or no according to your personal perceptions.

FINANCIAL ACCESS, USE, AND PERCEPTION	Yes	No
I find it easy to use digital financial solutions e.g., Tikkie, PayPal, split wise.		
I trust financial technology solutions such as Tikkie and Revolut.		
I look for interest rates and investment opportunities on the internet.		

How many digital bank accounts and/or wallets do you have?

☐ _____

In the past 5 years, I have applied for a loan (of any type or amount):

☐ Online ☐ At the bank branch ☐ I have not applied for
a loan

6. LABOR

In the previous 12 months, what was your average household gross monthly income?

☐ €1350 or less
☐ Between €1350 and €1850
☐ Between €1851 and €2350
☐ Between €2351 and €2850
☐ Between €2851 and €3350
☐ Between €3351 and €3850
☐ Between €3851 and €4350
☐ Between €4351 and €4850
☐ Between €4851 and €5350
☐ More than €5350

What is your employment status? (Can check multiple)

☐ Full-time employed ☐ Unemployed
☐ Part-time employed ☐ Retired
☐ In education ☐ Not looking for work
☐ Caregiver

IF EMPLOYED, what type of contract do you have?

☐ Temporary
☐ Permanent
☐ Other: _____

For the following statements, please select what is applicable to you.		
Please mark the occupations in which you are working now and/or in which you have worked in the last five years (multiple selections allowed).	**Current occupation** (mark only if you are currently employed)	**Last five years**
Building, craft, and related trade workers		
Plant machine operators and assemblers		
Sales, customer, or personal service workers		
Technicians		
Clerical support workers		
Skilled agricultural, forestry, and fishery workers		
Professionals		
Managers		

For the following statements, please select what is applicable to you.		
Please mark the sectors in which you are working now and/or in which you have worked in the last five years (multiple selections allowed).	**Current sector(s)** (mark only if you are currently employed)	**Last five years**
Agriculture, forestry, and fishing		
Manufacturing		
Electricity, gas, steam, and air conditioning supply		
Construction		
Wholesale and retail trade; repair of motor vehicles and motorcycles		
Transportation and storage		
Accommodation and food service activities		
Information and communication		
Professional, scientific, and technical activities		
Administrative and support service activities		
Education		
Human health and social work activities		

Considering your employment history, please answer the following questions.			
JOB STABILITY	Yes	No	N/A
In general, it has been difficult for me to find a job.			
In the past, I have had periods of unemployment.			
In the past, I have had difficulties finding a job because of my digital skills.			
I currently use digital devices in my job.			

7. ONLINE SERVICES

For the following statements, rate your agreement from 1 (strongly disagree) to 5 (strongly agree). Some municipal services include paying Council Tax, completing passport renewal, receiving a driving license, registering to vote, applying for public school.							
PERCEPTION OF MUNICIPAL SERVICES	1	2	3	4	5	N/A	Don't know
Most municipal services are offered online.							
I find online municipal services useful in my daily life.							
My interaction with online municipal services is clear and understandable.							

I prefer online services to in-person services.							
I would like to improve my ability to access online services.							

If the city of Rotterdam were to offer services for residents to improve their digital and internet skills, what format(s) would you prefer? (Check all that are of interest to you).

- ☐ Walk-in (no registration required)
- ☐ Requires prior registration

What type of assistance would you prefer?

- ☐ Once-weekly class (short – approx. 1 hour)
- ☐ Once-monthly workshop (long – approx. 2 to 4 hours)
- ☐ Office hours multiple times per week (open availability to ask someone for help)
- ☐ Other: _____

What location would you prefer? (Check all that are of interest to you).

- ☐ Neighborhood school
- ☐ Local library
- ☐ Local religious center
- ☐ Community center
- ☐ Other: _____

What days of the week would you prefer? (Check all that are of interest to you).

- ☐ Weekdays
- ☐ Weekends

What time frame would you prefer? (Check all that are of interest to you).

- ☐ Morning (9:00-12:00)
- ☐ Afternoon 12:00-15:00
- ☐ Late afternoon 15:00-18:00
- ☐ Evening 18:00-21:00
- ☐ Other: _____

8. GENERAL INFORMATION

How old are you?

[   ]

What is your gender?

☐ Male   ☐ Female   ☐ Other   ☐ Prefer not to say

How many children under the age of 18 live with you?

[   ]

What is your level of education (or equivalent)?
- ☐ Primary education
- ☐ Secondary education (VMBO, VWO, HAVO)
- ☐ Bachelor's degree – Vocational (HBO, MBO)

- ☐ Bachelor's degree – Academic (WO)
- ☐ Master´s degree or higher

What is your nationality? (Can list multiple).

What are your parents' places of birth?

Father	
Mother	

Do you have a DigiD?

☐ Yes ☐ No

In the past 12 months, have you used your DigiD to access any government services, information, etc.?

☐ Yes ☐ No

What is your native language? (Can list multiple).

IF YOUR NATIVE LANGUAGE(S) ARE NOT DUTCH OR ENGLISH,

Do you speak Dutch and at what level?

☐ Beginner ☐ Intermediate ☐ Advanced ☐ Fluent ☐ N/A

Do you speak English and at what level?

☐ Beginner ☐ Intermediate ☐ Advanced ☐ Fluent ☐ N/A

Are you registered with the Municipality of Rotterdam?

☐ Yes ☐ No

What is your zip code? (First four numbers only, e.g., 3073.)

Annex 2: Interview Guide

Digital divide in municipal services – Citizens' perspective

Interview guide

Part 1: Open Questions

The municipality of Rotterdam is transforming its service delivery process, from in-person to digital services that citizens need to inquire over the internet and digital technologies. It is no more intended for citizens to arrive at the municipality to look for the services they need, they should log-in online, follow the process, to request and receive the municipal service.

In this regard, we would like to know your opinion and experience with the following:

1. **What do you think about digital municipal services?**
   1.1 How would you describe its usefulness to you? What do you like most and least about digital municipal services?
   1.2 What could be the reasons for you to not use e-municipal services?
   1.3 In your opinion, should there be offline alternatives? Why?
2. **What would you say about your trust in digital municipal services?**
   2.1 Can you describe how you feel about sharing your information on the municipality's online platforms?
3. **Can you describe your information search experience when looking for digital municipal services online?**
   3.1 Where do you look for information? How easy is it for you to reach the required information?
   3.2 Can you describe a time when you needed help to find information online to access digital municipal services?
   3.3 When requesting the services online, to what extent do you feel you can understand the required information?
4. **If you compare when you use e-municipal services to e-commerce (like bol.com, coolblue.nl, amazon…), how would you describe the difficulty of accessing e-municipal services?**
   4.1 In your opinion, what are the reasons that make e-municipal services less easy to access compared to e-commerce?

Part 2: Closed questions:

1. **Are you registered with Rotterdam Municipality?**
   a. Yes
   b. No

2. **Do you have a BSN number?**
   a. Yes
   b. No
   c. Still waiting to get it

3. **I look for digital municipal services through my:**
   a. Smart mobile phone
   b. Laptop

c. Tablet
　　d. Family or friends' devices
　　e. I don't have the necessary device

4. **How do you find information to access digital municipal services?**
　　a. Browse the internet
　　b. Ask help from family or friends
　　c. Call the municipality
　　d. I don't have the social sources to access
　　e. I don't have the physical sources to access

5. **Have you used any of these digital services? :**
　　☐ Pay council tax
　　☐ Apply for passport renewal
　　☐ Apply for driver's license
　　☐ Apply for public library
　　☐ None

6. **If you use it, how often?:**
　　a. Weekly
　　b. Monthly
　　c. Yearly
　　d. Never
　　e. Other_____

7. **What are the challenges that you face when accessing digital municipal services? (you can choose more than one)**
　　☐ Language
　　☐ I don't feel safe sharing my information online
　　☐ It is difficult to find information
　　☐ Content is difficult to understand
　　☐ It is difficult to use the municipality's platform
　　☐ I need to improve my skills
　　☐ I don't have the necessary digital devices (e.g., phone, laptop)

Part 3: Personal Characteristics

8. **Your gender:**
　　__Female
　　__Male
　　__Other

9. **Your age:** _____
10. **In which country were you born?** _____
11. **What is your nationality(s)?** _____

12. **What's your highest education degree?**
　　__ Elementary school　　　__ Secondary School

__ High School	__ Diploma
__ Bachelor's degree	__ Master's Degree
__ Ph.D.	__ Post Doc
__ Other	

13. What is your employment status?

__Full time	__Part time
__Unemployed	__Student
__Retired	__Caretaker
__Not looking for work	

14. What's your average annual income?

- ☐ €1350 or less
- ☐ Between €1350 and €1850
- ☐ Between €1851 and €2350
- ☐ Between €2351 and €2850
- ☐ Between €2851 and €3350
- ☐ Between €3351 and €3850
- ☐ Between €3851 and €4350
- ☐ Between €4351 and €4850
- ☐ Between €4851 and €5350
- ☐ More than €5350

15. Your name? _____

Annex 3: Statistical testing

Assumption 1: dependent variables are categorical

Awareness (V1)	Freq.	Percent	Cum.
0	42	28.77	28.77
1	104	71.23	100.00
Total	146	100.00	

Perceived usefulness (V2)	Freq.	Percent	Cum.
0	65	42.76	42.76
1	87	57.24	100.00
Total	152	100.00	

Safe sharing info (V3)	Freq.	Percent	Cum.
0	75	46.30	46.30
1	87	53.70	100.00
Total	162	100.00	

Preference Of online services (V4)	Freq.	Percent	Cum.
0	95	61.29	61.29
1	60	38.71	100.00
Total	155	100.00	

Material access (V5)	Freq.	Percent	Cum.
0	10	5.62	5.62
1	168	94.38	100.00

Total	178	100.00	

Ease of Interact (V6)	Freq.	Percent	Cum.
0	68	44.74	44.74
1	84	55.26	100.00
Total	152	100.00	

Willingness to improve (V7)	Freq.	Percent	Cum.
0	79	53.38	53.38
1	69	46.62	100.00
Total	148	100.00	

digID access (V8)	Freq.	Percent	Cum.
0	22	12.50	12.50
1	154	87.50	100.00
Total	176	100.00	

Assumption 3: Multicollinearity test

```
(obs=139)

                 |    age   gender   educ_b income_b Migran~b
    -------------+---------------------------------------------
             age |  1.0000
          gender | -0.1684   1.0000
          educ_b | -0.1726  -0.0810   1.0000
        income_b |  0.0543  -0.1870   0.3016   1.0000
       Migrant_b | -0.2726  -0.0147   0.0076  -0.2301   1.0000
```

Annex 4: HIS copyright form

In order to allow the IHS Research Committee to select and publish the best UMD theses, participants need to sign and hand in this copy right form to the course bureau together with their final thesis.

Criteria for publishing:

1. A summary of 400 words should be included in the thesis.
2. The number of pages for the thesis is about 50 (without annexes).
3. The thesis should be edited

Please be aware of the length restrictions of the thesis. The Research Committee may choose not to publish very long and badly written theses.

By signing this form you are indicating that you are the sole author(s) of the work and that you have the right to transfer copyright to IHS, except for items cited or quoted in your work that are clearly indicated.

I grant IHS, or its successors, all copyrights to the work listed above, so that IHS may publish the work in *The IHS thesis series*, on the IHS website, in an electronic publication or in any other medium.

IHS is granted the right to approve reprinting.

The author(s) retain the rights to create derivative works and to distribute the work cited above within the institution that employs the author.

Please note that IHS copyrighted material from *The IHS thesis series* may be reproduced, up to ten copies for educational (excluding course packs purchased by students), non-commercial purposes, providing full acknowledgements and a copyright notice appear on all reproductions.

Thank you for your contribution to IHS.

Date   : ____August 7ᵗʰ, 2022_____

Your Name(s)   : _____Nadine Burbar_____

Your Signature(s)   :

Please direct this form and all questions regarding this form or IHS copyright policy to:

The Chairman, IHS Research Committee Burg. Oudlaan 50, T-Building 14ᵗʰ floor, 3062 PA Rotterdam, The Netherland	j.edelenbos@ihs.nl Tel. +31 10 4089851