Universitat Autònoma de Barcelona

# Essays on the digital divide

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# DOCTORAL DISSERTATION

## Essays on the digital divide

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# Abstract

Over the past decade, the internet has become a crucial aspect of networks based on the information and communication technologies, breaking down communication barriers between cultures by allowing access to almost any service worldwide. In addition to the spread of the internet worldwide, social media networking, online platforms, and other digital technologies have radically changed our daily lives. As a result, the internet is perhaps the most visible aspect of globalization and a driving force that integrates almost every industry.

Even though digital technology is spreading rapidly, most of the population does not enjoy the benefits. Digital divisions have arisen in the use of the internet and social media, and in conducting activities online. Initially, the digital divide referred to the gap between groups of individuals with access to technologies and those with restricted access or none at all. However, evidence has shown that the concept is more complex than mere access to digital devices.

In the last 15 years, researchers have tried to produce a comprehensive explanation of different digital divides. To better understand relations between different digital divide levels, van Dijk and associates developed their resources and appropriation theory (van Dijk, 2005, 2020). The RA theory proposes a sequential model to explain the relationship between different digital divide levels and how social inequalities are produced and reproduced. The sequential model shows that the process of appropriation goes from motivations to use of the internet (attitudes and reasons for (not) using the internet), to physical access to the internet (quality, quantity, and ubiquity), to digital skills (appropriate internet use), and to the internet use and outcomes (engaging with the internet and enjoying the benefits). That process is not equally distributed in society.

This doctoral dissertation, grounded in the resources and appropriation theory as the theoretical framework, explores the first digital divide in Thailand to explain internet access heterogeneity in a developing country. Considered were Thai users' access to the internet, theoretical drivers, and indicators of positional resources and social categories. It was found, in general, that computer and internet access opportunities are the primary drivers of internet use. However, the aggregate effect covers the fact that there is a digital and social transformation underway in Thailand. On the one hand, there is a new mobile group of internet users for which the most crucial driver of internet use is mobile access opportunities followed by internet and computer access opportunities. On the other hand, drivers for a traditional group of internet users are computer and internet access opportunities. As for the social properties of individuals in each groups, the mobile user group can be profiled as female, aged 15-35 years, well educated, a student, single, and resident in Bangkok or Central Thailand, while the traditional internet user group is composed of older, less well-educated individuals, with disabilities, unemployed, most typically married or widowed, and living in Northern Thailand. The drivers behind internet use diversity may be generational, suggesting a need to switch the research focus from households to individuals, even in less developed countries.

Also analysed was internet use by European Union citizens, by generalizing the validity of the sequential model proposed by the RA theory from one country to the entire bloc. Support was found for the hypothesized relationships, but another finding was that the drivers' effects on internet use vary depending on the digital development level of countries. While education overall is the primary determinant of the social production of digital inequalities, a country's digital development level is crucial for less well-educated Europeans. Furthermore, young and well-educated individuals are the best positioned in society to take advantage of digital technologies in each country. Our findings throw new light on the social process of internet appropriation, suggesting that it develops differently in different European countries.

Finally studied was the role of trust in producing a new digital divide. The sequential model of social internet appropriation was extended to include trust as a mediator in the causal chain. The extended model proposes that attitudes, physical access, digital skills, and now trust sequentially explain the appropriation process that ends in a digital divide in internet use. Findings indicate that while trust is another significant determiner of the digital divide that mediates digital skills on internet use, digital skills continue to be the most crucial driver in generating the digital gap. Trust is a socially constructed concept whose meaning depends on the digital skills of individuals.

To sum up, this research makes several contributions to our knowledge of the social production of the digital divide in developing and developed countries. Uncovered was the existence of a generational digital transformation in Thailand that impinges on the importance of theoretical drivers of access to the internet – a finding that raises doubts regarding the mobile underclass hypothesis. Generalizing the resources and appropriation model's validity, identified was the digital development level of a country as a public resource for reducing digital inequalities. and education and age as the primary social indicators of digital inequalities. Finally, the theoretical sequential model was extended to include trust as another level of the digital divide, finding that even though its role is significant, digital skills remain as the most influential driver.

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## List of abbreviations

| Abbreviation | Explanation |
|---|---|
| AIC | Akaike Information Criterion |
| BIC | Bayesian Information Criterion |
| CA | Correspondence Analysis |
| EU | European Union |
| EU27+UK | The European Union plus the United Kingdom |
| ICTs | Information and Communication Technologies |
| MCA | Multiple Correspondence Analysis |
| OECD | Organization for Economic Cooperation and Development |
| PCA | Principal Component Analysis |
| PLS-SEM | Partial Least Squares-Structural Equation Model |
| RA | The Resources and Appropriation theory |
| VOIP | Voice Over Internet Protocol |

# Chapter 1

## Introduction

People use the internet for various social and economic reasons, e.g., entertainment, shopping, distance learning, starting or running a business, making better informed health decisions, etc. Digital technology is increasingly digitalizing life (the so-called internet of things, or IoT), at the personal level through smart devices (smart TVs, cars and homes, wearable technologies, etc.), and also in many other fields, including medicine and health (van der Zeeuw et al., 2019). All these changes have dramatically transformed our experiences and daily life. Digital skills are becoming increasingly important not only for the social and economic advancement of individuals but also in enhancing the quality of human resources, increasing firms' productivity, and ensuring the fair distribution of wealth. However, those changes occur so fast that they always are several steps ahead of individuals, companies, and governments.

### 1.1 The concept of the digital divide

Even though digital technology is spreading rapidly, most of the population does not enjoy the benefits. The digital divide has been recorded in internet use, social media, and digital activities (Pearce & Rice, 2017; van Dijk, 2020). The concept of the digital divide first emerged in 1995 in public, political, and scholarly debate. It was first used in the United States to refer to the "haves and have-nots" of internet access (NTIA, 1995). Later, the concept spread to Europe and the rest of the world. According to the Organization for Economic Cooperation and Development (OECD), the digital divide refers to the gap between individuals, households, organizations, and geographic areas regarding opportunities to access information and communication technologies (ICTs) and to enjoy the corresponding benefits. Thus, the body of the literature on the digital divide studies how different social groups access digital technologies in order to describe and explain the role of the digital divide in increasing social inequality (OECD, 2001).

## 1.2 The evolution of the digital divide

Early research concerning the digital divide focused on the gap between individuals who have internet access and those that do not have access, now referred to as the first-level digital divide (Attewell, 2001; Chen & Wellman, 2004; Norris, 2001). The first digital divide suggests that individuals with access to digital devices are able to benefit from internet use, while lack of access means not benefiting from digital technologies. After social policies reduced the first digital gap (the access divide), the internet gap persisted. Attention consequently moved to a second-level digital divide: differences in the digital skills necessary to effectively use the internet (Blank & Groselj, 2014; Hargittai, 2002; Selwyn, 2004; van Deursen & van Dijk, 2010). More recently, researchers have focused their attention on a third digital divide, namely, internet outcomes (Ragnedda, 2017; van Deursen & Helsper, 2015a; Wei et al., 2010). Researchers have found that digital skills do not necessarily lead to beneficial outcomes for all users in the same way (Scheerder et al., 2017). Thus, research has focused its attention on internet uses and outcomes in four areas: economic, cultural, social, and personal (Blank & Lutz, 2018; Scheerder et al., 2017; van Deursen & Helsper, 2015a).

## 1.3 The resources and appropriation theory of the digital divide

In the last 15 years, researchers of all digital divide levels have tried to develop a comprehensive approach that could embrace most of the partial explanations of the digital divide. To better understand the relations among the different levels of the digital divide, van Dijk and associates developed the resources and appropriation (RA) theory (van Dijk, 2005, 2020). The RA theory proposes a sequential model to explain the relationship between the different digital divide levels and how digital inequalities are socially produced and reproduced in the sequential internet appropriation process. Originally, the sequential model covered attitudes, physical access, digital skills, and internet use; thus, the model proposes that the process of appropriation goes from motivations to use of the internet (attitudes and reasons for using the internet), to physical access to the internet (quality, quantity, and ubiquity), digital skills (appropriate internet use), and internet use and outcomes (engaging with internet and enjoying the benefits). That process is not equally distributed in society.

According to van Dijk (2020), the digital divide produces social inequalities. First, the digital divide affects the acceptance and development of ICTs in the economy and society, and consequently leads to a lack of or restrictions on innovation and development and impacts on the economic growth of economies and communities left behind (World Bank, 2016). Second, the digital divide produces inequalities within communities. People with more and better opportunities to access, develop skills, and use digital technologies will enjoy more privileged social positions and better life chances in general, resulting in economic, social, and cultural inequality for those who lack access to ICTs in the context of the information or networked society (van Dijk, 2012b). An additional factor is identifying the social categories excluded from society due to not enjoying the benefits of digital technologies in domains such as work, education, community, politics, and culture.

Although the digital divide is problematic and does not have an easy solution, social inequalities can at least partially be reduced by facilitating people's access to and use of the internet (van Dijk, 2012b). According to van Dijk (2020, p. 159), most people are currently motivated and have physical access to the internet, especially in developed countries. However, developing countries are still lagging behind in facilitating their citizens with access to the digital technologies (M. Lu, 2001; van Dijk, 2020; World Economic Forum, 2016). Without access, only more motivated individuals will be able to develop digital skills, leaving most citizens lagging behind.

Studies on the digital divide report that gaining the benefits of ICTs for individuals and firms requires attitudes, physical access, and digital skills, but also trust in the information provided and the expected behaviour of other individuals, social network platforms, firms, institutions, etc. (Chang et al., 2017; Dutton & Shepherd, 2006; Huang et al., 2003). Consequently, trust may be yet another internet use driver that countries will have to take on board in providing widespread access to digital technologies in everyday work, education, and leisure.

## 1.4 Research gap

Research into the digital divide has focused on the underlying social processes, with most literature documenting different aspects of digital divide drivers. The gap between developed and developing countries regarding internet access and uses is an important digital divide research topic. Although digital divide research has become global, less research has been conducted concerning internet use antecedents in developing countries like those in the southeastern Asian region. Scholars have recently concluded that, even in developed countries, the first digital gap in access remains a problem (van Deursen & van Dijk, 2019), which would suggest that inequalities in opportunities to access the internet must be even more problematic in developing countries.

Due to accelerated transformations of the digital environment, digital skills have become essential to individuals and firms. However, little research has been invested in a more holistic model of the digital divide. To the best of our knowledge, only one comprehensive empirical study has been conducted: by van Deursen and van Dijk (2015) and focused on the Netherlands. Since that empirical test, by now over half a decade old, no other such study has been conducted on within- and between-country digital divides. There is still little evidence on the social generation of inequalities in internet use and skills (in both developing and developed countries), and no study has analysed the role of trust in generating the digital divide. If the issue of trust reflects a new digital divide, this may make it easier for policy makers to reduce the digital gap and social inequalities. In contrast, if digital skills remain the most significant driver of the digital gap, then inequalities are likely to endure for longer.

## 1.5 Research aim

This doctoral dissertation aims to fill several gaps in our knowledge of the social generation of the digital divide in relation to the RA theory (van Dijk, 2005, 2012a, 2020), with three main objectives as follows:

1. To explain the first-level digital divide in a developing country using the RA theory to investigate internet access heterogeneity in developing countries. Thai users' access to the internet was selected as the topic of a case study to demonstrate how digital inequality is distributed among individuals characterized by different positional resources and social categories. The case of Thailand provides new insights into how the digital gap in internet access and uses is socially produced in a developing country.
2. To (a) extend the external validity of the RA theory and (b) uncover the social mechanisms influencing the effect of theoretical drivers of internet use inequality by identifying the relative importance of within-country and between-country resources and social categories. The European Union plus the United Kingdom (EU27+UK) was selected to study the social process of internet appropriation, covering attitudes and

motivations (representing possible barriers to internet use), access, digital skills, and internet use. Particular attention is paid to understanding how the impact of the sequential model drivers differs between countries depending on their level of digital development and individual resources and social categories.

3. To add to the theoretical drivers of the sequential model of social internet appropriation by including trust as a mediator in the causal chain, considering the mediation effect of European users' trust on other constructs: motivations to use the internet, physical access, and digital skills. The extended RA theory model may produce new insights regarding the theoretical sequential model of social appropriation of the internet and regarding policies to reduce digital inequalities.

Different statistical models, depending on the research question, were used to study the social production of inequalities. Regarding inequalities in access opportunities in a developing country, a measurement model of access opportunities and a latent regression model were used to identify heterogeneity in the social production of digital inequalities. Regarding extending the external validity and theoretical models, used were a measurement model of digital inequality drivers and a partial least squares-structural equation model (PLS-SEM) in combination with hybrid multigroup analysis developed in the pathmox model for PLS-SEM models.

## 1.6 Thesis outline

This doctoral dissertation is organized as follows. Chapter 2 presents a study of how the digital gap is socially produced in a developing country. Chapter 3 focuses on how the sequential model differs between countries depending on a country's level of digital development and identifies the relative importance of country- and individual-level resources and social categories. Chapter 4 focuses attention on extending the theoretical model by including trust as another driver of the digital divide. The thesis concludes with a summary of findings and recommendations for further research based on identified limitations of this analysis.

# Chapter 2

## The social structuring of the digital gap in a developing country

In this chapter, we examine the first digital divide in a developing country, Thailand, exploring how the resources and appropriation (RA) theory concepts explain internet use diversity. We find that computer and internet access opportunities are the primary drivers of internet use and also that their effect depends on individuals' resources and social categories (particularly gender, age, and education), resulting in mobile and traditional user classes (younger, better educated, urban women, and older, less well-educated, married, non-urban individuals, respectively). Drivers behind internet use diversity may be generational, suggesting a need to switch the research focus from households to individuals, even in less developed countries. Results have been recently published in *Technology in Society* (Lopez-Sintas et al., 2020). An introduction and theoretical framework (introducing the social internet appropriation process, presenting our scales and hypothesis) are followed by a statistical analysis and discussion of results and implications.

### 2.1 Introduction

People use the internet for various social and economic reasons, e.g., entertainment, shopping, to start or run a business, etc. Digital technology is increasingly digitalizing life (the so-called internet of things) – at the personal level through smart devices (smart TVs, cars, homes, etc), but also in many other socioeconomic fields, including medicine and health (van der Zeeuw et al., 2019). However, internet use is unequally distributed within and among countries and several levels of digital gap have been identified. A first gap is related to access to digital media and to an internet connection, while a second gap is associated with actual use of the internet (Wessels, 2013; Zillien & Marr, 2013).

While internet access and use are still unequally distributed among different populations and subpopulations in both developed and less developed countries, how inequalities are produced may differ. According to published data, southeast Asians are among the most engaged mobile internet users on the planet, as almost 90% of them access the internet through their mobile phones (Google et al., 2019). Even though Thailand has a wired broadband penetration rate (11.9% in 2017) well below the Organization for Economic Cooperation and Development (OECD) average (30.23% in 2017), two-thirds of Thais make use of the internet, while 98% have 3G and 4G mobile network coverage (OECD, 2019). This pattern differs from that in many more developed countries, although it is usual in Japan (Condry, 2004).

Scholars have recently concluded that the first digital gap remains a problem even in developed countries. Van Deursen and van Dijk (2019) argue that opportunities to connect to the internet and the diversity of devices are still unequally distributed according to resources and social categories and, further, suggest that this situation ensures the continuance of existing inequalities in internet skills, uses, and outcomes. However, to develop targeted digital policies aimed at reducing the digital gap, we need to better understand how, depending on the social position of individuals, the causal chain varies, starting with physical access to internet and terminating in internet use and outcomes.

Evidence from another research thread suggests that outcomes differ depending on the digital device used to connect to the internet; as some examples, emailing seems to be better supported by desktop and laptops, online gaming by especially powerful desktops and laptops, and shopping and banking by smartphones (Pearce & Rice, 2013). Furthermore, search types and durations differ depending on whether the person is using a desktop/laptop or tablet/smartphone. Consequently, accessing the internet using a mobile device may mean that a person is less likely ‘to gain as much economic, material or cultural benefits’ (Pearce & Rice, 2013) as a person using a computer. Napoli and Obar (2014) referred to a ‘mobile underclass’, consisting of individuals who exclusively use mobile devices to access the internet. This circumstance particularly affects developing countries, e.g., Thailand, where a large proportion of individuals rely on mobile devices (Kilenthong & Odton, 2014). However, there is still some uncertainty as to whether differences in device usage might be generational (Elena-Bucea et al., 2020; Penard et al., 2015), while the question remains as to whether we are underestimating the value of mobile access versus traditional wired access. Such propositions need to be contrasted while controlling for as many influences as possible.

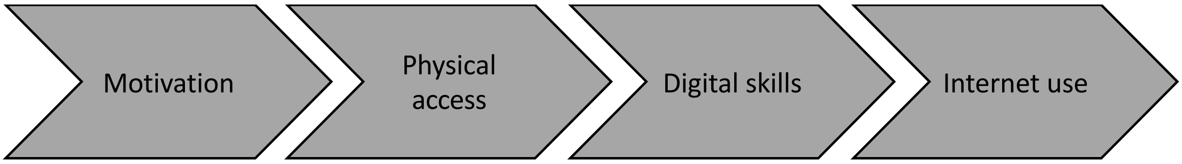
Our research is framed in the RA theory, as developed by van Dijk (van Dijk, 2005, 2012a, 2020) to explain heterogeneity in the internet access-to-use causality chain, and the proposition that a mobile underclass exists in developing countries. To investigate inequalities in the causality chain and social patterns in internet use, we used data on internet activity in Thailand (as an example of a developing country) to measure specific drivers of access to the internet. Specifically, we wished to address the following questions regarding Thailand: (1) to what extent does internet access explain gaps in the diversity of internet use; (2) to what extent do resources and social categories explain differences in the diversity of internet use; (3) to what extent do social categories moderate the effect of internet access on the diversity of internet use; and (4) can individuals be categorized according to the effect of internet access on the diversity of internet use. Our findings throw light, first, on current understanding of how the digital gap is socially produced in a developing country, and second, on social inequalities in the internet access-to-use causality chain, according to which we can infer whether or not a mobile underclass in fact exists.

## 2.2 Theoretical framework

Early internet research pointed to a divide between individuals with and without access to the internet (Attewell, 2001; Valadez & Duran, 2007) that came to be called the first digital divide (Chinn & Fairlie, 2007; Hargittai, 2010; Riggins & Dewan, 2005). Politicians (and researchers) hoped that closing this gap would reduce the reproduction of social inequalities in the digital realm (Thierer, 2000). However, later studies demonstrated that, even if differences in access to the internet were removed, how the internet is actually used continues to be socially patterned. Scholars have recently pointed to differences in access to the internet even in developed countries (Gonzales, 2016; Sylvester et al., 2017; van Deursen & van Dijk, 2019).

While several theories have been proposed to account for the effects of physical access on internet use (Compaine, 2001; Davis, 1989; Rogers, 1996; Thierer, 2000; Venkatesh et al., 2003), the RA theory (van Dijk, 2005, 2012a, 2020) has endeavoured to offer a comprehensive relational vision of the social production of digital inequalities that encompasses most of the previous theories. It describes and explains the social process of internet appropriation as a sequential path (see Figure 2.1), grounded in the fact that, to use the internet and ultimately enjoy the corresponding outcomes, the individual (1) must be motivated, (2) must have the physical means, and (3) must have the necessary digital skills. Differences in the distribution of motivations, physical access, digital skills, and uses will result in different internet use outcomes, with differences explained by the allocation of resources and social categories. The RA theory, therefore, ultimately suggests that any digital divide — in access, skills, use, and outcomes — is the result of an unequal distribution of resources and of social divisions between individuals. Accordingly, a digital divide in societies that reproduce an unequal distribution of resources brings about unequal outcomes in digital participation.

**Figure 2.1** Social internet appropriation process: the sequential path described by the resources and appropriation theory




According to the RA theory, while access is a necessary but insufficient condition to take full advantage of the internet (Valadez & Duran, 2007), digital skills are also a prerequisite, as demonstrated by several studies referring to developing countries (Lissitsa et al., 2017; Martínez-Domínguez & Mora-Rivera, 2020; Tewathia et al., 2020; Wijers, 2010). The social position of individuals shapes their interpretation of the benefits of digital media technologies, and, in consequence, their motivations, their development of digital skills, and their enjoyment of uses and outcomes (Tewathia et al., 2020; van Dijk, 2020).

### 2.2.1 Diversity of internet use

Internet use has been defined in terms of frequency of use, connection, duration of connection, depth of use, type of activities participated in, and diverse or differentiated use (Correa, 2016; Hargittai & Hinnant, 2008; van Deursen & van Dijk, 2014). According to the RA theory, differences in internet use mimic traditional inequalities in the social space and reproduce them in the digital space (Livingstone & Helsper, 2007; L. Robinson, 2009; van Deursen et al., 2015; van Deursen & van Dijk, 2014). Van Deursen and van Dijk (2015) have argued, nonetheless, that frequency and amount of time spent online should not be assumed to be related to optimal internet uses and outcomes, as those depend on how time is used online. Researchers have proposed different ways of classifying internet activities depending on theoretical frameworks and available data. Some classifications reflect offline outcomes (Helsper et al., 2016), while others measure activities in terms of diversity or patterns (Blank & Groselj, 2014; van Deursen & van Dijk, 2014). In this research, we explore internet use in terms of diversity of use (i.e., as a scale reflecting different uses made of the internet).

### 2.2.2 Access opportunities

Access refers to access to digital technologies and internet connections, whether in the home, at work, at school, or in public and community settings like libraries and internet cafes (Gonzales, 2016; Hassani, 2006; López-Sintas et al., 2012; van Dijk, 2020). To connect to the digital world, individuals need technological devices (desktop computers, laptops, smart TVs, tablets, smartphones, etc) and a fast and affordable internet connection. Individuals autonomously access the internet if they have the liberty to use it whenever and wherever they choose (Dimaggio et al., 2004). Good-quality, comprehensive, and ubiquitous access to the internet means people are likely to spend more time online and to live more online experiences (Gonzales, 2016; Hassani, 2006; Livingstone & Helsper, 2007, 2010; Mascheroni & Ólafsson, 2016). The process of appropriating digital benefits starts with collective appropriation at an internet café or in a community centre, library, school, or university, and progresses towards private appropriation in the home. The issue of household access is where the digital divide starts to deepen and to mark differences in possibilities for access, both within countries and between developed and developing countries (van Dijk, 2020). Internet access depends on subscriptions, electricity, software, hardware, etc (van Dijk, 2020) – usually relatively more costly in developing countries  (Fuchs & Horak, 2008; M. Lu, 2001) – so access refers not only to places where internet can be accessed but also to having access to suitable technological devices. Differences in the variety of ways of accessing the internet may produce differences in the content retrieved and in what is done when connected (Reisdorf et al., 2020; Zillien & Hargittai, 2009), and ultimately might evolve into different levels of digital skills and benefits (Kuhlemeier & Hemker, 2007; Mossberger et al., 2012; Napoli & Obar, 2014; Pearce & Rice, 2013; van Deursen & van Dijk, 2010, 2019). Internet applications usually offer different functionalities depending on the device used for access and connection (van Deursen & van Dijk, 2019); thus, desktops and laptops are viewed as productivity tools, while tablets and smartphones are viewed more as entertainment and consumption/e-commerce tools (Napoli & Obar, 2014; Pearce & Rice, 2013). In consequence, different devices offer different benefits, whereas all the devices, in combination, offer the full range of opportunities.

In our study of Thailand, we consider different dimensions of Thai users' access to the internet. We first consider (1) computer access opportunities (device diversity and where/when individuals use them), (2) mobile access opportunities (device diversity, covering concepts such as contracted services and maintenance costs), and (3) internet access opportunities (how, when, and where people connect to the internet). We then consider two additional variables related to the household dimension of access, namely, (4) household device diversity (different types of devices, if any, available in the home), and (5) household internet access (if any). We consequently propose the following hypotheses:

*H1: Computer access opportunities increase the diversity of internet use.*

*H2: Mobile access opportunities increase the diversity of internet use.*

*H3: Internet access opportunities increase the diversity of internet use.*

*H4: Household device diversity increases the diversity of internet use.*

*H5: Household internet access increases the diversity of internet use.*

### 2.2.3 Social inequalities

According to the RA theory (van Dijk, 2005, 2012a, 2020), inequalities in internet uses and outcomes are related to social divisions reflected in unequal resource distribution and social category differences. Resources and social categories relate individuals to their position in the social space (van Dijk, 2005, 2020), reflected in, for instance, educational categories (well-educated/less well-educated), occupational categories (entrepreneurs/workers, managers/employees, employed/unemployed), and household categories (partnered, single, with children, without children, etc). Personal social categories refer to other social divisions that do not reflect social position, e.g., age as a sociological category contrasts the behaviour of younger and older people, while gender contrasts the behaviours of men and women (Hargittai & Hinnant, 2008; Scheerder et al., 2017; van Deursen & van Dijk, 2014). In this research, we consider education, occupational status, and region of residence to be resources and social position categories, and age, gender, and marital status to be personal social categories.

*Education.* Education, which develops schemata for interpreting and acting in relation to reality, is one of the main barriers to personal use of the internet (Nishijima et al., 2017). Better educated individuals perceive the beneficial outcomes of using the internet, leveraging access to socially advance their positions and using digital skills to gain access to jobs, resources, and high-status groups (Bourdieu, 1984; Bourdieu & Passeron, 1990; van Dijk, 2020). An Indian study analysing the effect of social inequality on the digital divide recently reported that a higher education level increases use of the internet (Tewathia et al., 2020), while a similar finding has been reported for a study of internet diffusion in Cameroon (Penard et al., 2015). Accordingly, we propose the following hypotheses:

*H6a: Being better educated increases the diversity of internet use.*

*H6b: Education moderates the effect of internet access on the diversity of internet use.*

*Occupational status.* The main driver behind access to different and unequal internet outcomes is occupational status, i.e., being employed or unemployed (Gonzales, 2016; van Dijk, 2020). Van Deursen and van Dijk (2019) have found that being employed, having a higher income, and being well-educated increase the chances of individuals accessing the internet, and a similar pattern has been reported for an analysis of Shanghai survey data (Pan et al., 2011). Employed individuals are also more likely to access the internet using a greater variety of devices and connections. We accordingly hypothesize the following:

*H7: Occupational status influences the diversity of internet use.*

*Region.* Inhabiting a particular area or community may affect internet access opportunities (Correa, 2016; Srinuan et al., 2012). Urban areas and regions that concentrate industrial and commercial activity are likely to enjoy better quality, faster, and more reliable internet infrastructure than rural areas, even in developed countries (Kos-Łabędowicz, 2017; Salemink et al., 2017; Townsend et al., 2013). Thus, concerning Thailand, we hypothesize as follows:

*H8: Living in the Bangkok metropolitan area increases the diversity of internet use.*

*Marital status.* Marital status may influence access to and use of the internet (Helsper, 2010; van Deursen & van Dijk, 2019), as individuals' needs to interact socially vary at different life stages (López-Sintas et al., 2012). Shifts in life stages and changes in social roles lead to changes in daily routines, e.g., when singles become partnered, or when partnered people return to singledom. Singles may use the internet more frequently to interact and arrange interactions with peers (Pan et al., 2011). In contrast, people in couples may interact more with family than with friends, even when they meet the former regularly. We therefore hypothesize the following:

*H9: Being single increases the diversity of internet use.*

*Age.* Age is an indicator of both generational and structural effects. The generational effects derive from the fact that older individuals may have learned to use desktops/laptops before the advent of tablets/smartphones, whereas the reverse has happened with younger people. The structural effects result from the fact that the different generations are exposed to and share the same digital advances and social and economic events. Thus, younger individuals are more likely to use devices more for social interaction and leisure (Penard et al., 2015), whereas older users may use the internet more for information seeking, news, and personal development (López-Sintas et al., 2012; Martínez-Domínguez & Mora-Rivera, 2020; Serrano-Cinca et al., 2018; van Deursen & van Dijk, 2014). We therefore propose the following hypotheses:

*H10a: Being younger increases the diversity of internet use.*

*H10b: Age moderates the effect of internet access on the diversity of internet use.*

*Gender.* The social roles of men and women, as learned during youth, may mean that men access and use technology at a younger age, consequently placing them at an advantage in terms of favourable internet outcomes. However, the social meaning of gender may vary according to the temporal moment and to social position. According to the evidence, while women may have fewer opportunities to access the internet than men, this difference may have narrowed in recent years; in developed countries after the year

2000, women and men appeared to be equal in terms of accessing digital technologies at home, at work, and at school (van Dijk, 2020). However, according to Antonio and Tuffley (2014), the gender gap persists in developing countries. Concerning Thailand, we propose the following hypotheses:

*H11a: Gender influences the diversity of internet use.*

*H11b: Gender moderates the effect of internet access on the diversity of internet use.*

## 2.3 Data and methodology

### 2.3.1 Data

The Thai national statistical office provided microdata regarding the 2017 Household Survey on the Use of the Information and Communication Technologies.[1] The survey included interview data for 217,217 individuals sampled from 83,880 households. All members of households aged 15-75 years were interviewed, and the dataset, once cleaned, reflected 160,131 respondents, profiled as follows: 52.8% female; 90.1% aged 15-65 years old; 68.2% with a low education level; 71.3% employed; 64.6% married; and 30.2% resident in Central Thailand. Education labelled as low, intermediate, and high reflected the Thai education system (elementary and lower/lower secondary, upper secondary/post-secondary, and university and higher, respectively); occupational status was reflected in six categories (employed, unemployed, homemakers, students, disabled, and retired); and regions were classified as Bangkok (the capital city) and the Central, Northern, North-eastern, and Southern regions. Missing values were imputed as necessary from the mean value (numerical variables) or the most frequent category (factors).

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[1] The full report can be retrieved from http://www.nso.go.th/sites/2014en/itu

### 2.3.2 Scales and measurements

*Diversity of internet use*. Respondents were asked if they had used the internet for the following activities: (1) sending/receiving email; (2) seeking information; (3) ordering goods/services; (4) offering goods/services, (5) seeking health goods/information; (6) seeking government information; (7) downloading government information; (8) reading/downloading news; (9) job-seeking; (10) downloading entertainment; (11) downloading software; (12) online chatting; (13) social networking; (14) online studying/learning online; (15) voice over internet protocol (VOIP) telephony; (16) online/internet banking; and (17) sharing/uploading photos. Higher scores reflected greater diversity of internet use.

*Computer access opportunities*. Individuals were asked about the kind of device used in the previous three months and where/when they had used them, as follows: (1) personal computer/desktop computer; (2) laptop/notebook computer; (3) tablet; (4) household computer; (5) work (company/firm) computer; (6) education centre (school, college, university) computer; (7) internet cafe computer; (8) public service (library/information and communication technologies (ICTs) learning centre) computer; (9) other person's household computer; (10) district administration/organization computer; and (11) laptop/notebook computer in any other place.

*Mobile access opportunities.* Individuals were asked about mobile devices, payment mode, type of data service, etc, concretely: (1) whether they had a mobile phone; (2) number of feature phones (none, one, two or more); (3) number of smartphones (none, one, two or more); (4) mobile payment method (monthly, pay as you go/mobile top up, monthly payment plus mobile top up, other, none); (5) use of short message service (SMS); (6) use of data services (MMS, e-mail, social media); (7) use of mobile banking;

(8) use of phone functions (alarm clock, calendar); and (9) plans to buy a new mobile device (no plans, plans to buy a smartphone, plans to buy a feature phone).

*Internet access opportunities*. Indicators revealed how, when and where individuals connected to the internet, as follows: (1) type of connection (broadband ADSL/SDSL/VDSL, modem, mobile 3G, other connection, no connection); (2) if internet was accessed/used; (3) home access/use; (4) work (company/firm) access/use; (5) education centre (school, college, university) access/use; (6) internet café access/use; (7) public service (public library/ICT learning centre) access/use; (8) access/use from another person's home; (9) access/use from district administration/organization centre; (10) access using mobile phone; and (11) access using laptop/tablet.

*Household device diversity*. The indicator reflected types of equipment and devices, if any, in the home, as follows: (1) landline telephone; (2) fax; (3) personal/desktop computer; (4) laptop/notebook computer; (5) tablet; (6) whether device purchase is intended; and (7) reasons for not having a device (no need, no landline, cost, have access elsewhere, unable to use, unsafe for children).

*Household internet access*. The indicator reflected the speed of the internet connection (if any) and the type of device used to connect to the internet from home, as follows: (1) internet speed (ADSL/SDSL/VDSL broadband, modem, mobile 3G, other connection, no connection); (2) access via personal computer/desktop; (3) access via laptop; (4) access via tablet; (5) access via mobile phone; and (6) access via smart TV. All items were measured as a dichotomous yes/no score or according to the available options.

When variables are categorical, principal component analysis (PCA) and factor analysis are not capable of identifying interdependence between indicators; consequently, the best alternative is multiple correspondence analysis (MCA). MCA is for categorical variables what PCA is for numeric variables. For MCA, Greenacre (1993) has shown that the scores of individuals form an optimal scale when those scores are far apart, thereby maximizing differences between individuals. To compute optimal scales for our theoretical constructs, we used the first dimension of MCA, with results as summarized in Table 2.1 (a detailed description of the scales is available under request), while social categories are those listed in Table 2.2.

**Table 2.1** Multiple correspondence analysis (MCA) results

| **Scale** | **Definition** | **% variance* (MCA)** |
|---|---|---|
| Diversity of internet use | Internet as used for a broad range of activities | 71.5 % |
| Computer access opportunities | Computer device diversity and where/when used | 88.6% |
| Mobile access opportunities | Mobile device diversity, costs, payment modes, contracted data services, etc | 40.0% |
| Internet access opportunities | How individuals connect to the internet | 72.2% |
| Household device diversity | Digital devices available in the home | 49.1% |
| Household internet access | How internet is accessed in the home | 84.9 % |

* The proportion of variance captured or explained by the first MCA dimension.

**Table 2.2** Social categories

| **Personal social categories** | **n** | **%** | **Resources and social position categories** | **n** | **%** |
|---|---|---|---|---|---|
| **Marital status** | | | **Education** | | |
| Single | 36.904 | 23.0 | Low | 109.276 | 68.2 |
| Married | 103.482 | 64.6 | Intermediate | 30.280 | 18.9 |
| Widow | 11.745 | 7.3 | High | 20.575 | 12.8 |
| Divorced | 8.000 | 5.0 | **Occupational status** | | |
| **Gender** | | | Employed | 114.180 | 71.3 |
| Male | 75.510 | 47.2 | Unemployed | 13.096 | 8.2 |
| Female | 84.621 | 52.8 | Homemaker | 15.050 | 9.4 |
| **Age (years)** | | | Student | 11.011 | 6.9 |
| 15-35 | 48.563 | 30.3 | Disabled | 4.259 | 2.7 |
| 36-50 | 48.657 | 30.4 | Retired | 2.535 | 1.6 |
| 51-65 | 47.091 | 29.4 | **Region** | | |
| 66+ | 15.820 | 9.9 | Bangkok | 8.712 | 5.4 |
| | | | Central | 48.302 | 30.2 |
| | | | Northern | 33.922 | 21.2 |
| | | | Northeastern | 41.944 | 26.2 |
| | | | Southern | 27.251 | 17.0 |

### 2.3.3 Statistical analysis

We answered the first three of the four research questions using a linear model, considering three different inclusion scenarios: (1) the theoretical drivers of diversity of internet use; (2) the theoretical drivers of diversity of internet use plus resources and social categories; and (3) the theoretical drivers plus resources and social categories plus three interactions to uncover whether there was an impact on diversity of internet use (models 1, 2, and 3, respectively, in the Findings section). We then implemented a mixture regression model, which assumes that the sample is a mix of groups of individuals for whom the impact of explanatory variables on the dependent variable may differ due to the existence of heterogeneity (Wedel & Kamakura, 2000) reflected in social indicators. Flexibility in fitting finite mixture models makes them suitable for classifying observations into classes and simultaneously estimating different regression models for each class (Grün & Leisch, 2008).

We performed our analysis using R language and environment for data analysis(R Core Team, 2018), Greenacre's correspondence analysis (CA) package (Greenacre et al., 2018) to create our scales, and the flexmix package (Grün & Leisch, 2008) to estimate the mixture model.

## 2.4 Findings

### 2.4.1 To what extent does access to the internet explain differences in the diversity of internet use?

Model 1 in Table 2.3 points to a high value (0.718) for the adjusted $R^2$. All coefficients were statistically significant according to the p-value. As all scales were centred, it was easy to compare the importance of drivers behind diversity of internet use, with internet access opportunities (β=0.539) and computer access opportunities (β=0.223) having a greater positive effect. We therefore found support for hypotheses H1 and H3.

The effects of household device diversity (β=0.027) and household internet access (β=0.012) were small, comparatively speaking, a finding which may suggest that most connections to the internet may be made using work, school, or internet cafe computers and otherwise using smartphones. Access at home was most likely for entertainment (watching audiovisual productions) or to connect a laptop to the internet. Even though the effects were small, we found support for hypotheses H4 and H5.

Mobile access opportunities is a measure not only of the diversity of mobile devices but also of the capacity to finance the associated costs (data subscriptions, peripheral devices, etc). It was no surprise that the overall effect was less than for either computer access opportunities or internet access opportunities (β=0.143 vs β=0.223 and β=0.539), but greater than for household device diversity (β=0.027) or household internet access (β=0.012). Consequently, hypothesis H2 was supported.

### 2.4.2 To what extent do resources and social categories explain differences in the diversity of internet use?

Model 2 in Table 2.3 increased the explained variance to 0.737 ($R^2$), while the reduction in the Akaike information criterion (AIC) and Bayesian information criterion (BIC) measures indicated the superiority of this model. The greatest diversity of internet use was among better-educated individuals, with diversity decreasing as the level of education decreased (β=-0.155 for intermediate education and β=-0.223 for low education levels). This result supports hypothesis H6a.

Supporting hypothesis H7 is the fact that the diversity of internet use was greater for employed persons than for the other occupational categories except for individuals with disabilities. Supporting hypothesis H8 is the fact that individuals living Bangkok used the internet more. As hypothesized by H9, singles made more intensive use of the internet. Regarding personal social categories, as hypothesized by H10a, age was negatively related to the diversity of internet use (it decreased as individuals aged). Finally, hypothesis H11a was supported in that men used the internet less than women (the reference category).

### 2.4.3 To what extent do social categories moderate the effect of internet access on the diversity of internet use?

Model 3 reflects how age, gender, and education moderate the effects of computer access opportunities, mobile access opportunities, and internet access opportunities on the diversity of internet use. The explained variance further increased to 0.754, and the AIC and BIC measures were further reduced, indicating the superiority of this model. Note how the effects now correspond to the reference categories; thus, for highly educated young women, the coefficient for computer access opportunities fell to 0.217, the coefficient for mobile access opportunities rose to 0.736, and the coefficient for internet access opportunities fell to 0.286. The value of the intercept was also reduced (to 0.114).

Observing the coefficients for the interaction on the other social categories, we note that, in the case of computer access opportunities, the effect of social categories was very low, with the exception of education, where a negative effect resulted when education was low. Interestingly, the impact of internet access opportunities increased with age and decreased with education level, while gender showed a low negative effect ($\beta$=-0.028) for men. The opposite happened regarding mobile access opportunities, as the effect decreased as age increased and as education level decreased. These findings would suggest that young, well-educated individuals use less traditional means of internet access, i.e., they are more mobile-oriented than older and less well-educated individuals. However, both access types were lower among men than women. Hypotheses H6b, H10b and H11b are therefore supported.

In summary, concerning the predictive power of our models 1, 2, and 3, the adjusted $R^2$ indicates that diversity of internet use is mostly explained by the main scales (computer access, mobile access, internet access, household device diversity, and household internet access), while the social and personal categories, and the interaction between scales and those categories (also if significant), yield a relatively small improvement in the prediction of the dependent variables.

**Table 2.3** Linear regression analysis results

| | **Dependent variable: diversity of internet use** | | |
|---|---|---|---|
| **Coefficients** | **Model 1** | **Model 2** | **Model 3** |
| Intercept[1] | 0 | 0.314*** | 0.114*** |
| Computer access opportunities | 0.223*** | 0.211*** | 0.217*** |
| Mobile access opportunities | 0.143*** | 0.120*** | 0.736*** |
| Internet access opportunities | 0.539*** | 0.510*** | 0.286*** |
| Household device diversity | 0.027*** | 0.008*** | 0.008*** |
| Household internet access | 0.012*** | 0.014*** | 0.011*** |
| Gender (ref=Female) | | | |
| Male | | -0.029*** | -0.026*** |
| Age in years (ref=15-35) | | | |
| 36-50 | | -0.027*** | -0.014*** |
| 51-65 | | -0.038*** | -0.027*** |
| 66+ | | -0.025*** | -0.052*** |
| Marital status (ref=Single) | | | |
| Divorced | | -0.039*** | -0.039*** |
| Married | | -0.043*** | -0.043*** |
| Widowed | | -0.038*** | -0.047*** |
| Education (ref=High) | | | |
| Low | | -0.223*** | -0.074*** |
| Intermediate | | -0.155*** | -0.032*** |
| Occupational status (ref=Employed) | | | |
| Disabled | | 0.020*** | 0.017*** |
| Homemakers | | -0.009*** | -0.004NS |
| Retired | | -0.090*** | -0.007NS |

| | | | |
|---|---|---|---|
| Student | | -0.157$^{***}$ | -0.071$^{***}$ |
| Unemployed | | 0.010$^{***}$ | 0.001$^{NS}$ |
| Region (ref = Bangkok) | | | |
| Central | | -0.046$^{***}$ | -0.024$^{***}$ |
| Northern | | -0.056$^{***}$ | -0.034$^{***}$ |
| Northeastern | | -0.063$^{***}$ | -0.035$^{***}$ |
| Southern | | -0.061$^{***}$ | -0.030$^{***}$ |
| Computer access opportunities × age in years (ref=15-35) | | | |
| 36-50 | | | 0.028$^{***}$ |
| 51-65 | | | 0.010$^{*}$ |
| 66+ | | | -0.019$^{NS}$ |
| Computer access opportunities × gender (ref=Female) | | | |
| Male | | | 0.001$^{NS}$ |
| Computer access opportunities × education (ref=High) | | | |
| Low | | | -0.075$^{***}$ |
| Intermediate | | | -0.009$^{*}$ |
| Mobile access opportunities × age in years (ref=15-35) | | | |
| 36-50 | | | -0.143$^{***}$ |
| 51-65 | | | -0.212$^{***}$ |
| 66+ | | | -0.241$^{***}$ |
| Mobile access opportunities × gender (ref=Female) | | | |
| Male | | | -0.014$^{***}$ |
| Mobile access opportunities × education (ref=High) | | | |
| Low | | | -0.503$^{***}$ |
| Intermediate | | | -0.295$^{***}$ |
| Internet access opportunities × age in years (ref=15-35) | | | |
| 36-50 | | | 0.098$^{***}$ |
| 51-65 | | | 0.130$^{***}$ |
| 66+ | | | 0.125$^{***}$ |
| Internet access opportunities × gender (ref=Female) | | | |
| Male | | | -0.029$^{***}$ |
| Internet access opportunities × education (ref=High) | | | |
| Low | | | 0.172$^{***}$ |
| Intermediate | | | 0.104$^{***}$ |
| R^2 Adjusted | *0.718* | *0.737* | *0.754* |
| AIC | *91015* | *79981* | *68972* |
| BIC | *91085* | *80231* | *69401* |

**Notes:** In linear regression the intercept represents the value estimated for the dependent variable when all other predictor variables are equal to 0. In our analysis, in model 1 the intercept is 0 as all variables are standardized (mean=0; SD=1), whereas in models 2 and 3, the intercept represents the coefficients estimated for the reference level of the categorical variables (e.g., in model 2 the intercept of 0.314 represents the coefficient estimated for a female, aged 15-35 years, single, well educated, employed, and living in Bangkok).$^{***}$Significant at $p<0.001$; $^{**}$significant at $p<0.01$; $^{*}$significant at $p<0.05$; $^{NS}$ non-significant. AIC: Akaike information criterion (the lower, the better); BIC: Bayesian information criterion (the lower, the better).

### 2.4.4 Can individuals in Thailand be categorized according to the effect of internet access on the diversity of internet use?

The social pattern reflected in model 3 suggests that there are at least two user segments, one whose internet access is traditional, and another relying on a variety of mobile means and devices to access the internet (referred to in what follows as ‘traditional users’ and ‘mobile users’). To identify the effect of the theoretical constructs on those two groups, we used a mixture regression model. Table 2.4 reports the corresponding coefficients obtained as a result of the mixture regression estimate, and, for comparison purposes, the coefficients estimated using the linear regression corresponding to model 1 (the global model). Social indicators (see Table 2.5) were used to describe the individuals included in each group. For the mobile user group, the most crucial driver of internet use was mobile access opportunities (β=0.625), followed by internet access opportunities (β=0.259), and computer access opportunities (β=0.253), whereas for the traditional user group, the diversity of internet use was influenced mainly by computer access opportunities (β=0.742) and internet access opportunities (β=0.550).

**Table 2.4** Mixture regression analysis. Predictors of the diversity of internet use according to two clusters of users indentified by the mixture regression model

| Scale | Dependent variable: diversity of internet use | | |
|---|---|---|---|
| | **Global model** | **Mobile users** | **Traditional users** |
| Computer access opportunities | $0.223^{***}$ | $0.253^{***}$ | $0.742^{***}$ |
| Mobile access opportunities | $0.143^{***}$ | $0.625^{***}$ | $0.000^{***}$ |
| Internet access opportunities | $0.539^{***}$ | $0.259^{***}$ | $0.550^{***}$ |
| Houshold device diversity | $0.027^{***}$ | $0.011^{NS}$ | $0.000^{NS}$ |
| Household internet access | $0.012^{***}$ | $0.028^{***}$ | $0.000^{NS}$ |

**Note:** $^{***}$Significant at p<0.001; $^{**}$significant at p<0.01; $^{*}$significant at p<0.05; $^{NS}$ non-significant.

As for the social properties of the individuals in the two groups, the mobile user group could be profiled as follows: female, aged 15-35 years (55.5%, vs 30.3% for the sample), well educated (university 23.7%, vs 12.8% for the sample), a student (16.5%, vs 6.9% for the sample), single (16.5%, vs 6.9% for the sample), and resident in Bangkok (8.3%, vs 5.4% for the sample) or Central Thailand (33.9%, vs 30.2% for the sample). In contrast, the traditional user group was composed of individuals who were older, less well-educated, unemployed, with disabilities, most typically married or widowed, and living in Northern Thailand.

**Table 2.5** Social properties of mobile and traditional users

| **Social indicators** | **User profiles** | | |
|---|---|---|---|
| | **Global model** | **Mobile users** | **Traditional users** |
| **Gender** | | | |
| Male | 47.2% | 48.3% | 46.8% |
| **Age (years)** | | | |
| 15-35 | 30.3% | 55.5% | 21.6% |
| 36-50 | 30.4% | 29.9% | 30.5% |
| 51-65 | 29.4% | 13.3% | 35.0% |
| 66+ | 9.9% | 1.3% | 12.9% |
| **Education** | | | |
| Low | 68.2% | 45.8% | 76.0% |
| Intermediate | 18.9% | 30.5% | 14.9% |
| High | 12.8% | 23.7% | 9.1% |
| **Occupational status** | | | |
| Employed | 71.3% | 70.9% | 71.4% |
| Unemployed | 8.2% | 3.2% | 9.9% |
| Homemaker | 9.4% | 7.2% | 10.1% |
| Student | 6.9% | 16.5% | 3.5% |
| Disabled | 2.7% | 0.5% | 3.4% |
| Retired | 1.6% | 1.2% | 1.6% |
| **Marital status** | | | |
| Single | 23.0% | 39.8% | 17.2% |
| Married | 64.6% | 53.9% | 68.3% |
| Widowed | 7.3% | 1.7% | 9.3% |
| Divorced | 5.0% | 4.5% | 5.2% |

| | | | |
|---|---|---|---|
| **Region** | | | |
| Bangkok | 5.4% | 8.3% | 4.4% |
| Central | 30.2% | 33.9% | 28.9% |
| Northern | 21.2% | 18.2% | 22.2% |
| Northeastern | 26.2% | 21.0% | 28.0% |
| Southern | 17.0% | 18.7% | 16.4% |
| **Segment size (n)** | 160,131 | 41,183 | 118,948 |

To aid interpretation of this segmentation of internet users, Table 2.6 reports a breakdown of diversity in internet use for the traditional users and mobile users, along with, for comparative purposes, the global mean profile for the entire Thai population.

Mobile users make greater and more varied use of the internet than traditional users. Their internet use, furthermore, is mainly related to social networking (96.60%), downloading entertainment (83.80%), sharing/uploading photos (64.20%), and reading/downloading news (53.40%). However, their use is not limited to communication, information-seeking, and entertainment; they also seek health goods/information (48.40%), send/receive email (38.30%), and seek government-related information (33.00%). Finally, noteworthy is the higher proportion of mobile users compared to traditional users using the internet for studying/learning, ordering goods/services, and online/internet banking (19.30%, 13.40%, 12.00%, respectively).

Those results support two inferences regarding Thailand: first, the existence of a generational gap between mobile and traditional users (cf. the descriptors of both groups); and second, the greater diversity of internet use by mobile users.

**Table 2.6** Diversity of internet use by mobile and traditional users

| | User profiles | | |
|---|---|---|---|
| **Diversity of internet use activities** | **Global %** | **Mobile users %** | **Traditional users %** |
| Sending/receiving email | 14.60% | 38.30% | 7.70% |
| Seeking information | 19.50% | 51.60% | 10.20% |
| Ordering goods/services | 4.50% | 13.40% | 2.00% |
| Offering goods/services | 2.00% | 6.30% | 0.70% |
| Seeking health goods/information | 18.00% | 48.40% | 9.20% |
| Seeking government information | 12.00% | 33.00% | 5.90% |
| Downloading government information | 6.20% | 18.40% | 2.70% |
| Reading/downloading news | 22.30% | 53.40% | 13.30% |
| Job seeking | 1.70% | 5.80% | 0.60% |
| Downloading entertainment | 40.10% | 83.80% | 27.40% |
| Downloading software | 7.60% | 21.70% | 3.40% |
| Online chatting | 10.00% | 27.10% | 5.00% |
| Social networking | 45.80% | 96.60% | 31.10% |
| Online studying/learning online | 7.30% | 19.30% | 3.90% |
| VOIP telephony | 16.60% | 42.20% | 9.20 % |
| Online/internet banking | 3.90% | 12.00% | 1.60% |
| Sharing/uploading photos | 28.80% | 64.20% | 18.50% |

VOIP, voice over internet protocol.

## 2.5 Discussion

Our results show that the main driver behind diversity of internet use in Thailand is internet access opportunities, followed by computer access opportunities; this suggests that more opportunities to connect to the internet and to access computers play a crucial role in explaining the diversity of internet use as Reisdorf and associates have recently found (Reisdorf et al., 2020). The fact that the effect of internet access opportunities was greater than the effect of computer access opportunities suggests that the latter is a necessary but insufficient condition for internet use (Gonzales, 2016; Hargittai, 2004; Hassani, 2006; Mascheroni & Ólafsson, 2016; Napoli & Obar, 2014; van Deursen & van Dijk, 2019; van Dijk, 2012a, 2020).

Mobile access opportunities is the third crucial driver behind the diversity of internet use, indicating that household internet access and household device diversity play a marginal role in Thailand. Even though our model only takes into account the ways individuals access the internet, these account for almost three-quarters of the variance in the sample and make it clear that computer access opportunities, mobile access opportunities, and internet access opportunities are the most important drivers behind internet use.

Even though researchers have argued that the introduction of digital technologies and household internet connectivity would increase the digital gap (van Dijk, 2005, 2020), our findings suggest that, in Thailand, household access (internet access and device diversity) has a very minor impact on the diversity of internet use. Broadband cable coverage in Thailand is low (only 11.9% penetration in 2017), but mobile access is widespread, even in rural areas (Kilenthong & Odton, 2014). As other researchers have proposed (J. Lu, 2014; Marler, 2018), it seems reasonable to suppose that Thailand may follow a digital path different from that of developed countries, with access mainly based on work/school/internet café facilities and personal devices. It is projected that, by 2020, 90% of all subscriptions worldwide to the internet will be based on smartphones (Marler, 2018); therefore, the development of the 5G technologies may open up the possibility for developing countries to reduce the digital gap with more developed countries.

When we explored how the diversity of internet use was socially patterned in Thailand, we found that education was a key factor, indicating that well-educated individuals may have more means and opportunities to take full advantage of the benefits offered by the internet, as predicted by the RA theory (Dimaggio et al., 2004; van Dijk, 2020) and as reported for other developing countries (Martínez-Domínguez & Mora-Rivera, 2020; Penard et al., 2015; Tewathia et al., 2020). Being employed increased the diversity of internet use, which may indicate that people are accessing the internet at work

(Kilenthong & Odton, 2014). Individuals with disabilities also used the internet for a higher range of activities (probably because they have more free time), corroborating findings elsewhere (van Deursen & van Dijk, 2014). Being single led to more diversity of internet use, probably due to increased social interactions online (van Deursen & van Dijk, 2019). As for individuals living in Bangkok compared to other areas of Thailand, we found support for the proposition that individuals living in urban areas used the internet more intensively, probably due to good infrastructure and high levels of commercial and technological activities (Kilenthong & Odton, 2014; Kos-Łabędowicz, 2017; Salemink et al., 2017; Serrano-Cinca et al., 2018; Townsend et al., 2013); this was the case not only for social interactions (Elena-Bucea et al., 2020; van Deursen & van Dijk, 2014) but also for e-commerce and e-banking (Meng & Hsieh, 2013). Corroborating the findings of other researchers (Mascheroni & Ólafsson, 2016; Pew Research Center, 2018; van Deursen & Helsper, 2015b; van Deursen & van Dijk, 2019; van Dijk, 2020), we found that young people made more diverse use of the internet. As for gender, although recent research by van Dijk (2020) suggests that access opportunities are similar for women and men, we found that women in Thailand make more diverse use of the internet than men. Researchers in Chile have found that digital skills are negatively related to being female, but, after controlling for differences in digital skills, reported that being female is positively associated with internet use (Correa, 2016); this finding was also recently reported for Mexico (Martínez-Domínguez & Mora-Rivera, 2020). In our study, in which access opportunities are theoretically and empirically correlated with digital skills, for the same digital skills, diversity of use was greater for women than for men. Why women and men might have different patterns of internet use, according to (Schehl et al., 2019), remains unexplained, although differences in findings may be due to not controlling for digital skills.

The description of the internet use patterns for mobile compared to traditional users in Thailand would suggest that the former are more active in all areas of internet use – not only in communication and entertainment, but also in more productive activities usually associated with wired internet use. Our findings, viewed in combination with the description of users in each of those two groups, would point not only to a generational divide (traditional users are both older and less well-educated than mobile users), but also to differences in diversity of internet use (traditional users make more limited use of the internet than more mobile users). In Thailand, therefore, mobile access to the internet is more diverse and associated with a younger generation.

In summary, in Thailand as in other developing countries (Correa, 2016; Correa et al., 2017; Martínez-Domínguez & Mora-Rivera, 2020; Penard et al., 2015; Tewathia et al., 2020), diversity of internet use can be socially profiled as corresponding to young, well-educated, employed, single women living in urban environments, which, as a profile, is similar to that corresponding to more developed countries (Dimaggio et al., 2004; Livingstone & Helsper, 2007; L. Robinson, 2009; van Deursen et al., 2015; van Deursen & van Dijk, 2014, 2019). Positional resources and social categories not only produce differences in the diversity of internet use but also explain heterogeneity in how specific drivers affect that diversity, giving rise, in our study of Thailand, to two classes of internet users: mobile users (around a quarter of the population) and traditional users. The fact that mobile users are typically city-based, young, well-educated, single women, some working and some still studying, corroborates a finding reported elsewhere (Srinuan et al., 2012). As for traditional users, these tend to be older, less well-educated, employed, married individuals, who are not necessarily resident in urban areas. Mobile users mainly use smartphones, while traditional users use more traditional wired devices (typically desktops or laptops). We found that mobile users were better educated, contrasting with reports by other researchers (Napoli & Obar, 2014; Pearce & Rice, 2013; Serrano-Cinca et al., 2018; van Deursen & van Dijk, 2014; van Dijk, 2020).

Consequently, while we found no support for a mobile underclass, we did find support for a generational difference in internet access patterns, an interpretation that corroborates the recent finding by Reisdorf and associates (Reisdorf et al., 2020).

### 2.5.1 Theoretical contribution

Our main theoretical contributions are two. First, we contribute to current understanding of how the digital gap is socially produced (van Deursen & van Dijk, 2019) in developing countries. Considering different individuals' resources and social categories, we point to gender, age, and education as most affecting the internet access-to-use causality chain (drivers and diversity of internet use). Thus, our analysis stresses the importance of considering society as composed of classes of mixed individuals for which theoretical constructs may have different effects on internet use. Most research implicitly assumes that access has a homogeneous effect on internet use; however, assuming that the way people access the internet has a similar impact on internet use may produce biased conclusions and policies.

Second, our findings suggest that drivers behind the diversity of internet use may be generational and technology-based. This would suggest that we need to switch the research focus from studying households to studying individuals, even in less developed countries. Directing the focus to individuals, rather than families, may change the perception that young people's use of mobile access may reflect a mobile underclass. It may be that the underclass is the older wired generation that rarely or never use mobile access.

### 2.5.2 Limitations and further research

Our study's main limitation is that it was conducted considering only a single country and using secondary data. Multi-country research designs are necessary to test whether the two classes of internet users that we identified in Thailand – younger mobile users and older traditional users – exist in other countries and in what proportions. Furthermore, data from several temporal points are needed to test for generational changes in internet use diversity. Finally, primary data that reflects proper measures of the RA theory constructs, including digital skills, would result in better measures and tests of internet use and diversity.

## 2.6 Conclusion

Our research, focused on Thailand as a developing country, contributes to the development of the sequential model of internet appropriation proposed by the RA theory. Internet access opportunities seem to be the primary driver of the diversity of internet use, followed by computer access opportunities, then mobile access opportunities. The effect, nonetheless, is moderated by positional resources and social categories, most especially, education, age, and gender. The impact of different drivers on the diversity of internet use is unequal. For a mobile user class (mainly younger and well-educated women), the main driver is mobile access opportunities, followed by internet access opportunities, whereas for a traditional user class, the main driver is computer access opportunities, followed by internet access opportunities. Our findings suggest that the drivers behind diversity of internet use may be generational, suggesting a need to switch focus from studying households to studying individuals, even in less developed countries.

# Chapter 3

## The social process of internet appropriation: The relative importance of country, individual resources and social categories

In this chapter, we generalize and extend the sequential model proposed by the resources and appropriation (RA) theory to explain the digital divide in the European Union plus the United Kingdom (EU27+UK). We measure the theoretical constructs of the model with data provided by the EU and test the theoretical predictions using a partial least squares structural equation model (PLS-SEM). We find support for the hypothesized relationships but also find that the effects vary depending on the digital development level of countries. While education overall is the primary determinant of the social production of digital inequalities, a country's digital development level is crucial for less well-educated Europeans. These findings have theoretical and practical implications: (1) they call into question the homogeneity of the effect of causal relationships and the assumption that individuals differ only in terms of motivation, access, and digital skills, and (2) they indicate that socially disadvantaged Europeans benefit from living in more digitally developed countries. Finding from this chapter have been recently published in *Telecommunication Policy* (Lamberti et al., 2021). Chapter 3 is organized as follows. We first consider the theoretical background and describe our conceptual model and research hypotheses. We next describe the research design in terms of aims, data, and analyses. We then report our results, our theoretical construct measurements, and our estimates of the causal links that explain heterogeneity in the model. Finally, we discuss our findings and present our conclusions.

## 3.1 Introduction

People use the internet for entertainment but also to increase their chances of social and economic advancement, e.g., to improve their education using distance learning, to work from home or start their own business, to make better-informed health decisions, to find lower-priced goods and services, etc. Digital competence is becoming increasingly important for individuals to improve their position in the social hierarchy and for firms to enhance the quality of their human resources and increase their productivity and competitiveness. However, evidence from the literature suggests that physical possibilities for accessing the internet, digital skills, and uses of the internet are not equally distributed in society.

The RA theory (van Deursen & van Dijk, 2015; van Dijk, 2005, 2012a, 2020) proposes a sequential model to explain how social inequalities are produced in internet appropriation. The sequential model covers attitudes (i.e., motivations to use the internet), physical access to devices and connections, digital skills, and internet use (Van Dijk, 2020). The complete sequential model has only been tested on a sample of Dutch citizens (van Deursen & van Dijk, 2015), although partial tests have been conducted in several countries (Hargittai, 2002; Scheerder et al., 2017; van Deursen et al., 2016; van Deursen & van Dijk, 2015); as for comparative studies (Cueto et al., 2018), none have as yet been implemented using the complete model.

The relational view of inequality adopted by the RA theory (Bourdieu, 1984; Tilly, 1999; van Dijk, 2020) is based on Bourdieu’s (1984) theory of consumption and Tilly’s (1999) theory of durable inequality. Both theories, together with the RA theory, direct our attention to the social positioning of people within and between countries and to the fact that individuals temporarily occupy positions based on their resources, according to

Bourdieu's theory (called autonomous goods by Tilly). In all cases, therefore, practices will be related to positions and social categories occupied temporarily by individuals in clusters. What interests social researchers is the relationship between resources (i.e., autonomous goods) and practices (i.e., relational goods) and the social categories in which resources and practices are unequally distributed (Tilly, 1999, p. 26). The RA theory, then, suggests that theoretical relationships between attitudes, physical access, digital skills, and internet use may vary across countries, resources, and social categories. Furthermore, inequalities in internet appropriation produced by country-specific resources may operate in ways that reduce any disadvantages accruing to privileged individuals, although, according to (van Dijk, 2020), this proposition is an empirical one.

The aim of this research was to identify the relative importance of between-country and within-country resources and social categories in producing inequalities in the process of internet appropriation. We first tested the sequential model of digital technology appropriation for the EU27+UK,[2] and we then checked to what extent the proposed theoretical relationships in the model differed depending on the digital development of countries and other indivdiual-specific drivers of inequality.

We contribute to the development of the RA theory in two ways: first, by describing the different ways in which the relationships hypothesized by the sequential model differ between countries depending on their level of digital development; and second, by identifying the relative importance of country-specific and individual-specific resources and social categories in the social production of digital inequalities. The latter issue is of paramount importance, because public material resources, like the digital development of countries, positively affect the possibilities for reducing the digital gap, especially in

[2] The list of EU27+ UK countries is available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:EU_enlargements

the short term. Thus, if the primary producers of inequality are country-specific rather than individual-specific resources and social categories, then countries can more easily develop targeted digital policies aimed at addressing inequalities.

## 3.2 Theoretical framework

Social and economic life nowadays is mostly and increasingly digital. The digital technologies play an essential role in almost every aspect of our lives, including social interactions, economic exchanges, and political campaigns. Instant messaging and social media have eroded physical distances and help coordinate in-person interactions. Facebook, Twitter, and even WhatsApp play a critical role in political campaigning (Friesen et al., 2019). E-commerce, e-government, e-health, e-learning, e-banking, and e-finance are all means for conducting the corresponding activities online, with digital technologies keeping track of all transactions (World Bank, 2018). Privileged positions in society are reproduced by firms – and also by individuals – in the deployment of the digital technologies to the advantage of each (Autor, 2015; Bresnahan et al., 2002).

Researchers and policymakers, however, have concerns regarding inequalities in access to and use of the digital technologies. Researchers initially examined the reproduction of social inequalities in terms of access to digital technologies, identifying, as the so-called digital divide, the gap between individuals with and without access within and between countries (Abdollahyan et al., 2013). While many policies were introduced that aimed to close that first digital divide, subsequent research showed that a more persistent gap was emerging in terms of different uses made of the internet, referred to as the second digital divide (Hargittai, 2002; Hargittai & Hinnant, 2008). The endeavor to understand the processes that generated the second divide led to awareness of what could be named a third divide, related to individual digital skills that explain the gap between access and uses (Hargittai, 2002; Scheerder et al., 2017; van Deursen & Helsper, 2015b; van Deursen & van Dijk, 2015). However, to understand the digital divide better, the gap in digital skills suggests that we need to examine the sequential process that produces the gap, starting from attitudes, motivations, and possibilities for physically accessing the internet and developing digital skills, and ultimately examining particular uses and possible outcomes of internet use. If we look at the sequential process that ends in a digital divide, the first divide would be the access gap, the second the skills gap, and the third the uses and outcomes gap. Understanding the process underpinning internet appropriation is crucial because some individuals or groups are argued to be at a disadvantage in comparison with other sectors of society.

### 3.2.1 The social process of internet appropriation leading to a digital divide

van Dijk and associates (van Deursen & van Dijk, 2015; van Dijk, 2005, 2012a, 2020) have proposed a sequential model of internet use to describe the process of internet appropriation that is formalized in their RA theory. The internet appropriation process that results in a digital divide reflecting social inequalities is based on four constructs that influence each other sequentially: attitudes, physical access, digital skills, and internet uses and outcomes. In this study, due to a lack of appropriate data on attitudes, we measure the precedent of attitudes, i.e., perceived barriers to internet use.

*Perceived barriers to internet use.* Motivations segment individuals according to those who want/do not want, can/cannot, or care/do not care about access to digital technologies (Ragneda & Muschert, 2013). While being motivated means having a positive attitude towards doing something (Ryan & Deci, 2000), to be motivated to use digital technologies, individuals may need to overcome structural barriers, as argued by Porter and Donthu (2006, p. 1001). According to a World Economic Forum white paper (World Economic Forum, 2016), barriers to internet use fall into four categories: (1)

infrastructure, (2) awareness and cultural acceptance, (3) affordability, and (4) skills. The first category can be interpreted as the availability of the corresponding public material resource, the second as a social resource – called social barriers by (van Deursen & Helsper, 2015b) when absent or barely present – and the last two as related to economic and digital competence barriers, respectively. In this research, as mentioned above, we refer to perceived barriers to internet use, as our measure of barriers reflects only part of motivated access as described in the RA theory.

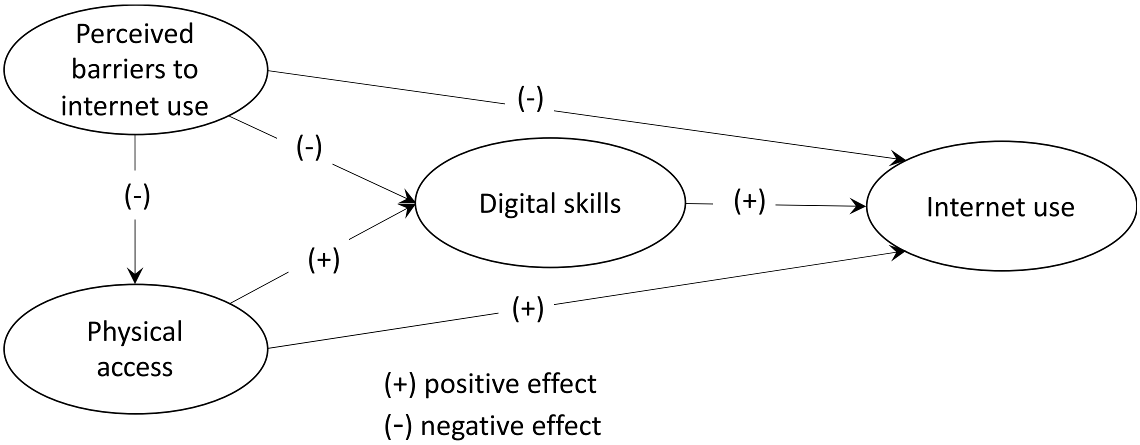
Research conducted by Venkatesh et al. (2003) has found that a positive attitude towards digital technologies is a precondition to using digital devices and accessing the internet. Researchers have found support for the proposition that attitudes reflect differences in both internet access (Brandtzæg, 2010) and internet use (Dutton & Reisdorf, 2017; Helsper, 2012; Porter & Donthu, 2006; van Deursen & van Dijk, 2015). Poor digital infrastructure and low cultural acceptance may affect physical access, while internet-related anxiety is a psychological barrier that may have a negative bearing on internet use (Durndell & Haag, 2002; Meuter et al., 2003). We can therefore expect that such barriers to internet use will have a negative impact on physical access, digital skills, and internet use.

*Physical access.* Since the earliest studies of the first digital divide, researchers have referred to physical access as the opportunity to access the internet (Dimaggio et al., 2004; Hargittai, 2003). According to van Deursen and van Dijk (2015), physical access can be defined in terms of the different devices that people use to access the internet and the entire web, including desktops, laptops, tablets, smartphones, game consoles, and interactive television (van Deursen & van Dijk, 2015, 2019). Zillien and Hargittai (2009) have further proposed that the quality of equipment may affect what is done while connected, while van Deursen and van Dijk (2010, 2019) have suggested that differences in physical access might evolve into different online skill levels; according to Napoli and Obar (2014), the outcome could be the emergence of a mobile internet underclass that reflects a deepening of the digital divide. Considering all those findings that physical access is associated with skill levels and diversity of internet uses (Kuhlemeier & Hemker, 2007; Mossberger et al., 2012), we propose that physical access positively influences the development of digital skills and internet use.

*Digital skills.* From the construction of theoretical concepts regarding attitudes and physical access and their links with internet use, researchers have turned their attention to the issue of the skills and abilities needed to use the internet efficiently and effectively (Hargittai, 2002; Hargittai & Shafer, 2006). Digital skills have been conceptualized in different ways (Broos & Roe, 2006; Hargittai & Hinnant, 2008; Litt, 2013; van Deursen, Courtois, et al., 2014; van Deursen et al., 2016; van Deursen & van Dijk, 2008), but can especially be categorized according to the following six dimensions: medium-related skills, content-related skills, information skills, communication skills, safety skills, and problem-solving skills (Ferrari, 2012; Hargittai et al., 2019; van Deursen & Mossberger, 2018; van Deursen & van Dijk, 2009, 2010, 2015; van Dijk & Hacker, 2003). Following previous research, we define digital skills as the ability to use the internet to (1) obtain information, (2) communicate information, (3) solve software and hardware problems, and (4) solve substantive problems. Researchers have found evidence that the possession of internet skills has a positive effect on internet use (van Deursen, Courtois, et al., 2014; van Deursen et al., 2011; van Deursen, Helsper, et al., 2014; van Deursen & van Dijk, 2015), and particularly on expressive use of the internet (Shaw & Hargittai, 2018).

*Internet use.* Internet use has been defined in a variety of ways, including in terms of frequency of use, connection duration, diversity of uses, and variety of activities (Hargittai & Hinnant, 2008; van Deursen & van Dijk, 2014). Social heterogeneity arising from the social properties of individuals may reproduce traditional distinctions in internet use (Livingstone & Helsper, 2007; L. Robinson, 2009; van Deursen et al., 2015; van Deursen & van Dijk, 2014). However, van Deursen and van Dijk (2015) have argued that frequency and time spent online should not be necessarily interpreted as the best potential outcomes of internet use; rather, we should also consider precisely how time online is used. The classification of internet activities proposed by (Helsper et al., 2016) takes into account potential outcomes of time spent online as follows: economic (related to property, finance, employment, education, etc), cultural (related to identity, belonging, etc), social (reflecting personal, formal, political networks, etc), and personal (health, lifestyle, self-actualization, leisure, etc). Other researchers have classified internet use in terms of activity patterns such as information seeking, personal development, social interaction, leisure, entertainment, commercial transactions, commerce, emailing, blogging, and production (Blank & Groselj, 2014; van Deursen & van Dijk, 2014). Internet uses can therefore be operationalized in different ways depending on theoretical frameworks and available data. Accordingly, for our purposes and in line with van Deursen and van Dijk (2015), we define internet use in terms of diversity of uses, i.e., as the number and variety of different internet activities participated in online. Our sequential model is depicted in Figure 3.1.

**Figure 3.1** The sequential model of internet use




**Source:** Authors, adapted from van Deursen and van Dijk (2015).

### 3.2.2 Between-country differences in internet appropriation: digital development

We expect that there may be differences in causal links due to how country-specific barriers affect physical access, the development of digital skills, and internet use. Several studies have shown that an unequal distribution of resources produces inequalities in attitudes, physical access, digital skills, and internet use within a country (Hargittai, 2010; Hargittai et al., 2019; van Deursen & van Dijk, 2014; van Dijk, 2012a). However, inequalities in relation to telecommunication infrastructures, digital policies, wealth, and education also result in between-country differences (Chen & Wellman, 2004; Cueto et al., 2018; Kos-Łabędowicz, 2017; OECD, 2001). Cruz-Jesus et al. (2012) have proposed the existence of two kinds of drivers of digital inequality, one operating at the international level, and the other operating at the intra-national level, i.e., between and within countries, respectively. Digital infrastructure development is a major challenge for less digitally advanced countries with large rural populations (van Dijk, 2013, 2020; World Economic Forum, 2016), as building up an interconnected digital network requires a massive and very costly investment by firms, governments, and individuals. Since most developing countries cannot afford this investment, to their detriment they cannot move on to more advanced digital technologies.

According to van Dijk (2020), by 2000-2005, developed countries reached a point in the diffusion of digital technologies from which physical access quickly spread out to all individuals. Developing countries, however, have not as yet reached that point, although mobile internet access may lead to a reduction in the digital gap (Donner, 2015; Donner & Bezuidenhoudt, 2013; Donner & Walton, 2013). Digital devices are, logically, not of much use to individuals if they cannot connect through stable and affordable connections. An effective digital infrastructure requires a network of access that reaches most individuals, a transparent regulatory framework for firms, a tax system that fosters private sector investment in building the digital network, and the development of new business models that ensure that it is profitable for individuals and firms to engage in the digital transformation of their country. Furthermore, even if individuals can digitally connect, local content has to be available in mother tongues and cultures to reduce the digital gap within a country (Napoli & Obar, 2014, p. 330), given that only the most privileged individuals will be able to access content available in other languages (English mainly). Findings reported by Cruz-Jesus et al. (2012) suggest that countries need to advance along two dimensions of the digital divide: the individual level (access to and use of the internet), and the organizational level (firms and governments).

Even with an excellent infrastructure and content reflecting the local language and culture, citizens will still need affordable connections and equipment. Affordability depends on market mechanisms, but demand (depending on how useful the technology is to individuals and their willingness to pay) and supply (depending on competition in offers of affordable technology) are affected by a country's digital infrastructure and other country-specific properties. If the population is sufficiently large and wealthy, the elasticity of demand will drive prices down, whereas the opposite will happen in smaller and less wealthy countries. Even though globalization, by aggregating local markets into a massive global market, can make it profitable to develop and offer low-cost digital devices, firms will still mainly be interested in densely populated markets where an infrastructure can give service to many people.

Lack of awareness of the benefits of digital technologies is typically accompanied by high psychological barriers and by little motivation to access the internet and to develop the skills necessary to benefit from the internet. This fact has both individual and social consequences. Because privileged individuals have the necessary conditions for physical access and perceive the benefits of, and are motivated to use, the internet, they contribute to widening the digital gap between themselves and non-privileged individuals. Furthermore, another kind of inequality emerges when we compare social groups, as people tend to live within social groups in which most members have similar levels of access; the fact that social groups of privileged individuals have physical access to the internet, the necessary digital skills, and varied uses for the internet creates a bubble in which they can exchange help, advice, knowledge, information, etc. In fact, researchers have found that social capital acquired in the usual social network has a bearing on physical access, and also that connection with people in different social networks may also influence internet use intensity. A famous example is Steve Jobs, co-founder of Apple Computers Inc., who, lacking the technical skills to develop a new game for Atari, turned for help to Steve Wozniak, a close friend and engineer at Hewlett Packard (Wikipedia, 2020).

In generating social inequalities, differences in digital skills operate not only within countries but also between countries. Furthermore, the evolution of digital technologies is such that, today, digital skills are being embedded in devices, making these easier to use but also making them more expensive. This means that individuals in larger and more technologically advanced countries will benefit to the detriment of individuals from other countries.

Consequently, we can expect differences in the effects brought about by causal links in the sequential model of social internet appropriation according to the following hypotheses:

*H1: The more digitally developed a country, the less the impact of barriers to internet use on the other constructs in the sequential process.*

*H2: The more digitally developed a country, the less the impact of physical access on the other constructs in the sequential process.*

*H3: The more digitally developed a country, the less the impact of digital skills on other theoretical constructs in the sequential process.*

### 3.2.3 Between-country and within-country differences in the production of inequalities

The RA theory (van Deursen & van Dijk, 2015; van Dijk, 2005, 2012a, 2020) provides an explanation for the unequal distribution of attitudes, physical access, digital skills, and internet use according to relational theories, for which building blocks have been developed by leading scholars like (Bourdieu, 1984) and (Tilly, 1999). Those relational theories explain the origins of, and differences in, social practices, and further explain how those practices are produced and maintained. The RA theory has proposed several resources and social categories to explain the inequalities observed in internet appropriation (van Dijk, 2020). These resources and social categories can also explain between-country and within-country inequalities. The main between-country distinction (as described in the previous section) reflects a greater or lesser level of digital development. The main within-country categories are gender (women versus men), age (younger people versus older adults), and education (well-educated versus less well-educated individuals) (van Deursen & Helsper, 2015b; van Dijk, 2020; Wilson et al., 2003).

However, an unresolved issue is to determine the relative importance of between-country and within-country resources and social categories in producing and reproducing the digital divide. According to the RA theory, the relative importance of between-country and within-country resources and social categories is a matter of empirical observation and will produce different results for each society (van Dijk, 2020). The relational view of inequality adopted by the RA theory (Bourdieu, 1984; Tilly, 1999; van Dijk, 2020) directs our attention to the position of people according to their personal and social categories, both within their country and compared to another country.

## 3.3. Research design

### 3.3.1 Research questions

van Dijk's model (2005, 2020) has been partially tested across several countries (e.g., Brandtzæg et al., 2011), and has also been tested for skills (Hargittai, 2010; Helsper & Reisdorf, 2017; Zillien & Hargittai, 2009), and for attitudes (Dutton & Blank, 2015; Dutton & Reisdorf, 2019). However not all aspects of the sequential model were considered in those studies, and, with the exception of the study by (van Deursen & van Dijk, 2015) for the Netherlands, no study has comparatively analysed the sequential model to identify the main producers of digital inequalities. We therefore formulate research questions as follows:

RQ1: To what extent does the RA sequential model explain the process of internet appropriation by Europeans?

RQ2: To what extent do the relationships hypothesized by the RA theory differ depending on the digital development of the country?

RQ3: What is the relative importance of between-country and within-country resources and social categories in the production of the digital divide?

### 3.3.2 Data

#### *3.3.2.1 European internet user characteristics*

Representative data on digital technology use in 2016 were taken from an EU27+UK survey obtained on request from Eurostat (https://ec.europa.eu/eurostat/). Selected were the main resources and social categories that produce inequality according to the RA theory. At the individual level we used a single positional category (education level) and three individual social categories (gender, age, and occupational status), following the classification provided by (van Deursen & van Dijk, 2015) and (Van Dijk, 2020). At the country-level we used a single digital development indicator, in accordance with the classification proposed by (Cruz-Jesus et al., 2012), who reduced a set of 16 indicators reflecting the percentage of people and enterprises using the internet in the EU to two digital development factors: ICT infrastructure and adoption by the population, and e-business and internet access costs; they next clustered EU countries according to their factor scores, producing a taxonomy of three classes: digital leaders (Denmark, Finland, Luxembourg, Netherlands, and Sweden); digital followers (Austria, Belgium, Germany, Ireland, Malta, UK, Poland, Portugal, Spain, and Slovakia); and digital laggards (Estonia, Italy, Latvia, Romania, Bulgaria, France, Lithuania, Croatia, Slovenia, Cyprus, Greece, Czechia, and Hungary). Digital leaders not only had the highest score in both digital development factors but also more balanced digital development (Cruz-Jesus et al., 2012, p. 282).

Table 3.1 summarizes social indicator details. Of the 151 660 survey respondents, 51.6% were female, just over three quarters were aged 25-64 years, 32.7% had a high education level, and 62.7% were employed. As for the digital development level, almost half of the countries were classified as digital leaders or followers.

**Table 3.1** Sample characteristics

| **Individuals** | | | **Countries** | | |
|---|---|---|---|---|---|
| **Variable** | **Frequency** | **%** | **Variable** | **Frequency** | **%** |
| **Gender** | | | **Digital development** | | |
| Male | 73472 | 48.4 | Leaders | 13038 | 8.6 |
| Female | 78188 | 51.6 | Followers | 59226 | 39.1 |
| | | | Laggards | 78658 | 52.3 |
| **Age (years)** | | | | | |
| 16-24 | 1991 | 13.1 | | | |
| 25-44 | 58822 | 38.8 | | | |
| 45-64 | 58749 | 38.7 | | | |
| > 64 | 14179 | 9.3 | | | |
| **Education** | | | | | |
| Low | 28288 | 18.7 | | | |
| Intermediate | 73855 | 48.7 | | | |
| High | 49517 | 32.7 | | | |
| **Occupational status** | | | | | |
| Employed | 95131 | 62.7 | | | |
| Unemployed | 11292 | 7.4 | | | |
| Student | 14311 | 9.4 | | | |
| Other | 30926 | 20.4 | | | |

### *3.3.2.2 Measurement scales*

In accordance with the model proposed in Figure 3.1, we used operational measures from the Eurostat survey on perceived barriers to internet use, physical access, digital skills, and internet use. Full details of the measures are provided in Table 3.2.

Perceived barriers to internet[3] use were measured using a scale of eight items reflecting reasons for not accessing the internet from home (e.g., ‘I have access to the internet elsewhere’, ‘equipment costs are too high’, etc). Appendix A reports the frequencies for each item. On a scale that summed the items – ranging from 0 (no barriers) to 8 (most barriers) – the mean score was 7.960 and standard deviation (SD) was 0.300.

Physical access was measured using a scale of six dichotomous items referring to devices used to access the internet: desktop computer, laptop/notebook, tablet, mobile phone/smartphone, other mobile device (e-book reader, smartwatch, gaming device, etc), or smart TV. On a summary scale reflecting the number of devices used (ranging from 0 to 6), the mean (SD) was 2.430 (1.250).

Digital skills, in accordance with Eurostat, were measured on a Likert scale, ranging from 1 (no skills) to 4 (highest skills), for four different kinds of skills, namely, information skills, communication skills, problem-solving skills, and software skills.

Finally, following van Deursen and van Dijk (2015), internet use was measured in terms of diversity using a dichotomous scale for 18 items reflecting engagement in online activities, including e-mailing, reading news, playing games, listening to music, managing a website, running a business, etc. For the summary scale, ranging from 0 (no internet use) to 18 (most diverse use), the mean (SD) was 7.990 (3.730).

The five social indicators (see Table 3.1) were used to identify the resources and social categories that most contributed to the generation of digital inequalities.

[3] In the Eurostat survey, the perceived barriers to internet use items are designed to reflect perceptions of barriers by internet users without access at home in the previous three months, while barriers are assumed to be none for people with home internet access.

**Table 3.2** Measurements

| **Scales** | |
|---|---|
| **Perceived barriers to internet use** | **Physical access** |
| *What are your reasons for not accessing internet at home?* | *Which devices do you use to access the internet?* |
| 1 - Have access elsewhere | 1 - Desktop computer |
| 2 - Do not need it (not useful, not interesting, etc) | 2 - Laptop/notebook |
| 3 - Equipment costs too high | 3 - Tablet computer |
| 4 - Connection costs too high (telephone, DSL subscription, etc) | 4 - Mobile phone/smartphone |
| 5 – Perceived lack of skills | 5 - Other mobile devices (e.g., e-book reader, smartwatch) |
| 6 - Privacy or security concerns | 6 - Smart TV (directly connected to internet) |
| 7 - Broadband internet not available in our area | |
| 8 - Other | |
| **Digital skills** | |
| *Rate your skills on a scale of 1 (minimum) to 4 (maximum)* | |
| Information skills | |
| Problem-solving skills | |
| Communication skills | |
| Software skills | |
| **Internet use (diversity)** | |
| *Which activities have you used internet for?* | |
| 1 - E-mailing | |
| 2 - Telephoning over the internet/video calls (via webcam) over the internet (e.g., Skype or Facetime) | |
| 3 - Participating in social networks (creating user profile, posting messages or other contributions to Facebook, etc) | |
| 4 - Reading online news newspapers/news magazines | |
| 5 - Finding information on goods or services | |
| 6 - Playing or downloading games | |
| 7 - Listening to music (e.g., web radio, music streaming) | |
| 8 - Watching internet-streamed TV (live or catch-up) from broadcasters | |
| 9 - Watching video on demand from commercial services (Netflix, HBO, etc) | |
| 10 - Watching video content from sharing services (e.g., YouTube) | |
| 11 - Uploading self-created content (text, photos, music, videos, software, etc) to any website to be shared | |
| 12 - Creating websites or blogs | |
| 13 - Seeking health-related information (e.g., injury, disease, nutrition, health, etc) | |
| 14 - Making an appointment with a practitioner via the website (e.g., hospital or health care centre) | |
| 15 - Using services related to travel or travel-related accommodation | |
| 16 - Selling goods or services (e.g., via auctions, on eBay, etc) | |
| 17 - Internet banking | |
| 18 - Using payment accounts (e.g. PayPal) to pay for goods or services purchased over the internet | |

### 3.3.3 Statistical analysis

To fit the model we used partial least squares structural equation modelling (PLS-SEM), which has previously been used to evaluate internet use (Alt & Boniel-Nissim, 2018; E. Y. Lu et al., 2007; O'Cass & Fenech, 2003). PLS-SEM is a statistical technique used to estimate the parameters of a causal model and determine the strength and direction of relationships between model variables (Lohmoller, 1989). We used this method because of its flexibility in terms of distribution assumptions and capacity to handle complex predictive models (Hair, Hollingsworth, et al., 2017).

The digital skills scale was validated following a procedure described elsewhere (Hair, Hollingsworth, et al., 2017). Since the construct was reflective, we calculated different measures of reliability – an approach indicated when the PLS-SEM methodology is used to estimate model parameters. Thus, we verified that loadings were greater than 0.7, that they were all significant, and that composite reliability and Cronbach's alpha were both greater than 0.7. We also confirmed that the average variance extraction (AVE) value was greater than 0.5.

The effect of heterogeneity between countries was assessed using the multi-group parametric test (Hair, Hollingsworth, et al., 2017; Sarstedt et al., 2011) and pathmox analysis (Lamberti et al., 2016, 2017). The multi-group parametric test is a procedure for statistically testing for between-segment differences in coefficients. Data are split into groups according to a categorical variable, path coefficients are estimated for each group, and the obtained coefficients are then compared to check for significant differences. In our study, path coefficient differences were compared using the Keil approach (Keil et al., 2000).

Pathmox analysis (Lamberti et al., 2016, 2017) was used to identify the most significant factors generating digital inequalities within and between countries. This method, recently proposed to analyse heterogeneity in a PLS-SEM environment following an exploratory approach, identifies different segments holding different relationships among constructs. The principles of binary segmentation are used to produce a tree with different models in each of the obtained nodes. Starting with the results of a global model, the models with the greatest differences in child nodes are identified by an algorithm applying an iterative procedure (i.e., the data is recursively partitioned to identify iterations whose categories yield the most significant differences after comparing pairs of PLS-SEM models of child nodes).

To avoid the generation of a large number of nodes, pathmox runs a pre-pruning process based on three criteria: limiting the maximum depth of the tree; fixing a minimum node size; and considering the non-significance of the split criterion.

In our study, causal parameters were estimated and causal model heterogeneity was identified using the plspm package version 0.4.9 (Sanchez et al., 2015) and the genpathmox package version 0.3 (Lamberti, 2017), respectively, both developed in the R Software Language and Environment for Data Analysis.

## 3.4 Findings

### 3.4.1 To what extent does the resources and appropriation sequential model explain internet appropriation by Europeans? (RQ1)

The structural relationship results for our sequential model are reported in Table 3.3. According to this model, perceived barriers to internet use mainly negatively affect opportunities for physical access ($\beta$=-0.102) and, to a lesser degree, digital skills development ($\beta$=-0.076). but have little impact on internet use ($\beta$=-0.018). Furthermore, as would be expected, physical access strongly influences digital skills development (β=0.511), but influences internet use far less (β=0.252), while the greatest influence on internet use is digital skills (β=0.608).

We also found evidence to support sequential causality, in that the more significant influences are direct causal links, namely, between perceived barriers to internet use and physical access, between physical access and digital skills, and between digital skills and internet use. Concerning the predictability of the model, we obtained $R^2$=0.595 and a positive Stone-Geisser test value for predictive relevance of $Q^2$=0.600 for internet use (Figure 3.2).

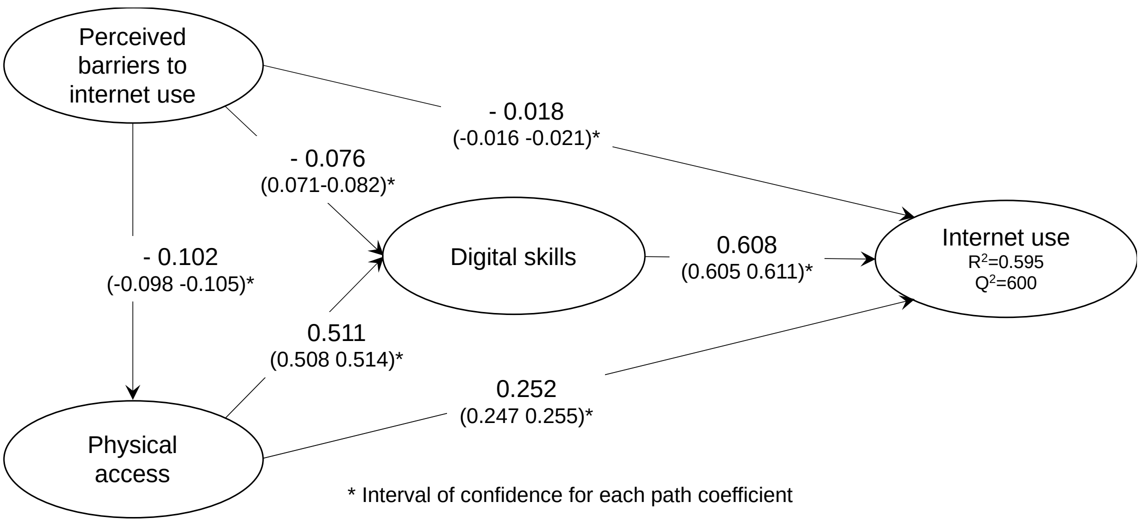
In summary, the RA sequential model depicts the process that produces the digital divide in the EU. Our empirical test of the model adds support to the theory and shows that the first digital gap divides Europeans among those with access to computers and the internet according to perceived barriers (motivations/attitude). However, the digital gap increases with the access divide: the impact of physical access on digital skills, in absolute terms, is almost fivefold the impact of perceived barriers on physical access. This is theoretically the second digital divide. Finally, according to our empirical test, the third theoretical digital divide increases with differences in digital skills, whose impact is even greater than in the second digital divide.

**Table 3.3** Results for the sequential model of inequality production

| Path | Value | T-test value | SE | Bootstrap | |
|---|---|---|---|---|---|
| | | | | Low | High |
| Perceived barriers to internet use → Physical access | -0.102* | -39.800 | 0.002 | -0.098 | -0.105 |
| Perceived barriers to internet use → Digital skills | -0.076* | -34.700 | 0.003 | -0.071 | -0.082 |
| Physical access → Digital skills | 0.511* | 232.000 | 0.002 | 0.508 | 0.514 |
| Perceived barriers to internet use → Internet use | -0.018* | -11.000 | 0.002 | -0.016 | -0.021 |
| Physical access → Internet use | 0.252* | 132.000 | 0.002 | 0.247 | 0.255 |
| Digital skills → Internet use | 0.608* | 317.000 | 0.002 | 0.605 | 0.611 |

SE, standard error. Significance: *p=<0.001.

**Figure 3.2** Results for the sequential model




### 3.4.2 To what extent do the relationships hypothesized by the resources and appropriation theory differ depending on the digital development of the country? (RQ2)

To this point we have assumed that the drivers of internet use are homogenous. However, the level of digital development of countries may affect the magnitude of the digital divide, i.e., the magnitude of the effects in the causality chain, from perceived barriers to internet use, to physical access, to digital skills, to diversity of internet uses. To check whether the model that explains the production of the digital divide differs among countries according to their level of digital development, we estimated the model for the leader, follower and laggard countries (as defined in the methods section). Using multigroup analysis we compared how the digital divide is produced. Results are reported in Table 3.4; the threshold significance was set to p=0.001 due to the large sample size, with asterisks indicating significant differences.

**Table 3.4** Multigroup comparison by digital development level

| Path | Le | Fo | Lg | P value | | |
|---|---|---|---|---|---|---|
| | | | | Le vs Fo | Le vs Lg | Fo vs Lg |
| Perceived barriers to internet use →Physical access | -0.073 | *-0.109* | *-0.098* | *0.000** | *0.000** | 0.003 |
| Perceived barriers to internet use →Digital skills | -0.095 | -0.076 | -0.074 | 0.054 | 0.022 | 0.427 |
| Physical access →Digital skills | 0.474 | *0.526* | *0.483* | *0.000** | 0.078 | 0.000* |
| Perceived barriers to internet use →Internet use | -0.013 | -0.014 | -0.022 | 0.438 | 0.038 | 0.007 |
| Physical access →Internet use | 0.207 | *0.254* | *0.220* | *0.000** | 0.051 | *0.000** |
| Digital skills →Internet use | 0.601 | *0.613* | *0.620* | 0.021 | *0.001** | 0.013 |

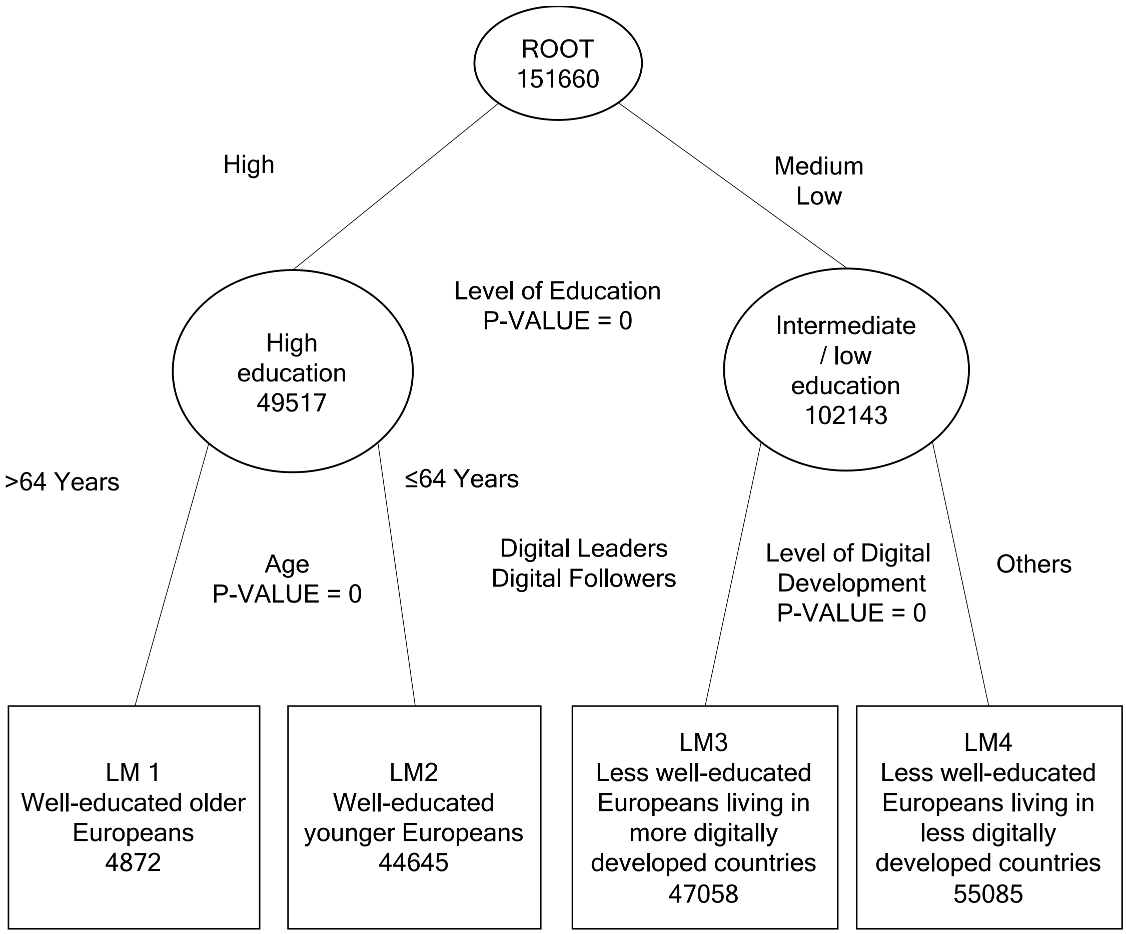
Le, leaders, Fo, followers, Lg, laggards. An asterisk indicates significant differences between path coefficients equal to or lower than 0.001.

The issue of perceived barriers to internet use as a driver for physical access was significantly more important for follower countries than for leader and laggard countries (p<0.001 in each case). The same occurred with physical access as a driver for digital skills, more important for followers than for leaders and laggards (p<0.001 in each case). As for internet use, we found differences in physical access and digital skills: physical access as a driver for internet use was more important for followers than for leaders and laggards (p<0.001), while digital skills digital skills as a driver for internet use were more important for laggards than for leaders (p=0.001). We conclude, therefore, that H1, H2 and H3 receive empirical support: differences in the production of the digital divide reflect the level of digital development of countries.

### 3.4.3 What is the relative importance of between-country and within-country resources and social categories in the production of the digital divide? (RQ3)

When analysing the digital divide across countries, it is important to assess to what extent between-country differences play a more important role than within-country similarities in the production of the digital divide. To find an answer to that question we used the pathmox algorithm that identifies which positional and social categories explain the most variation in the estimated sequential model. We limited the process to identifying the three resources and social categories that most explain the social production of digital divide. That means that the pathmox segmentation tree must be restricted to a maximum depth of two levels, bounding the final number of segments to a maximum of four. The minimum admissible size for a node was set to 10% of the total sample, while threshold significance for the partitioning algorithm was set to p=0.001 due to the large sample size. The pathmox segmentation tree is depicted in Figure 3.3, where the root node corresponds to the global model described in Table 3.3 and Figure 3.2. The terminal nodes depict the main social indicators explaining heterogeneity, resulting in four segmented local models labelled LM1 to LM4.

**Figure 3.3** Pathmox segmentation tree




The indicator that most explained inequality was the positional category of education, as it reflected the most significant variation in the model (F=2317; p<0.001), separating Europeans with a high education level (to the left in Figure 3.3) from those with an intermediate or low education level (to the right in Figure 3.3). In a subsequent segmentation step, well-educated Europeans were further segmented according to age as older and younger than 65 years (F=789; p<0.001), while less well-educated Europeans were further segmented according to the digital development of their country of residence (F=1406; p<0.001).

Table 3.5 reports the F-coefficient test results (statistics and p values) for each partition of the tree. This test identifies the path coefficients responsible for the splits obtained by the pathmox (in our analysis, education, age, and country digital development), providing a measure of how great differences are across the theoretical constructs once the sample is partitioned according to the categorical variable.

Concerning education, primarily responsible for the split was physical access as a driver for digital skills (F=2781.583; p<0.001) and digital skills as a driver for internet use (F=259.595; p<0.001), followed by perceived barriers to internet use as driver for physical access (F=35.197; p<0.001) and physical access as a driver for internet use (F=15.876; p<0.001). As for age, we found that the split primarily derived from physical access as a driver for digital skills (F=402.796; p<0.001) and digital skills as a driver for internet use (F=105.189; p<0.001). Finally, for country digital development, the split was primarily caused by digital skills as a driver for internet use (F=102.108; p<0.001), physical access as a driver for digital skills (F=60.923; p<0.001) and perceived barriers to internet use as a driver for physical access (F=53.325; p<0.001).

**Table 3.5** F-coefficient results

| **Path** | **Split 1 Education** | | **Split 2 Age** | | **Split 3 Digital development** | |
|---|---|---|---|---|---|---|
| | **Statistic** | **P value** | **Statistic** | **P value** | **Statistic** | **P value** |
| Perceived barriers to internet use →Physical access | 35.197 | <0.001* | 9.253 | 0.002 | 53.325 | <0.001 * |
| Perceived barriers to internet use →Digital skills | 3.462 | 0.063 | 4.19 | 0.041 | 1.497 | 0.221 |
| Physical access →Digital skills | 2781.583 | <0.001* | 402.796 | <0.001 * | 60.923 | <0.001 * |
| Perceived barriers to internet use →Internet use | 3.52 | 0.061 | 0.05 | 0.823 | 2.378 | 0.123 |
| Physical access →Internet use | 15.876 | <0.001* | 8.027 | 0.005 | 0.592 | 0.442 |
| Digital skills →Internet use | 259.595 | <0.001* | 105.189 | <0.001 * | 102.108 | <0.001 * |

Significance: *p=<0.001

Returning to the terminal nodes, the four resulting models were LM1 and LM2, reflecting well-educated older Europeans and well-educated younger Europeans, respectively, and LM3 and LM4, reflecting less well-educated Europeans living in more and in less digitally advanced countries, respectively. The structural coefficients for LM1 to LM4 are reported in Table 3.6, where it can be observed that the sequential causality chain is maintained for all the models, as indicated by van Deursen and van Dijk (2015). This means that perceived barriers to internet use impact on physical access, that physical access remains crucial for the development of digital skills, and that digital skills are an essential driver for internet use. However, differences across models are evident.

For well-educated Europeans, when older (LM1), perceived barriers to internet use has the strongest negative influence as a driver for digital skills (-0.097) among all groups; and when younger (LM2), physical access has the strongest positive influence (0.279) as a driver for internet use, whereas the positive influence of digital skills was less important (0.528). For less well-educated Europeans, if they lived in a more digitally advanced country (LM3), physical access was critical as a driver for digital skills (0.533), and digital skills as a driver for internet use (0.640); however, if less well-educated Europeans live in a less digitally advanced country (LM4), digital skills have the strongest influence in driving internet use (0.641), whereas – relative to the individuals living in a more digitally advanced country – perceived barriers to internet use have a smaller impact on physical access (-0.092), and, likewise, physical access on digital skills (0.469).

**Table 3.6** Path coefficients for the structural model

| Path | B | | | |
|---|---|---|---|---|
| | **LM1** | **LM2** | **LM3** | **LM4** |
| Perceived barriers to internet use → Physical access | -0.077* | -0.095* | -0.110* | -0.092* |
| Perceived barriers to internet use → Digital skills | -0.097* | -0.091* | -0.077* | -0.070* |
| Physical access → Digital skills | 0.466* | 0.398* | 0.533* | 0.469* |
| Perceived barriers to internet use → Internet use | -0.028* | -0.019* | -0.013* | -0.023* |
| Physical access → Internet use | 0.228* | 0.279* | 0.232* | 0.200* |
| Digital skills → Internet use | 0.614* | 0.528* | 0.640* | 0.641* |

**Notes.** LM1 = well-educated older Europeans; LM2 = well-educated younger Europeans; LM3 = less well-educated Europeans living in more digitally developed countries; LM4 = less well-educated Europeans living in less digitally developed countries. Significance: *p=<0.001.

To sum up the findings, even though differences occur in the production of the digital divide according to country digital development, it is the educational level of Europeans that mainly explains social heterogeneity in the production of the digital divide. Education, an indicator of cultural capital according to Bourdieu (1984), is the resource across countries that best explains unequally distributed internet use and the digital divide. Furthermore, this digital divide results, first, from the development of digital skills driven by physical access, and second, from internet use as fostered by the development of digital skills. Among the best educated Europeans, a generational gap exists that explains the differences in this group, and surprisingly, country digital development seems to act as a public material resource that particularly benefits less well-educated Europeans.

## 3.5 Discussion

While a direct comparison with previous research was not possible due to measurement differences, our results generalized for the EU27+UK tend to support previous findings (Hargittai, 2002; Scheerder et al., 2017; van Deursen & Helsper, 2015b; van Deursen & van Dijk, 2015) concerning the sequential link between physical access, digital skills, and internet use. Overall, the general model for the EU explains to a great extent the production of the digital divide. As was expected, overall, perceived barriers to internet use have a negative effect on the other theoretical constructs, indicating that perceived barriers (motivations/attitudes) may have a negative impact on the process of appropriating digital technologies (van Dijk, 2013, 2020; World Economic Forum, 2016).

Our findings support our hypotheses and, therefore, the RA theory (van Dijk, 2020). Thus, considering the effect of country digital development on the sequential model, we found that perceived barriers to internet use and physical access are especially crucial for individuals living in digital follower and digital laggard countries. Those findings give support to our hypothesis (H1) that the more digitally advanced a country, the less the impact of perceived barriers, particularly as a driver for physical access to digital devices. Reducing perceived barriers (improved infrastructure, more localized content, and more affordable connections) would therefore have a more significant impact on individuals living in less digitally advanced countries. Other effects of the perceived barriers were not found to be statistically significant. We also find empirical support for our hypothesis (H2) that the more digitally advanced a country, the less the impact of physical access on the other constructs in the sequential model; in other words, for individuals living in less digitally advanced countries, the effect of physical access as a driver for digital skills and internet use is higher. This would suggest that increased physical access would have a relatively greater impact in less digitally advanced countries. Finally, as hypothesized (H3), the effect of digital skills as a driver for internet use is higher for individuals living in digital laggard countries.

Regarding the relative importance of between-country and within-country resources and social categories in the production of the digital divide – irrespective of the country of origin – education (an individual-specific resource or positional category) was found to be the most critical source of inequality in the process of internet appropriation (measured in this study in terms of diversity of uses), as Europeans in the sequential causality chain were split according to their education level into high and intermediate/low subgroups. As in other studies, whether of parents (Gui & Argentin, 2011) or respondents (Dutton & Reisdorf, 2019; Reisdorf & Groselj, 2017; van Deursen & van Dijk, 2010, 2015), education most strongly predicts differences in the social process of generating digital inequalities. In our model, well-educated Europeans are segmented by age into an older group (>64 years old) and a younger group (≤64 years old), while less well-educated Europeans are divided according to the digital development of their country of origin. Country digital development of countries is therefore revealed as a public material resource that particularly benefits socially less privileged Europeans. These findings suggest that, in less digitally developed countries, education could yield the cognitive (and probably material) resources to overcome perceived barriers to internet use, and also that well-educated individuals may form a social group that crosses EU frontiers. As for less well-educated individuals, perceived barriers to internet use and physical access may be less if they happen to live in a more digitally developed country.

In terms of comparison between our four groups of Europeans, the causality model indicates that the impact of perceived barriers to internet use as a driver for both digital skills and internet use is especially crucial for well-educated older Europeans, suggesting that fewer perceived barriers might increase internet use in this group of individuals. For well-educated younger Europeans, physical access may have the greatest impact in increasing internet use in this group. As for less well-educated Europeans, when these live in more digitally developed countries, they avail of better digital support and infrastructure, which, in turn, improves physical access, digital skills, and internet use, as has been argued by van Dijk (2020). This group is, consequently, more significantly impacted, in terms of physical access and digital skills, by perceived barriers to internet use, whereas for their counterparts living in less digitally developed countries, enhancing physical access has less impact on internet use.

In summary, we identify education as the primary generator of inequalities in the process of internet appropriation, but suggest that the fact of living in a digitally advanced country may overcome some of the limitations faced by less well-educated Europeans regarding physical access and digital skills. In consequence, a key result concerning the overall analysis of the impact of between-country and within-country resources and social categories is that the sequential causality chain is maintained but operates differently depending on both country- and individual-level positional resources and social categories. In other words, the models we estimated according to the inequalities generated in the sequential links are particular cases of the general causality model: perceived barriers to internet use influence physical access, physical access is crucial to developing digital skills, and finally, digital skills affect how the internet is used. While these findings are hardly surprising (since they are aligned with the RA theory), for the first time we demonstrate that the strength of links between constructs may vary depending on positional and social categories and also show that education plays a key role in generating the digital divide.

### 3.5.1. Policy implications

Our findings have several implications for reducing digital inequalities. As a precursor to improving digital skills and enhancing internet use, less well-educated population segments should be the target of policies aimed at reducing perceived barriers and enhancing physical access, as improving physical access to digital devices and connections, and therefore, to the internet is crucial to developing the necessary digital skills, according to both our own findings and those of other researchers (Helsper, 2012; van Deursen & van Dijk, 2015, 2019). Digital skills can be developed in less privileged individuals in two main ways: by improving a country's digital infrastructures to reduce material and other barriers, and by increasing general and widespread access to a variety of digital devices, encouraging access through as many different devices as possible. Device variety is important in enhancing digital skills overall, because different devices are optimized for specific uses (Napoli & Obar, 2014; van Dijk, 2020). The issue of perceived barriers is ultimately crucial to reducing inequalities because, as they are dismantled, physical access and digital skills will improve, and variations between groups will be reduced.

However, while this inference is valid for both more and less digitally advanced countries, ultimately, any reduction in digital inequalities will be hampered by underlying inequalities in education (see Shaw & Hargittai, 2018). We suggest that more user-friendly technologies and devices would reduce the need for advanced digital skills, particularly among older well-educated individuals; while older people are reported to make more rational use of the internet, they have poorer operational skills, which means they make less use of the internet compared to younger people (van Deursen et al., 2011; van Deursen & van Dijk, 2014). Ultimately, however, education is key, as only better educated individuals, on the basis of their digital skills and their social capital, will be equipped to take full advantage of the digital technologies (Hargittai et al., 2019) and ensure better outcomes from internet use.

### 3.5.2 Limitations and future research

To investigate the digital divide in the EU27+UK, we tested the four theoretical constructs of the sequential model developed by van Deursen and van Dijk (2015): barriers to internet use, physical access, digital skills, and internet use (defined in terms of diversity of uses). The main limitation of our approach was that the indicators available were not as rich as the indicators obtained for the (more specific) research by van Deursen and van Dijk (2015), because of the need to harmonize fieldwork for the EU27+UK. As a consequence, instead of measuring internet motivations/attitudes as, we had to measure the antecedent, i.e., *perceived* barriers to internet use, according to the logic that the existence of perceived barriers makes a positive attitude to the internet less likely. Further related to the perceived barriers, the survey only partially accounted for the perceptions of European users, as this concept was only measured for users without home internet access. Therefore, although we found support for the sequential model, the measurement model could undoubtedly be improved with better data.

From a methodological point of view, at least two limitations arise from the use of causal models. First, without panel data, the cyclical nature of the sequential model cannot be reflected. Second, according to (Bollen & Pearl, 2013), causal models do not allow causal effects in the strictest sense to be estimated. Nonetheless, these models are useful for evaluating the plausibility of causal chains. One interesting future line of work would be, for Europe in recent decades, to monitor evolution in digital inequalities and to include indicators of implemented digital policies to identify what key policies might have narrowed the digital divide.

## 3.6 Conclusions

In our generalization of the van Dijk model (2005, 2020) to a representative EU27+UK dataset, we contribute to the development of the RA theory (van Dijk, 2020) in suggesting that the social process of internet appropriation differs depending broadly on country-level digital development and individual-level education, with the relative importance of specific resources and social categories (country digital development and individual education and age) contributing in different ways to social production of the digital divide.

To sum up, individuals with relatively fewer personal resources will enjoy a comparative advantage if they happen to live in a more digitally advanced country, meaning that an advanced digital context is a public good that benefits all of society. As for more privileged individuals, and particularly young, educated individuals, these are well positioned to take advantage of the digital technologies. Our findings suggest that the social process of internet appropriation unfolds differently within and between countries, not only because attitudes and motivations (representing possible barriers to internet use), physical access, digital skills, and internet use are socially patterned, but also because the impact of causal links between them also varies.

# Chapter 4

## The role of trust in the social process of internet appropriation

In this chapter, we analyse the role of trust in producing a new digital divide by extending the sequential model of social internet appropriation, developed according to the resources and appropriation (RA) theory, to include trust as a mediator in the causal chain. The extended model proposes that attitudes (reflected in perceived barriers to internet use), physical access, digital skills, and now trust, sequentially explain the appropriation process that ends in a digital divide. Our model was tested with data from a European Union (EU) information and communication technologies (ICTs) survey and was estimated using a partial least squares structural equation model (PLS-SEM). Findings indicate that while trust is another significant determiner of the digital divide that mediates the effect of digital skills on internet use, digital skills continue to be the most crucial driver in generating the digital gap. Trust is a socially constructed concept, so its meaning has to be interpreted according to the digital skills of individuals. The findings of this chapter, recently submitted to *New Media and Society,* are currently under review. Chapter 4 is organized as follows. We provide an introduction to the research topic, consider the theoretical framework and develop our research hypotheses, describe the research design and methodology, and report our results. We conclude with a discussion of our findings, study limitations, and suggestions for future research.

### 4.1 Introduction

Internet use has increased exponentially in recent years, penetrating every aspect of people's lives. Most areas of activity (entertainment, shopping, health, etc), have gradually been transformed by the internet (to e-entertainment, e-shopping, e-health, etc). Thus, it comes as no surprise that institutions and organizations have put the internet at the centre of their policies.

This trend has also naturally affected the academic field. Scholars research internet use with particular emphasis on both antecedents and outcomes. One focus is on the digital gap produced by unequal internet access and unequal distribution of the benefits. Initially, the digital divide was defined as the gap between individuals with and without access to the ICTs (van Deursen & van Dijk, 2019). However, evidence has revealed that the concept of a gap is more complex than mere access to ICTs, but also includes how the internet is used, what digital skills individuals have (Hargittai, 2002; van Deursen & Helsper, 2015b; Zillien & Hargittai, 2009) and attitudes to internet use. Physical access to ICT devices leads to the development of digital skills in only motivated individuals, with the result that different digital gaps are unequally distributed in society (van Deursen & van Dijk, 2015; van Dijk, 2005, 2020).

Reaping the benefits of the ICTs for individuals and firms not only requires digital skills, trust in digital partners is also necessary (Chang et al., 2017). Individuals need to trust the information provided and the expected behaviour of other individuals, social media platforms, commercial outlets, government structures, financial institutions, non-government organizations, etc (Dutton & Shepherd, 2006; Huang et al., 2003; S. C. Robinson, 2018; Suh & Han, 2002). Steedman et al. (2020) argue that individuals try to balance trust and risk when disclosing personal information according to previous positive and negative experiences of using the internet. Dutton and Shepherd (2006) found that trust in the internet is shaped by experience and that the disclosure of personal information depends on the trust inspired by digital partners.

If internet use is associated with outcomes and tangible benefits of digital interactions (van Deursen & van Dijk, 2015; van Dijk, 2005, 2020), and if trust is associated with internet use (Chang et al., 2017; Dutton & Shepherd, 2006; Suh & Han, 2002), then it may be that trust turns out to be another determiner of the digital divide (Nelms et al., 2018), as was suggested by Huang et al. (2003) in their research on the influence of trust on internet adoption rates across countries. Trust, however, is a complex concept that is approached from different points of view (Crosno et al., 2007; Garbarino & Johnson, 1999; McKnight & Chervany, 2001; Morgan & Hunt, 1994; Pavlou, 2003), with most research focusing on specific links or components in the causality chain or in the formation of theoretical constructs.

Several researchers have analysed trust concerning specific internet uses, such as e-banking (Yap et al., 2010), e-government (Bélanger & Carter, 2008; Pérez-Morote et al., 2020), and e-commerce (McKnight & Chervany, 2001; Stouthuysen, 2020). More recently, Steedman et al. (2020) drew attention to what institutions can do to increase user trust, introducing the innovative notion of 'complex ecologies of trust' to capture the multiple factors at play in generating trust in data practices and data-driven services. However, while it is well established that a close relationship exists between trust and internet use, so far our understanding of trust is limited, both as a determiner of the digital divide and its relative importance concerning other factors affecting internet use (see Bagchi, 2005; Huang et al., 2003).

In this research, we extend van Dijk's sequential model (van Deursen & van Dijk, 2015) intending to test whether a more comprehensive model that includes trust could better describe and explain the digital divide and determine whether trust mediates the effects of attitudes, physical access, and digital skills on internet use. We tested our model with data from the 27 countries of the European Union[4] plus the United Kingdom (UE27+UK) and checked to what extent the proposed theoretical relationships are supported. This extension of the original sequential model potentially has academic and policy implications. If trust mediates the effect of the theoretical constructs included in the original model, then, as suggested by Huang et al. (2003), this would provide evidence that trust could be another factor in explaining the digital divide.

## 4.2 Theoretical framework

### 4.2.1 Types of digital divide

Researchers, in extensively examining the reproduction of social inequalities in access to the ICTs, initially identified a gap between individuals with and without online access, referred to as the first digital divide (van Deursen & van Dijk, 2019). While many policies were introduced that aimed to close that gap, subsequent research showed that a more persistent gap reflecting emerged use gap, referred to as the second digital divide (Hargittai, 2002; Zillien & Hargittai, 2009). In investigations of the second divide, a third divide was identified related to the digital skills of individuals in optimizing internet use and benefits (van Deursen & van Dijk, 2015). To better understand digital divides, van Dijk (2005, 2020) proposed a model to sequentially examine the social process of internet appropriation according to attitudes, physical access, and digital skills, which, when tested by van Deursen and van Dijk (2015), provided support for the sequential causality chain.

[4] The list of the 27 countries of the European Union is available at:
https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:EU_enlargements

### 4.2.2 The sequential model

The sequential model of the social process of internet appropriation that generates digital divides, formalized in the resources and appropriation (RA) theory (van Deursen & van Dijk, 2015; van Dijk, 2005, 2020), explains the reproduction of social inequalities in the digital realm in terms of four constructs that influence each other sequentially: attitudes (or its antecedent, barriers to use), physical access, digital skills, and internet use.

*Barriers to use.* van Dijk (2005) has proposed that attitudes segment individuals as those motivated or not motivated to access/use ICTs (Ragneda & Muschert, 2013). While being motivated generally means having a positive attitude towards doing something (Ryan & Deci, 2000), motivation to use ICTs (Durndell & Haag, 2002; Dutton & Reisdorf, 2017; Meuter et al., 2003; van Deursen & van Dijk, 2015) may require individuals to overcome structural barriers. According to the World Economic Forum (2016) and van Deursen and Helsper (2015b), barriers to internet use are social (infrastructure, awareness, cultural acceptance) and psychological (affordability, skills). In this research, as our measure of barriers covers only part of motivated access as described in the RA theory, we will refer to *perceived* barriers to internet use, which we can expect to have a negative impact on physical access, digital skills, and internet use.

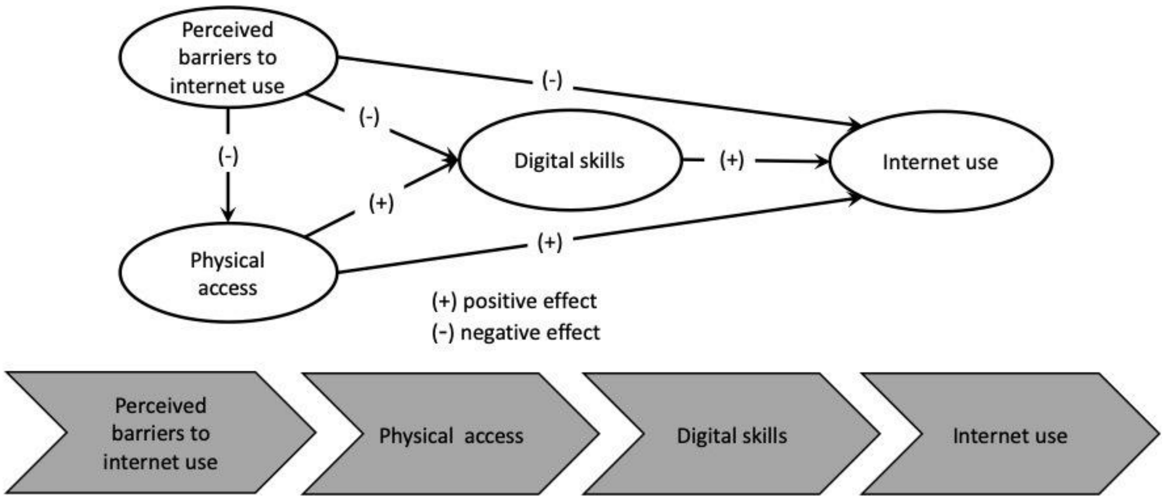
*Physical access.* Since studies of the first digital divide, researchers have defined physical access as opportunity to access the internet. Zillien and Hargittai (2009) have further proposed, however, that equipment quality may affect internet use, while (van Deursen & van Dijk, 2010, 2019) have proposed that differences in physical access might evolve into different digital skill levels. Along the same lines, Kuhlemeier and Hemker (2007) and Mossberger et al. (2012) found that physical access is associated with skill levels and diversity of internet use.

*Digital skills*. While digital skills may have many dimensions, key skills include the ability to obtain information, manage information, communicate, and solve problems (van Deursen & van Dijk, 2009, 2010, 2015). Researchers have found evidence that the possession of those key digital skills positively impacts internet use (van Deursen, Courtois, et al., 2014; van Deursen & van Dijk, 2015).

*Internet use.* Internet use has been conceptualized in several ways, including in terms of frequency of use, connection duration, and the variety of activities participated in (Hargittai & Hinnant, 2008; van Deursen & van Dijk, 2014). Traditional social inequalities may be reproduced in internet use diversity (L. Robinson, 2009; van Deursen & van Dijk, 2014), which can be classified in terms of activities reflecting offline outcomes: economic (e.g., related to property, employment, education), cultural (e.g., related to identity and belongingness), social (e.g., reflecting personal, formal, and political networks) and personal (e.g., health, lifestyle, leisure). For our purposes we define internet use in terms of diversity of internet activities participated in online.

The core argument of the causality chain is portrayed in Figure 4.1, which shows that perceived barriers to internet use are negatively related to physical access, digital skills, and internet use; physical access is positively related to digital skills and internet use; and finally, digital skills are positively related to internet use.

**Figure 4.1** Social internet appropriation resulting in a digital divide




### 4.2.3 The sequential model and trust

To interact with ICT and, in general, navigate the digital world, individuals need to feel they can trust expected behaviours and information provided by digital partners. Trust, the bridge that overcomes perceptions of risk and uncertainty (McKnight et al., 2002; Pavlou, 2003), is a driver of exchanges that decades ago attracted the attention of marketing theorists (Morgan & Hunt, 1994), and more recently, internet researchers (Blank & Lutz, 2018; Chang et al., 2017; Dutton & Shepherd, 2006; Nelms et al., 2018; Suh & Han, 2002).

Trust has many dimensions that are individual, organizational, or institutional. Mayer et al. (1995) studied individual beliefs about the ability of others to do as promised, their benevolence in interpreting words and behaviours, and the integrity of behaviours. Morgan and Hunt (1994) explored the organizational dimension of trust – understood as confidence between exchange partners – in terms of 'relational trust', which includes the components of reliability and integrity. McKnight and Chervany (2001) considers trust to arise from institutional mechanisms transmitting signals of trustworthiness designed to reduce risk and uncertainty and to increase consumer trust in online sales interactions (e.g., with AliExpress, Amazon, PayPal, etc). ‘Institutional-based trust’ arises with social and geographical distance and extensive networks of interdependent transactions (Zucker, 1986).

Psychologists are interested in the personal properties of trustors and trustees, economists in the terms and conditions of exchange, and sociologists in the socially embedded properties of interactions (Rousseau et al., 1998). Assumed is the fact the trustee and trustor share not too different meanings about how the interaction and the expected exchange will unfold. Trust is paramount for internet use (Giantari et al., 2013; McKnight et al., 2002; Pavlou, 2003; Pavlou & Gefen, 2004), and for trust to remove risk and uncertainty, buyers must believe that their information travelling along digital highways and in the hands of digital partners is secure (Steedman et al., 2020). Trust concerning personal data disclosures and data management in organizations is of keen interest to researchers (Heirman et al., 2013; Malhotra et al., 2004), and also in its relationship to internet use (Dutton & Shepherd, 2006; Huang et al., 2003; S. C. Robinson, 2018; Suh & Han, 2002).

Individuals that trust the internet show a greater willingness to do business, cooperate, and share information online (Beaudoin, 2008; Chang et al., 2017; Dutton & Shepherd, 2006; Giantari et al., 2013; Jarvenpaa et al., 2000; McKnight et al., 2002; McKnight & Chervany, 2001; Shin, 2010). Trust is an essential driver of internet use that can potentially reduce the digital divide between countries (Bagchi, 2005), while distrust in individuals may lead them to avoid disclosing personal information (CIGI-Ipsos, 2019). As personal information is often requested when accessing the internet, distrust leads to fears concerning loss of privacy, unauthorized access, and loss of data (Cate et al., 2014; Lankton & McKnight, 2011; Metzger, 2006). In our study, we measure trust in internet use according to individuals’ willingness to disclose personal information online. We expect that disclosing personal information is a manifestation of trust, and the greater the trust, the more the internet is used (Dutton & Shepherd, 2006). We therefore hypothesize the following:

*H1: The greater the trust in internet use, the greater the internet use.*

Trust not only influences internet use, however, but also may be related to other drivers of the digital divide: attitudes (which reflect barriers), physical access, and digital skills. Blank and Dutton (2012) found that attitudes are positively associated with trust, and that a lack of trust is a barrier to internet use (Bansal et al., 2016; Chang et al., 2016; Dinev & Hart, 2006; Joinson et al., 2010; Shin, 2010). We expect that motivated people with a positive attitude will have sufficient trust in the internet, while the inverse relationship can also be expected (Joinson et al., 2010; van Deursen & Helsper, 2015b). Therefore, we hypothesize as follows:

*H2a: The greater the perceived barriers to internet use, the less trust in internet use.*

*H2b: The effect of perceived barriers to internet use is mediated by trust.*

Trust, physical access, and internet use are also related. Individuals with greater access to digital equipment will trust the internet more. They may use trusted ways of accessing the internet (using virtual private networks, secure browsers, and secure computers, managing cookies properly, etc) that protect them against malware or harmful access to their personal data (Maple, 2017). Using trusted devices and mechanisms and recognizing trust signals from institutions enhance confidence in service reliability and security (Køien, 2011; Mahatanankoon et al., 2006). We, therefore, hypothesize as follows:

*H3a: The better the quality of physical access, the greater the trust in internet use.*

*H3b: The effect of physical access on internet use is mediated by trust.*

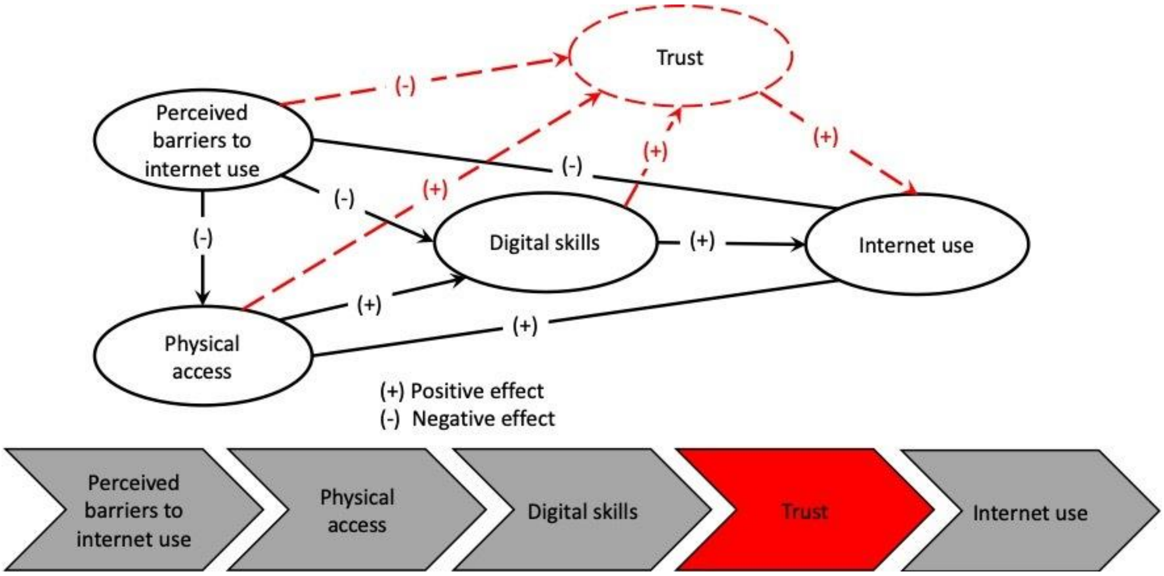
More advanced digital skills can also increase trust and, consequently, internet use (Dutton & Shepherd, 2006; Steedman et al., 2020), as it enables individuals to mitigate online risks. Monforti and Marichal (2014) indicate that digital skills are associated with generalized trust, suggesting that developing digital skills may increase levels of trust (Dutton & Shepherd, 2006; van Dijk, 2020). We, therefore, hypothesize as follows:

*H4a: The more advanced digital skills are, the greater the trust in internet use.*

*H4b: The effect of digital skills on internet use is mediated by trust.*

Based on previous research into relational trust between partners, we extend the social process of internet appropriation to incorporate the construct of trust, as not only influencing internet use, but also mediating the effects on internet use of barriers to use, physical access, and digital skills. This extended causality chain is portrayed in Figure 4.2.

**Figure 4.2** The role of trust in social internet appropriation resulting in a digital divide



## 4.3 Research design

### 4.3.1 Research aims

In exploring trust as a potential driver in the production of the digital divide, we try to answer the following research questions based on the hypotheses developed above:

1. To what extent does trust enhance understanding of the sequential model of social internet appropriation?
2. To what extent does trust mediate the effects of barriers to use, physical access, and digital skills, on internet use, and, therefore, reveal itself as a fourth digital divide?

### 4.3.2 Data

#### *4.3.2.1 The sample*

To test our model, we used Eurostat data on ICT use in the EU27+UK for the year 2016, collected by each country's European statistical office. Table 4.1 describes the social indicators for the sample of 151 660 Europeans (51.6% women, mostly aged between 25-64 years, with intermediate education, and mostly employed).

**Table 4.1** Sample demographic characteristics

| Variable | N | % | Variable | N | % |
|---|---|---|---|---|---|
| **Gender** | | | **Education** | | |
| Male | 73472 | 48.4 | Low | 28288 | 18.7 |
| Female | 78188 | 51.6 | Intermediate | 73855 | 48.7 |
| | | | High | 49517 | 32.7 |
| **Age (years)** | | | **Occupation** | | |
| 16-24 | 1991 | 13.1 | Employed | 95131 | 62.7 |
| 25-44 | 58822 | 38.8 | Unemployed | 11292 | 7.4 |
| 45-64 | 58749 | 38.7 | Student | 14311 | 9.4 |
| > 64 | 14179 | 9.3 | Other | 30926 | 20.4 |

#### *4.3.2.2 Measurement scales*

Operational measures regarding perceived barriers to internet use, physical access, digital skills, internet use, and trust included in the Eurostat survey are presented in Appendix A and briefly described in what follows.

Perceived barriers were measured using eight items reflecting reasons for not accessing the internet from home (e.g., ‘I have access to the internet elsewhere’, ‘equipment costs are too high’, etc.), scored on a scale from 0 to 8 (no barriers to most barriers). Physical access was measured using six items (desktop computer, laptop or notebook, tablet, mobile phone or smartphone, other mobile devices, e.g., e-book reader, smartwatch, gaming device, or smart TV) scored on a scale of 0 to 6 (no devices to most devices). The four dimensions of digital skills (obtain information, managing information, communicating, and problem-solving) were scored on a four-item Likert scale from 1 to 4 (no skills to most advanced skills). Internet use, following van Deursen and van Dijk (2015), was measured in terms of diversity using using as dummy variables the 18 Eurostat items reflecting online activities (e.g., e-mailing, reading news, playing games, listening to music, managing a website, running a business, etc), summed on a scale from 0 to 18 (no internet use to most diverse use). Finally, trust was measured for four dichotomous items reflecting information provided online (personal details, contact details, payment details, and other personal information), summed on a scale scored from 0 to 4 (distrust to high trust).

The summed items had mean scores (standard deviations) as follows: perceived barriers to internet use, 7.960 (0.300.); physical access, 2.430 (1.250); internet use, 7.990 (3.730), and trust, 1.540 (1.380).

### 4.3.3 Statistical analysis

To fit the model, we used PLS-SEM, which has previously been used to evaluate online trust (Chang et al., 2017; Ogonowski et al., 2014). PLS-SEM is a multivariate technique that tests the psychometric properties of scales used to estimate parameters in a causal model, specifically, the strength and direction of relationships between variables. According to Hair et al. (2019), PLS-SEM enables the estimation of complex models with many theoretical constructs, variables, and causal relationships without imposing distributional assumptions regarding the data. More importantly, PLS-SEM is a causal-predictive approach that emphasizes prediction in estimated models.

We validated the digital skills scale by calculating different measures of reliability to estimate model parameters (Hair, Hollingsworth, et al., 2017). We verified that loadings were greater than 0.7, that they all were significant, that both composite reliability and Cronbach's alpha were greater than 0.7, and that the average variance extraction (AVE) value was greater than 0.5.

The mediation analysis was conducted following the procedure proposed by Hair, Hult, et al. (2017) and Nitzl et al. (2016) as most suitable when causal models are estimated using PLS-SEM. The aim was to identify to what extent the effect of one variable on another is 'mediated' (i.e., absorbed) by a third 'mediator' variable. When mediation occurs, it means that the mediator variable (in our case, trust) governs the nature of the relationship between two theoretical constructs (i.e., the underlying mechanism or process). Bootstrap intervals were computed for direct effects of barriers to internet use, physical access, and digital skills on internet use, and for the indirect effect of trust on internet use (coefficients of the predictor variables on the dependent variable). Sequentially, the significance and signs of the effects were checked to determine the presence and nature of the mediation.

The analysis was interpreted as follows (Hair, Hult, et al., 2017): (1) the direct effect is significant but not the indirect effect (direct-only non-mediation); (2) the indirect and direct effects are both significant and present the same sign (complementary mediation); (3) the indirect and direct effects are both significant but present opposite signs (competitive mediation); and (4) only the indirect effect is significant (indirect-only mediation). According to our theoretical framework, we expect that trust complementarily mediates the effects of barriers to use, physical access, and digital skills on internet use.

Our statistical analysis was conducted using R Software Language and Environment for Data Analysis.

## 4.4 Findings

### 4.4.1 To what extent does trust enhance understanding of the sequential model of social internet appropriation?

The extended causal model of internet use is presented in Table 4.2 and Figure 4.2. According to our model, perceived barriers to internet use negatively affect opportunities of physically accessing the internet (β=-0.102) and, to a lesser degree, the development of digital skills (β=-0.076), but have little impact on internet use (β=-0.018). Furthermore, as expected, physical access strongly influences the development of digital skills (β=0.512), but influences internet use far less (β=0.225). Physical access is, therefore, revealed as a necessary condition to develop the digital skills that have the greatest influence on internet use (β=0.531). Those results support the sequential causality proposed by van Deursen and van Dijk (2015) and Van Dijk (2005, 2020), suggesting that more significant influences are direct causal links in the sequential model, i.e., between barriers to use and physical access, between physical access and digital skills, and between digital skills and internet use.

Concerning the causal relationship between the sequential model and trust, perceived barriers to internet use have a low and negative effect on trust (β=-0.004), while physical access shows a moderately positive effect on trust (β=0.157). Digital skills, in contrast, have the highest positive effect on trust (β=0.425), while trust is positively linked to internet use (β=0.175). All coefficients are significant according to the confidence interval (CI).

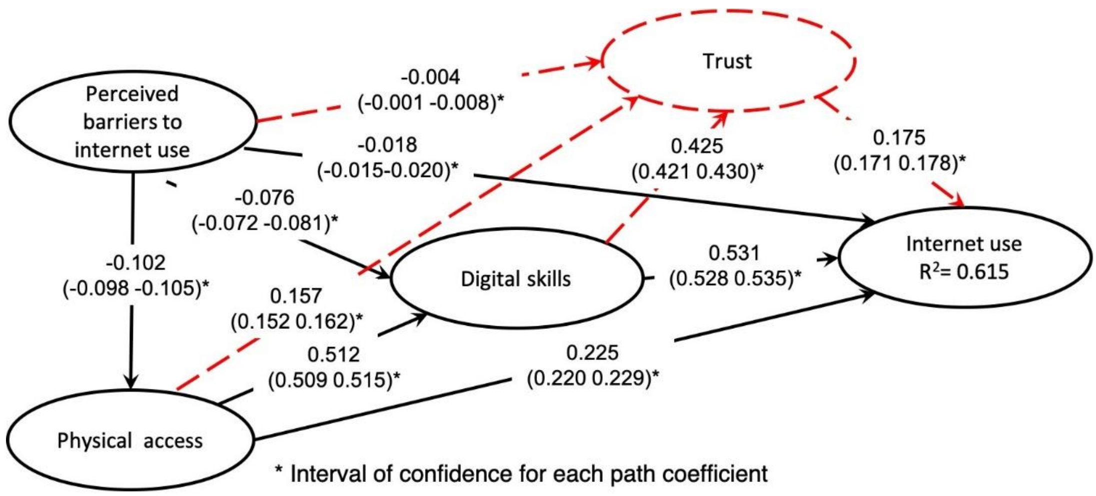
We thus find support for hypotheses H1, H2a, H3a, and H4a, thereby confirming that trust is another critical dimension potentially affecting the social internet appropriation process and so contributing to the digital divide. The validity of the model also finds support in its high predictive power, as indicated by the $R^2$ value (0.615) for internet use.

**Table 4.2** The sequential model of inequality production

| **Path** | **Value** | **SE** | **T-test** | **Bootstrap** | |
|---|---|---|---|---|---|
| | | | | **Low** | **High** |
| Perceived barriers to internet use → Physical access | -0.102* | 0.002 | -39.800 | -0.098 | -0.105 |
| Perceived barriers to internet use → Digital skills | -0.076* | 0.003 | -34.600 | -0.072 | -0.081 |
| Physical access→ Digital skills | 0.512* | 0.002 | 233.000 | 0.509 | 0.515 |
| Perceived barriers to internet use → Internet use | -0.018* | 0.001 | -11.000 | -0.015 | -0.020 |
| Physical access→ Internet use | 0.225* | 0.002 | 119.000 | 0.220 | 0.229 |
| Digital skills → Internet use | 0.531* | 0.002 | 261.000 | 0.528 | 0.535 |
| Perceived barriers to internet use→ Trust | -0.004* | 0.002 | -1.860 | -0.001 | -0.008 |
| Physical access→ Trust | 0.157* | 0.003 | 61.400 | 0.152 | 0.162 |
| Digital skills→ Trust | 0.425* | 0.002 | 166.000 | 0.421 | 0.430 |
| Trust→ Internet use | 0.175* | 0.002 | 93.300 | 0.171 | 0.178 |

Notes. SE, standard error. Significance: *p=<0.001.

**Figure 4.3** The sequential model of inequality production




### 4.4.2 To what extent does trust mediate the effects of barriers to use, physical access, and digital skills, on internet use, and, therefore, reveal itself as a fourth digital divide?

Our structural model provides evidence of the importance of including trust in the sequential internet use model. However, to obtain a full overview of the role played by trust, we need to investigate to what extent trust mediates the relationship between barriers to use, physical access, and digital skills, and internet use. Following our hypotheses, if trust mediates these relationships, then we could hypothesize that a fourth digital divide exists. We, therefore, performed a mediation analysis, as described above, summarizing the results in Table 4.3, which shows the direct effects of barriers to use, physical access, and digital skills on internet use as well as the indirect effects of trust on internet. For both kinds of effects, we computed the bootstrap CI to assess their significance.

According to our results, while all direct effects are significant, only the digital skills effect is partially mediated by trust (indirect effect 0.074). As the same sign is present in the effects, we can conclude that trust complementarily mediates the impact of digital skills on internet use. Thus, hypotheses H2b, H3b are rejected while H4b is supported.

**Table 4.3** Results of the mediation analysis

| Path | Direct | 95%CI direct effect | Sig | Trust indirect effect | 95% CI indirect effect | Sig |
|---|---|---|---|---|---|---|
| Perceived barriers to internet use →Internet use | -0.018 | [-0.020, -0.015] | YES | -0.001 | [-0.003, 0.002] | NO |
| Physical access →Internet use | 0.225 | [0.221, 0.228] | YES | 0.027 | [0.026, -0.023] | NO |
| Digital skills →Internet use | 0.531 | [0.528, 0.534] | YES | 0.074 | [0.071, 0.078] | YES |

Sig = significant.

## 4.5 Discussion

We contribute to the development of the social process of internet appropriation by extending the sequential model of van Dijk and associates (van Deursen & van Dijk, 2015; van Dijk, 2005, 2020) to include trust. We show that trust is the third most important direct effect of internet use, after digital skills and physical access, and that trust complementarily mediates the effect of digital skills on internet use.

Although our measurement of the theoretical constructs differs from that of van Deursen and van Dijk (2015), our estimates point in the same direction, with a similar strength, as reported by those authors and by van Dijk (2005, 2020). After introducing trust in the model, barriers to use remain statistically meaningful, influencing all other constructs in the model (van Deursen & Helsper, 2015b; van Dijk, 2020; World Economic Forum, 2016). Europeans not motivated or facing barriers to internet use will not access the internet physically, will not develop the required digital skills, will not trust the internet, and will not benefit from using the internet, thereby adding support to the qualitative research reported by Steedman et al. (2020).

Our findings are consistent with previous results, which suggest that physical access will reduce online privacy concerns and increase trust (Chang et al., 2016; Køien, 2011; Mahatanankoon et al., 2006). Better and trusty devices are crucial to enhancing trust and internet use (Maple, 2017), as sophisticated smartphones and computers offering better anti-intrusion protection enhance trust in digital devices and the internet, reducing perceived risks and privacy concerns, with the result that individuals are more likely to share personal data online.

The finding that perceived barriers to internet use is negatively related to online trust is consistent with the view that attitudes to technology are associated with trust in the internet (Blank & Dutton, 2012; Joinson et al., 2010); i.e., attitude, positive or negative, will impact on trust in technologies or information disclosure. The findings also suggest that a more positive attitude may build greater trust in the internet in non-social and social interactions: in providing personal data, not limiting personal profile data, etc,

To our knowledge, this is the first study that tests whether trust mediates the effects of perceived barriers to internet use, physical access, and digital skills on internet use. While we find no support for the mediation effect of trust on barriers and physical access, we do observe an effect on digital skills. This finding suggests that more advanced digital skills not only improve benefits from using the internet but also foster online trust (Dutton & Shepherd, 2006). The influence of digital skills on trust – an experience concept (Dutton & Shepherd, 2006; Steedman et al., 2020) – suggests that the ability to accurately assess online risks depends on digital skill levels: better skills mean more accurate online risk assessment and greater online trust. Our findings, therefore, provide evidence that individuals with better digital skills trust digital partners more and are more confident online (Giantari et al., 2013; Monforti & Marichal, 2014; van Dijk, 2020). Finally, the effect of trust on internet use suggests that trust is a result of having physical internet access and of having developed the required digital skills to assess risk. Individuals that trust online digital partners will be more willing to enter into transactions and share private data.

Regarding the existence of a fourth digital divide, our results do not provide enough support for this hypothesis; consequently, digital skills remain the most significant element in explaining the presence of a digital divide. Our research shows that both institutional trust (secure payments and transactions, etc) and relational trust (secure websites, returns policies, etc) are based on signals that require digital skills for their interpretation (McKnight & Chervany, 2001; Morgan & Hunt, 1994; Steedman et al., 2020). Indeed, not only do individuals themselves need to develop trust, enterprises also need to transmit signals that can be interpreted as reducing perceived risks, minimizing privacy concerns, and increasing trust in partners (Beaudoin, 2008; Chang et al., 2017; Giantari et al., 2013; Jarvenpaa et al., 2000; McKnight et al., 2002; Shin, 2010). Ultimately, however, individuals need digital skills to be able to decode the meaning of secure signals. Overall, we can infer that trust is a constructed state that needs to be interpreted, which is why digital skills remain the key to benefiting from the internet.

### 4.5.1 Theoretical implications

This study makes two main theoretical contributions. First, we extend the concept of social internet appropriation by introducing trust in the sequential model (van Deursen & van Dijk, 2015; van Dijk, 2005, 2020), finding that trust is a crucial theoretical construct, but only to physical access and digital skills. This finding may increase our understanding of the social internet appropriation process that culminates in a digital divide. Second, we show that trust is a socially constructed phenomenon, which may explain the fact that it moderately mediates the effect of digital skills on internet use.

### 4.5.2 Social implications

Trust and online risk assessment depend on individuals' digital skills. Institutions, organizations, and enterprises need to both transmit signals that can be interpreted as guaranteeing secure online interactions, and helping individuals develop the skills required to decipher those signals. Trust and concern are two sides of the same coin: more concerned individuals may be the same distrustful individuals with poorer capacities to interpret online risk (Steedman et al., 2020). Policymakers, therefore, should encourage service providers to both adopt technologically innovative and secure online interaction mechanisms (Jarvenpaa et al., 2000; Pavlou & Gefen, 2004) and help individuals decipher trust signals. While van van Deursen and van Dijk (2019) show that physical access has a crucial impact on digital skills development, we show that digital skills are essential to enhancing online trust.

The development of more secure technologies, systems, and infrastructures is essential to enhancing trust in potentially risky online environments. Moreover, bearing in mind rapid change in digital technologies, individuals may have fewer privacy concerns and greater confidence in the future if they are better capable of interpreting digital contexts (Blank & Lutz, 2018). Improving digital skills and technical knowledge is fundamental to reducing online risk and increasing online trust associated with social interactions and non-social transactions.

### 4.5.3 Limitations and further research

The main limitation of our study is how the model's theoretical constructs were measured, as the sample was not designed to test the sequential model of social internet appropriation as proposed by van Dijk (2005, 2020) and tested by van Deursen and van Dijk (2015). We measured perceived barriers to internet use rather than attitudes as in the original model. Even though the EU ICT survey provides useful indicators to measure the theoretical constructs, the fact that we do not use the same indicators as used by van Deursen and van Dijk (2015) makes direct comparison a challenge. A second limitation is related to the statistical model as, according to Bollen and Pearl (2013), a causal model does not allow a causal effect to be estimated in the strictest sense. However, it provides a useful instrument for evaluating the plausibility of causal chains. Given that we have obtained an overview of the relationship between trust and the other theoretical constructs, an interesting further development would be to include social indicators and categories that might influence perceptions of online trust (education, age, country digital development, etc), and, therefore, furnish a social dimension to the digital divide (Huang et al., 2003). This is the direction to be taken by upcoming research.

## 4.6 Conclusion

Trust is a fundamental element in forming any relationship. As a vital factor in the adoption of ICTs (Yan et al., 2014), it is crucial to understanding how the digital divide develops. By including trust in the sequential model of social internet appropriation, we propose a more comprehensive vision of interactions between different determiners of the digital divide. Our study provides evidence of the links between trust and internet use and of the underlying importance of trust in the generation of the digital divide. Our extended model provides evidence that trust moderately mediates the effect of digital skills on internet use, although it does not provide enough evidence to support the existence of a fourth digital divide. We conclude that trust is a socially constructed concept whose meaning has to be interpreted in terms of the digital skills of individuals.

# Chapter 5

## Discussion, limitations, and future work

This doctoral dissertation aimed (1) to explain the first digital divide for a developing country, (2) to extend the external validity of the RA theory and uncover country- and individual-level resources and social categories that explain differences across European countries, and (3) to extend the theoretical model originally developed for the RA theory to explain the mediating role of trust in the sequential process of internet appropriation.

The study of the first digital divide in Thailand explains internet access heterogeneity in a developing country. The findings suggest that aggregated empirical testing of the effect of theoretical drivers on the digital divided may be misleading. The analytical tool used to identify the social process that generated inequality in internet use in Thailand has uncovered a generational transformation that is masked in aggregated studies. Mobile versus traditional groups of internet users are formed of individuals with different social resources and categories. Those results support two inferences regarding Thailand: first, the existence of a generational gap between mobile and traditional users (cf. the descriptors of both groups), and second, the greater diversity of internet use by mobile users.

The description of internet use patterns for mobile compared to traditional users in Thailand would suggest that the former are more active in all areas of internet use – not only in communication and entertainment, but also in more productive activities usually associated with wired internet use. Our findings, viewed in combination with the description of users in each of those two groups, would point not only to a generational divide (traditional users are both older and less well-educated than mobile users), but also to differences in diversity of internet use (traditional users make more limited use of the internet than mobile users). In Thailand, therefore, mobile access to the internet is more diverse and associated with a younger generation. Consequently, while no support was found for a mobile underclass, support was found for a generational difference in internet access patterns, an interpretation that corroborates the recent finding by Reisdorf and associates (Reisdorf et al., 2020).

In generalizing the RA sequential model to Europe education was identified as the primary generator of inequalities in the process of internet appropriation, but also suggested is that the fact of living in a digitally advanced country may overcome some of the limitations faced by less well-educated Europeans regarding physical access and digital skills. In consequence, a key result concerning the overall analysis of the impact of between-country and within-country resources and social categories is that the sequential causality chain is maintained but operates differently depending on both country- and individual-level positional resources and social categories. In other words, the models estimated according to the inequalities generated in the sequential links are particular cases of the general causality model: perceived barriers to internet use influence physical access, physical access is crucial to developing digital skills, and finally, digital skills affect how the internet is used. While these findings are hardly surprising (since they are aligned with the RA theory), for the first time it is demonstrated that the strength of links between constructs may vary depending on positional and social categories, and also show that education plays a key role in generating the digital divide.

The original RA sequential model has also been theoretically extended, providing evidence that the extended sequential social appropriation model incorporating trust better explains the digital divide in Europe, with the model providing support for the first, second, and third digital divides affecting physical access, digital skills, and uses and outcomes, respectively (van Dijk, 2005, 2012a, 2020). Concerning the predictive power, the extended model better explains the sequential model with respect to the base model (i.e., without trust). The evidence also shows that trust mediates the effect of digital skills on internet use, but not of perceived barriers to use or physical access.

To our knowledge, this is the first study that tests whether trust mediates the effects of perceived barriers to internet use, physical access, and digital skills on internet use. The findings suggest that having more advanced digital skills improves internet outcomes and fosters trust between online parties (Dutton & Shepherd, 2006). The influence of digital skills on trust – an experience concept (Dutton & Shepherd, 2006; Steedman et al., 2020)– suggests that the ability to assess online risks accurately depends on digital skills: better skills mean more accurate online risk assessment and greater online trust. The findings, therefore, provide evidence that individuals with better digital skills trust digital partners more and are more confident in using the internet (Giantari et al., 2013; Monforti & Marichal, 2014; van Dijk, 2020). Individuals that trust online digital partners will be more willing to enter into transactions and to share private data. The effect of trust on internet use further suggests that trust results from having physical access and developing the necessary digital skills to assess risk.

These findings have theoretical and policy implications. At the theoretical level the hypothesis of a mobile underclass is challenged. Technology is changing from a cable-based internet access to mobile internet access, and this transformation suggests that theories need to stop looking only at the traditional way of accessing the internet and start paying more attention to individual-based access to the internet. Furthermore, the 5G technology is accelerating this transformation in both developed and developing countries and is creating a generational divide.

Evidence has been provided that the sequential model of appropriation of the internet follows a different social mechanism to produce digital inequalities. The effect of the theoretical drivers that generate digital inequalities are socially patterned in such a way that their effect varies according to education, age, and the digital development of countries. Those three indicators of resources and social categories are the main determinants of the social process of internet appropriation. To date, the social mechanism that produces inequality in the process of internet appropriation has only been tested at the level of theoretical constructs, while assuming that their effect is homogenous and only the score varies according to the social indicators.

The inclusion of trust in the sequential model developed by van Dijk and associates (van Deursen & van Dijk, 2015; van Dijk, 2005, 2020) provides evidence that trust is the third most important driver of internet use, after digital skills and physical access, and that trust complementarily mediates the effect of digital skills on internet use. This extension of the original model suggest new ways of addressing the digital divide.

The above findings have several implications for reducing digital inequalities. Less well-educated population segments should be the target of policies aimed at reducing perceived barriers and enhancing physical access, as improving physical access to digital devices and internet connections, and, therefore, to the internet is crucial to developing the necessary digital skills, according to both findings here and those of other researchers (Helsper, 2012; Van Deursen & Van Dijk, 2015, 2019). Digital skills can be developed in less privileged individuals in two main ways: by improving a country’s digital infrastructures, and by increasing general and widespread access to a variety of digital devices, encouraging access through as many different devices as possible. Device variety is important in enhancing digital skills overall, because different devices are optimized for specific uses (van Dijk 2020; Napoli & Obar

2014). The issue of perceived barriers is ultimately crucial to reducing inequalities because, as they are dismantled, physical access and digital skills will improve, and variations between groups will be reduced.

However, while this inference is valid for both more and less digitally advanced countries, ultimately, any reduction in digital inequalities will be hampered by underlying inequalities in education (see Shaw & Hargittai, 2018). More user-friendly technologies and devices would reduce the need for advanced digital skills, particularly for older well-educated individuals; while older people are reported to make more rational use of the internet, they have poorer operational skills, which means they make less use of the internet compared to younger people (van Deursen et al., 2011; van Deursen & van Dijk, 2014). Ultimately, however, education is key, as only better educated individuals, on the basis of their digital skills and their social capital, will be equipped to take full advantage of the digital technologies (Hargittai et al., 2019) and ensure better outcomes from internet use.

## Limitations and future work

This doctoral dissertation was not without limitations. The indicators available in the datasets were not as rich as the indicators obtained for the fieldwork by van Dijk and associates (van Deursen & van Dijk, 2015). This fact is directly related to the use of secondary data to analyse the different research questions. Thus, for example, instead of measuring internet motivations/attitudes, it was necessary to measure the antecedent, i.e., perceived barriers to internet use, according to the logic that the existence of perceived barriers makes a positive attitude to the internet less likely.

Future research will use primary data that reflects proper measures of the RA theory constructs, as this would result in better measurements and tests of the model. Apart from the use of primary data coming from fieldwork, regarding this doctoral dissertation’s first issue, it can be argued that it is just a beginning. Multi-country research is necessary to test whether the two classes of internet users (younger mobile users and older traditional users) exist in other countries and in what proportions. Regarding the third issue, future research should include social indicators and categories that might influence online trust perceptions and furnish a social dimension to the digital divide.

Future research efforts could use different data sources regarding the various forms of new technologies, as the internet of things (IoT), artificial intelligence, and big data may considerably enhance digital and social inequality. In this respect, the methodology developed in this work offers the possibility of analysing digital inequalities in differences in attitudes, physical access, skills, usage, and trust through new technologies. Cross-country analysis or multi-country analysis of users in terms of resources and social categories may enrich and increase the generalizability of the results.

# Appendix

## Thailand dataset

The Association of Southeast Asian Nations (ASEAN)[5] is now transitioning towards a digital economy. They created "AIM 2020," which has focused on the digitally-enabled (infrastructure, technology, digital skill); secure (building trust in online); sustainable (responsible and environmentally friendly use of the information and communication technologies (ICTs)); transformative (use technology for social and economic benefits); innovative (encourages innovative and novel uses of ICTs); inclusive and integrated (empowered and connected citizens and stakeholders) (ASEAN Secretariat, 2015). Concerning the member of the ASEAN, we found that apart from Singapore, the next highest fixed broadband penetration rates in the ASEAN were Thailand (OECD, 2019, p. 34). Furthermore, the Thai population has 3G and 4G mobile network coverage of over 98% (OECD, 2019, p. 37). As the high fixed broadband penetration rates and high network coverage, therefore, it is interesting to investigate a case study in Thailand.

In 2020, for 69.71 million Thailand inhabitants, there were 52 million internet users, an increase of 1 million users compared with the year 2019, and there were 52 million social media users (an increase of 2.3 million). There were 93.39 million mobile connections in Thailand, equivalent to 134% of the total population. The most popular owned devices were mobile phones, at 94%, followed by laptop or desktop computer at 50%, tablet device at 33%, smartwatch or wristband at 15%.[6] Now the internet is used mostly on social media, especially Facebook, Twitter, Google Plus, Line and Instagram. Together

[5] ASEAN was established on 8 August 1967. The member states of the association are Brunei Darussalam, Cambodia, Indonesia, Lao P.D.R., Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.
[6] Digital 2020: Thailand by Datareportal: https://datareportal.com/reports/digital-2020-thailand

with social media, activities such as downloading or uploading pictures/movies/video/music/games, searching for information goods or services, e-commerce and reading or downloading news are now highlighted as routine (Economic Statistics Division, 2019, p. 45). Therefore, investigating and understanding the access opportunities for Thai internet users represents a research opportunity to redefine the digital divide in this developing country.

## European dataset

The Horizon 2020 digital agenda for the European Union (EU) set out that maximizing the social and economic potential and use of ICTs, especially the internet, is crucial to providing Europeans with a better quality of life (European Commission, 2010). A new digital strategy launched in 2018 describes a new digital strategy to exploit the potential of digitalization in a more trustworthy, effective, efficient, transparent and secure way (European Commission, 2018) and ensure that Europe will become a digitally transformed, user-focused and data-driven administration. The goal is for the digital transformation to be experienced in a way that makes it work for people, businesses, and the planet in a way that respects European values (European Commission, 2020).

The population of the EU is estimated at 447.7 million. The 27 member states are Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland and Sweden (Eurostat, 2020). According to the digital economy and society index, although 85% of EU citizens already use the internet, there still are disparities across EU members (DESI, 2020). Finland, Sweden, the Netherlands and Denmark have the highest proportions of active internet users and Romania, Bulgaria, and Italy the least. Numerous barriers persist. The top reasons for not having internet access at home remains the lack of need or interest (46%), followed by insufficient skills (44%), equipment costs (26%), and high cost (24%). The ratio of people in the EU who have never gone online is still large in Bulgaria, Greece, Portugal and Croatia. Concerning broadband coverage, internet access at home is provided mainly by fixed technologies, which remained stable at 97% in European countries. The 4G mobile network coverage is almost universal at 99.4%. Only 17 EU members have assigned the band spectrum for deploying 5G. The internet is mostly used for music, playing games and watching videos, following by reading news online, online shopping and online banking. As disparities exist across EU member states and in broadband coverage rates and network coverage, investigating and understanding the digital divide for internet use represents a research opportunity to redefine the digital divide in the EU.

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