D1.1 Literature review

Effects of digitalization in mobility in society

Date: 20 May 2020 **Version:** 1.1

Author(s): Lisette Hoeke, Christel Noteborn, Magali Patrocinio Goncalves, Nina Nesterova
Breda University of Applied Sciences (NL)

Project: DIGNITY | www.dignity-project.eu
Project duration: 01.01.2020 – 31.12.2022
Grant Agreement N°: 875542

Coordinator: Silvia Gaggi
Email: sgaggi@isinnova.org

Executive summary

This literature review (deliverable 1.1) is part of Work package 1 (Framing the digital gap) in the Horizon 2020 research and innovation project DIGNITY. Within this project we build the DIGNITY-approach in order to bridge the digital gap in mobility. In the last few years, digitalization has been a trend in society with a major impact on citizens and industry. While digital technology brings a lot of positive effects, not everyone benefits from these developments. People who experience difficulties with digitalization are at risk of being digitally excluded in a society where digitalization seems an important aspect of life. When the transport and mobility sector adopts digital technology in their products and services, people who are at risk of digital exclusion will face problems in mobility as well. This might lead to mobility exclusion. This report examines the definition of the digital gap. It seems that the focus of the digital gap has changed over the years. In the nineties, accessibility and connection to the internet was the main topic of possible digital exclusion whereas in the last decade the focus has changed to digital skills and use of digital devices and the internet. In Europe, digital performance varies between countries. Northern Europe countries seem much more digitally developed than countries in the east of Europe. In general there are several 'risk factors' for digital exclusion. In this report the following are mentioned as vulnerable groups for digital exclusion and studies that focus on these groups are used to build a clear view of the difficulties that these groups have regarding digital technology and mobility in general.

- Older people
- People with disabilities
- Inhabitants of rural areas
- Women (gender inequity regarding digitalization)
- People with low education levels and/or income

The last topic that is covered in this report is policy regarding the digital gap in Europe. Several reports are used to point out the main challenges for policy.

Document History

Date	Person	Action	Status
20-04	Lisette Hoeke	Document send to reviewer	Draft
22-04	Elisabet Roca	Reviewed document	Reviewed
13-05	Lisette Hoeke	Processed feedback, send for final English-check	Final
13-05	Anya Petyaeva	English-check	English-check
18-05	Joy Deane	English proof check	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

List of figures and tables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

1. Introduction

1.1 Project summary

The overarching goal of DIGNITY is to foster a sustainable, integrated and user-friendly digital travel eco-system that improves accessibility and social inclusion, along with the travel experience and daily life of all citizens. The project delves into the digital transport eco-system to grasp the full range of factors that might lead to disparities in the uptake of digitalised mobility solutions by different user groups in Europe. Analysing the digital transition from both a user and provider's perspective, DIGNITY looks at the challenges brought about by digitalisation, to then design, test and validate the DIGNITY approach, a novel concept that seeks to become the 'ABCs for a digital inclusive travel system'. The approach combines proven inclusive design methodologies with the principles of foresight analysis to examine how a structured involvement of all actors - local institutions, market players, interest groups and end users - can help to bridge the digital gap by co-creating more inclusive mobility solutions and by formulating user-centred policy frameworks.

The idea is to support public and private mobility providers in conceiving mainstream digital products or services that are accessible to and usable by as many people as possible, regardless of their income, location, social or health situation or age; and to help policy makers formulate long-term strategies that promote innovation in transport while responding to global social, demographic and economic changes, including the challenges of poverty and migration.

By focusing on and involving end-users throughout the process of designing policies, products, or services, it is possible to reduce social exclusion while boosting new business models and social innovation. The aim of DIGNITY is to provide an innovative decision support tool that can help local and regional decision-makers formulate digitally inclusive policies and strategies, and digital providers design more inclusive products and services.

1.2 Work package structure

The DIGNITY project is broken down into six work packages, which are described in Figure 1. This deliverable (D1.1 Report with an overview of knowledge about the effects of digitalization in mobility in society) is part of work packages 1: Understanding the digital gap. The objectives of work package 1 are:

- To understand the effect of digitalisation on society in general, and more specifically on people's mobility behaviour.
- To understand the success factors of existing mobility services and products that meet the needs of the widest range of end users.
- To identify the nature and quantify the size of various groups that are potentially excluded from digital mobility services in urban and suburban areas across the EU.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- To understand the diversity of user skills and requirements in potentially excluded groups in using mobility services in urban and suburban areas across the EU.
- To identify the obstacles that potentially excluded groups are facing when using digital mobility products and services

Deliverable 1.1 will cover the first objective. With the knowledge from deliverable 1.1 and the other outcomes of work package 1, the DIGNITY approach will be built (WP 2) and demonstrated in the pilot regions (WP 3).

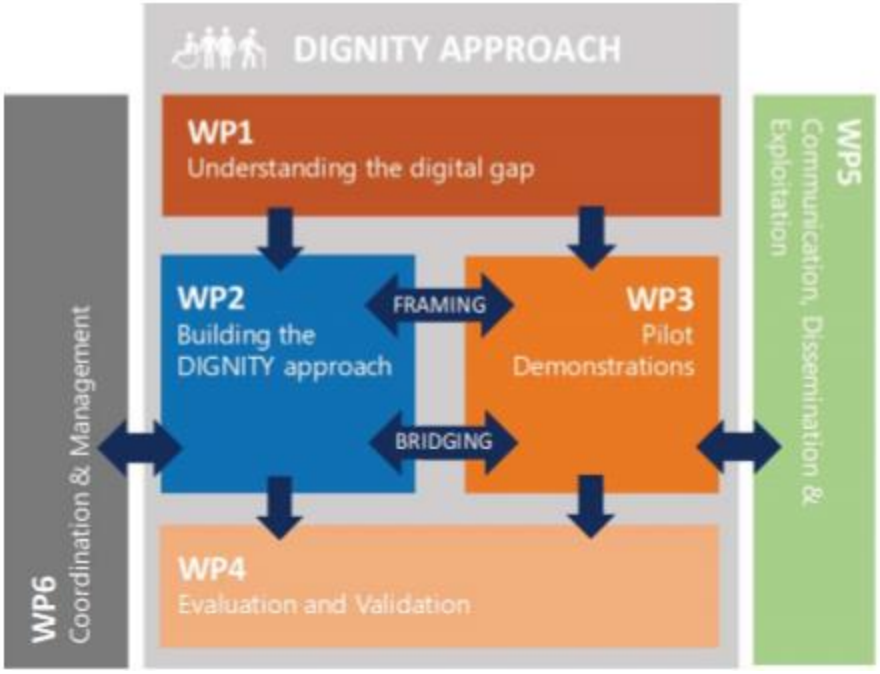

Figure 1 Work package structure of DIGNITY

1.3 Deliverable objective

The aim of task 1.1 is to get a better understanding of the effects of digitalisation in society in general and more specifically in transport and mobility. The literature review will answer questions such as:

- Which positive effects are found related to quality of life, social contact and involvement in activities of citizens?
- Which negative effects are caused by digitalization (in mobility) and the dissatisfaction of people facing the complexity of the digital world?
- Who is facing the effects?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- Who is involved in the digitalization in mobility?
- What strategies and policies can be found in order to enlarge the positive effects or minimize the negative effects?
- To what extent countries and regions acknowledge the difficulties for citizens (some specific target groups) in relation to digitalization in mobility and are they willing to work towards an inclusive society?

This deliverable (D1.1) is the result of task 1.1 and contains an overview of knowledge about the effects of digitalization in mobility in society.

1.4 Methodology

The literature review was carried out by searching for key words both in Google Scholar and in the metadata search from the Library at Breda University of Applied Sciences, which has access to several databases: Library Catalogue; Business Source Premier; Ebsco e-Books; Emerald; DOAJ, Directory of Open Access Journals; HBO Kennisbank; Hospitality and Tourism Complete (Ebsco); Narcis; Sage Online Journals; Springer Journals; ScienceDirect (Elsevier); Taylor and Francis; Wiley Online Library.

The search was conducted firstly focusing on the differences in transport options between different target groups, and secondly on digital skills. Finally, the search was narrowed down to the interplay of the two fields in the digital gap in mobility. We also searched for articles about the adoption of digital tools by target groups identified as important during the research about mobility poverty: elderly people, disabled people, less educated people and poor people. We focused on studies already published, mainly peer reviewed, and also European Union information about ICT (Information and Communication Technology) skills over Europe.

We focused on English written literature since it is the most common language in the European context.

Key words used for the search on the digital gap in mobility were Digital skills; Digital gap; Digital divide; Digitalization; Digitization; Illiteracy in combination with Transport; Transportation; Mobility; and Public transport. Further, based on the target groups identified in the literature, research was conducted attempting to understand the dimension of the problem, the factors of influence and the needs of specific target groups, namely: elderly people, disabled people, people living in rural areas, as well as people with low education levels and low income.

In total 180 articles were found on the topics of the digital gap, mobility, transport poverty, inclusive mobility, mobility as a service and the special needs of the different target groups. Besides articles, papers and reports, some useful information was found on websites (such as those related to European Union). We found 21 articles related to digital skills and the digital divide and used statistics from reports from European Commission and Eurostat. To describe the relation between the digital divide and mobility poverty (chapter 4), seven articles and papers were used.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

There were 27 articles found focusing on the mobility of elderly people and six on the mobility of disabled people. However, there are certainly more articles focusing on the topic from different angles. Relevant studies examining the relation between digital exclusion and low levels of income or education were limited. We mainly used studies of Barcelona (Barcelona Mobile World Capital, 2016) and the UK (Goodman-Deane et al, 2020b). At the policy level we focused on the European Level and found 8 relevant references. In the end, 61 articles were used in writing this document, as some of the articles were found to focus on a specific technology, or have a different focus than expected.

1.5 Outline of this deliverable

This deliverable consists of four chapters. Chapter 2 (framing the digital gap) addresses the effects of digitalization on society and mobility. In chapter 3 the digital gap and the quantification of the digital gap in Europe will be described. Chapter 4 focus on digital exclusion in relation to mobility poverty. In chapter 5 vulnerable groups for digital exclusion are described in more detail to give a better understanding of the problems they face. Chapter 6 gives an overview of policy regarding the digital gap and European actions that are planned to decrease the gap. The last chapter contains the conclusions of this literature review.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

2. Effects of digitalization on society and mobility

Digitalization is one of the current societal trends that has a major impact on the future of businesses and that affects the everyday life of citizens. Digitalization refers to the "adoption or increase in use of digital or computer technology by an organisation, industry, country and so on. In other words, it is the use of digital technologies to improve processes, lower costs and gain productivity (e.g. operation and maintenance) and to establish new business models providing new revenue, and value-producing opportunities; it is the process of moving to a digital business" (Oxford English Dictionary in UITP, 2017). "It is the integration of digital technologies into everyday life by the digitization of everything that can be digitized" (Business dictionary in UITP, 2017). Translating this trend to the consumer level Durand, Zijlstra and van Oort (2019) indicate that "manifestations for the general public include the smartphone revolution, the massive growth in social media use, and the transitions from physical services and infrastructure to internet banking, e-government and e-health services to give just a few examples". Like any disruptive trend or technology, digitalization brings opportunities and challenges and results in some major positive and negative effects on society.

There are several positive major effects of digitalization on the economy and society. For example, Ceechini noted in 2002 "Information and Communications Technology (ICT) can reduce poverty by improving poor people's access to education, health, government and financial services. ICT can also help small farmers and artisans by connecting them to markets". Digitalization is facilitating the connectivity between people, businesses, regions and countries. Location and distance are no longer a barrier to meeting and exchanging information. Digitalization also provides additional opportunities for education: knowledge becomes more accessible and easily shared. From a business perspective, ICT is increasingly determining the ability of individuals, firms, and territories to remain competitive and to do things in a more effective and efficient way (ITU, 2006). New types of companies are emerging, fully reshaping some economic sectors and offering companies new market opportunities and new channels to reach their customers.

At the same time, as mentioned by WEF (2017), "digital transformation itself is raising concerns about its potential negative impacts, such as job loss, an erosion of trust and cybercrime, which threaten the pace of technological development". The Digital Britain final report (BIS, 2009) highlights the growing importance of access to the digital infrastructure: "with digital technologies often being used to make mainstream public services (such as education, health care and transport) more effective and efficient, the importance of having access to digital tools and knowing how to operate them becomes flagrant". In addition, there are PC and digital media illiterate people, and people who do not have a digital connection or who cannot access digital technologies due to low income: these parts of society are being directly excluded from a large number of services, products and processes in the modern world. Overall, the inequalities

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

generated by the diffusion of digital technologies and resulting from unequal digital skills "may have serious implications for economic growth, human development, and the creation of wealth" (ITU, 2006). For this reason, the so-called digital divide has become a major issue on both international and national arenas (ITU & UNCTAD, 2007) and will further be explained in chapter 3. In their reflections, WEF (2017) authors go as far as stating that "for the first time in its brief history, perhaps, the continued growth of a trend that once seemed irresistible is now open to question. Will the digital revolution deliver a more prosperous global economy quickly and inclusively, or will it become mired in mistrust, regulatory fragmentation and a popular backlash?"

Translating the digitalization trend to the transport sector, Durand, Zijlstra and van Oort (2019), referring to Aguiléra (2019) and Pangbourne et al. (2018) mention that "the transport sector is no exception: digitalization in transport and around travelling is already happening in ways that have transformed how people travel". Growing access to customer information is really a game-changer in mobility. "Digitalization is firmly placing the customer at the center of developments, and it is customer behavior, together with technological advancement, which is the main driver of change, leading to the emergence of new mobility services" (UITP, 2017). "With the spread of the internet and connected mobile devices, travellers are increasingly invited to rely on digital tools and knowledge on how to navigate the digital world" Durand, Zijlstra and van Oort (2019).

"Traditionally, transportation decision-makers have had to rely on subjective assumptions and manual data collection processes to optimize the efficiency and planning processes for the systems for which they are responsible" (WEF, 2020). Digital transformation introduced a completely new perspective into this process, making data collection and analysis processes easier, more accurate and in real-time and bringing both opportunities and challenges for the policymakers, mobility companies and users. Some of the most evident benefits from the exponential access to data and information and digitalization in mobility are:

- Increased understanding of the consumers travelling profiles allows companies to create individualized travel advice based on real-time user preferences.
- Creation of travel planner apps simplifies user access to travel information and enables companies to communicate changes and disruptions to travel in a real-time format.
- Improved user feelings of control over their travel, by allowing them to optimize their journey choice based on a combination of preferences for cost, time, comfort or convenience.
- Improved planning opportunities arising from better access to data from other sectors (e.g. integration of weather predictions in travel advice).
- Possibility of improving the overall mobility situation in a city, by, for example, anticipating traffic jams, by using cameras and geographical information systems to manage traffic almost automatically and enable the decision support system to perform corrective measures.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

Furthermore, digitalization is at the origin of the current reshaping of the mobility market: new services are being developed (e.g. car-sharing; route planners; on demand mobility, etc.), which sometimes result in the introduction of new market players to the mobility market; existing providers need to think about new business models in light of competition from new players; and new policies are necessary to regulate this evolving market. Platform economy, combined with increased knowledge of consumers' travelling patterns enable the appearance of integrated mobility platforms (e.g. Mobility as a Service), providing completely new channels for mobility companies to reach their clients.

Finally, digitalization enables an increase in the efficiency of provided services (e.g. digital customer service, failure-prediction systems, etc.), a reduction in costs (e.g. from condition- and status-based predictive infrastructure maintenance), diversification of revenue streams of mobility providers (e.g. digital advertising, provision of connectivity infrastructure on-board), and an improvement in customer relationships (e.g. electronic ticketing).

The following main challenges that digitalization introduces to mobility can be identified. First, a complex policy debate about data privacy and access to consumer information is one of the most non-evident topics in relation to mobility. Integrity, confidentiality and privacy of the collected and processed consumer data needs to be carefully addressed. In addition, UITP (2017) states the sector itself is "under increasing pressure to make its data publicly available", for which, of course, pros and cons exist. Secondly, big data generation, processing, storage and analysis is not a simple process. It requires a technical perspective in addition to substantial human and financial investments in the process. Finally, referring to the potential impact of the digital gap in mobility, Durand, Zijlstra and van Oort, (2019) argue that "There is hardly any literature on the potentially exclusive effects of digitization in mobility services and on the (consequences of this for the) 'victims'".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

3. Digital gap

3.1 Definition of the digital gap

Not everyone benefits from digitalization in society. Varying levels of access to digital infrastructure, technologies, knowledge and the skills required to use digital systems have led to notions of the 'digital divide' with gender, age, income, ethnicity and location being identified as significant factors (BIS, 2009; Velaga et al., 2012). In order to create awareness about the differences in accessibility of digital technology, the US Department of Commerce published a report in 1990 in which they mentioned people who have and people who have not access to digital technology. In 2001 the term digital divide was used by the OECD (Organisation for Economic Cooperation and Development) and defined as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICT) and to their use of the internet for a wide variety of activities" (European Union, 2015). In this definition not only the accessibility of digital technology but also the use of the internet was mentioned. Nowadays, the definition includes a broader perspective of digital technology. A definition of the digital divide "referring to the inequality between people who have access and knowledge of new technologies and those who do not" is described in Barcelona Mobile World Capital study (2016).

All recent definitions of the digital divide or digital gap have two things in common:

- They acknowledge that the digital aspect consists of multiple factors related to digitalization such as accessibility, usage and skills.
- The divide or gap occurs when people experience different levels of access to digital products or the internet and different levels of skills/usage/experience with digital products in society. The digital divide is not a simple separation of two groups: one of those who are included and one of those who are excluded.

In van Dijk (2013) four aspects are mentioned that influence the 'digital' level of people's motivation, access, skills and usage (Figure 2). In order to use digital products and services, you need digital skills and access to digital products. But it starts with a motivation, a wish to have a computer or to have access to internet.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

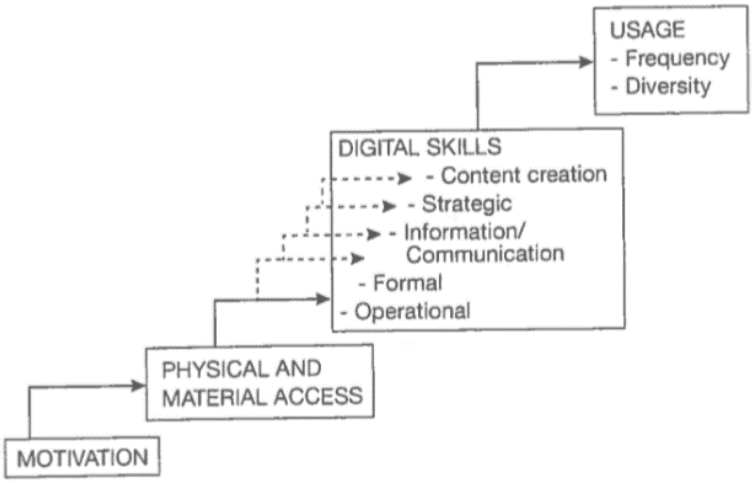

Figure 2 Relation between variables that influence the 'digital level' of people (van Dijk, 2013)

On a European level, the Digital Economy and Society Index (DESI) has been introduced to monitor progress on digitalization in Europe. The index consists of five dimensions:

- connectivity
- use of internet services
- human capital
- digital public services
- integration of digital technology

The dimension of human capital covers both skills and digital inclusion. The DESI-score shows which aspects contribute to the digital performance of countries in Europe (European Commission, 2019).

In 2010, the EU set a digital agenda with broadband connectivity targets to bring broadband internet with high speed in phases to all Europeans. More and more people have been connected to internet and the percentage of internet use via mobile devices has grown from 36% (2012) to 75% (2019) (Eurostat, 2020). With the increase in connection and access to the internet, the focus shifts to digital skills. In 2020 the European Commission will present a Digital Skills Agenda that will focus on how to improve the digital skills of citizens in Europe.

3.2 Digital performance in Europe

The digital performance for European countries, indicated by the Digital Economy and Society Index, varies from global leaders in digitalization such as Finland, Sweden, The Netherlands and

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

Denmark to countries that still have a long way to go such as Romania and Bulgaria (European Commission, 2019). Figure 3 shows the DESI ranking per country in Europe in 2019.

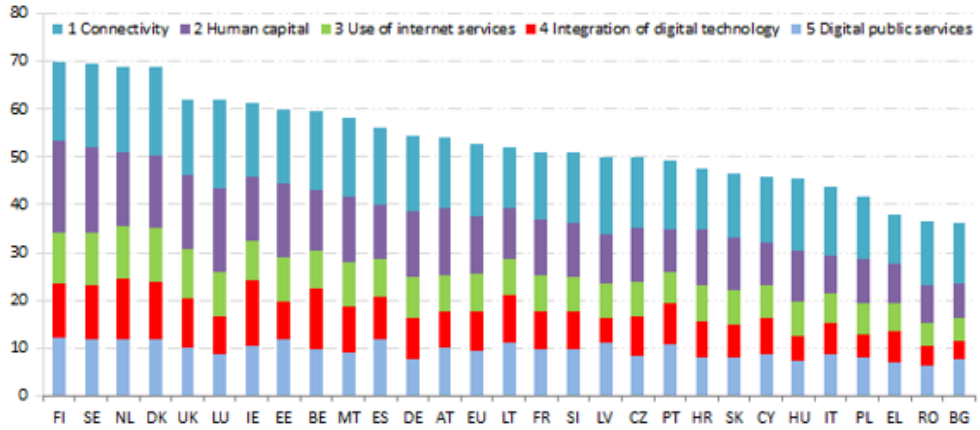

Figure 3 Digital Economy and Society Index (DESI) 2019 ranking (European Commission, 2019)

The dimension of 'human capital' focusses on digital inclusion and skills. According to the DESI Report 2019: Human Capital, at least 57% of EU individuals have at least basic digital skills (2017), 3.7% of total employment in Europe was of ICT specialists (2017) and 3.5% of all graduates in Europe were ICT graduates (2015). In Figure 4 the DESI-ranking for Human Capital 2019 per country is shown, where internet user skills are the digital skills of individuals and advanced skills and development are ICT specialists and graduates. According to this report, the main reasons for not having internet access at home are lack of need/interest, insufficient skills and high access and equipment costs. The fastest-growing factor for not having internet access at home is insufficient skills. Maybe that is also one of the reasons accounting for the large numbers of EU households that still declare not having internet access at home because they do not need it. (European Commission, 2019).

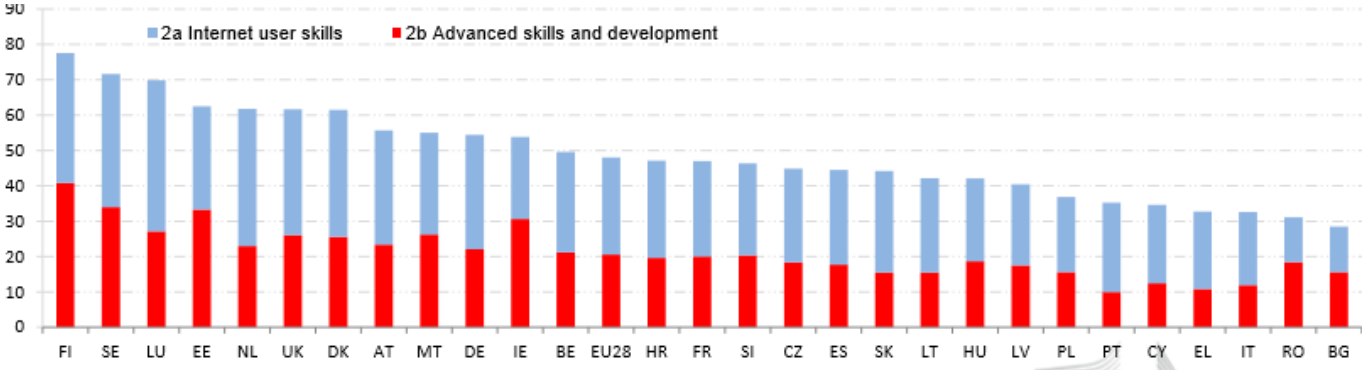

Figure 4 DESI-ranking, digital skills (European Commission, 2019)

"In 2017, 43% of the EU population had an insufficient level of digital skills. 17% had none at all, as they either did not use the internet or barely did so" (European Commission, 2019). Figure 5 shows the share of people per country in Europe.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

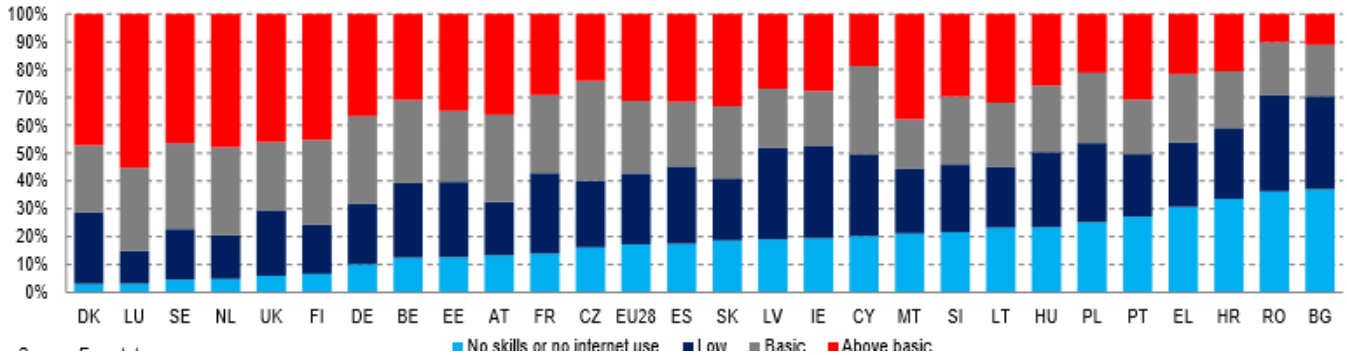

Figure 5 Digital skills of the EU population, 2017 (% of individuals, by skills level) (European Commission, 2019)

3.3 How to measure digital skills

In 2009, van Deursen and van Dijk stated that "very little scientific research has been done on the actual level of digital skills possessed by citizens. Unfortunately, it is extremely difficult to determine the actual level because most digital skills are not the result of computer courses, but of learning through practice in particular social user environments." Nowadays, more studies related to this topic have been executed and more knowledge on people's digital skills is available. However, determining people's digital skills is still a difficult task. Van Deursen and an Dijk (2009) used a performance test to measure the digital skills of the Dutch population in general. In their study 109 participants completed nine assignments to measure the level of four types of skills. In Table 1 Main parameters predicting people's digital skills (Van Deursen and Van Dijk, 2009)Table 1 we have captured the four skills they defined and their main findings.

Table 1 Main parameters predicting people's digital skills (Van Deursen and Van Dijk, 2009)

Skill	Definition	Results
Operational skills	The skills to operate digital media	Main predictors: age and internet experience
Formal skills	The skills to handle the special structures of digital media such as menus and hyperlinks	Main predictors: education, age. Also, the more time spent on the internet per week the quicker they managed to finish the tasks
Information skills	The skills to search, select and evaluate information in digital media	Main predictors: education
Strategic skills	The skills to employ the information contained in digital media as a means to reach a particular personal or professional goal	Main predictors: education

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

From the studies of van Deursen and van Dijk (2009) we can see that the main predictors in general for digital skills are age, education and previous experience with the internet.

In recent years, several studies have been done to measure digital skills using performance tasks. Goodman-Deane et al (2020b) examined how people performed on eight component interface patterns on a smartphone interface using simplified paper prototypes. In their study, 338 people from England and Wales completed a 20-minute questionnaire with an interviewer in which common digital interface symbols and patterns were examined. The results provide additional information about the types of people with a basic level of digital competence. This knowledge helps to determine the digital gap.

Other relevant data regarding people's digital skills can be derived from the Survey of Adult Skills conducted by the OECD (OECD, 2013; OECD, 2016). This study surveyed thousands of people aged 16-65 from various countries on levels of numeracy, literacy and computer skills (more specifically 'problem-solving in technology rich environments'). Computer skills were assessed by performance tasks on real computer interfaces and examined a range of 'widely available and familiar technology applications, such as e-mail software or a web browser'. Although it is valuable work, it only examines fairly high-level skills and divides participants into four main levels. It does not examine the ability to use more basic technology interfaces (e.g. smartphones) and it cannot be used to examine performance on component aspects of an interface. Nevertheless, it gives a good indication of the spread of digital skills across the working age population.

Another relevant piece of work is the computer literacy scale for older adults constructed by Sengpiel and Dittberner (2008). This scale tests knowledge of ICT-related symbols and terms as an indicator for "the ability to understand and use computer related symbols, functional elements and interaction patterns". While this is not direct assessment, it is not purely self-report and showed good correlation with actual performance.

3.4 Risk factors for digital exclusion

There are many risk factors for digital exclusion. Goodman-Deane et al (2020a) highlighted eight main categories of user characteristics that affect a person's ability to use digital interfaces (**Errore. L'origine riferimento non è stata trovata.**). These characteristics were determined after an examination of a wide range of literature, with two papers being identified as being particularly influential for this schema: Barnard et al (2013) and Wagner et al (2010).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

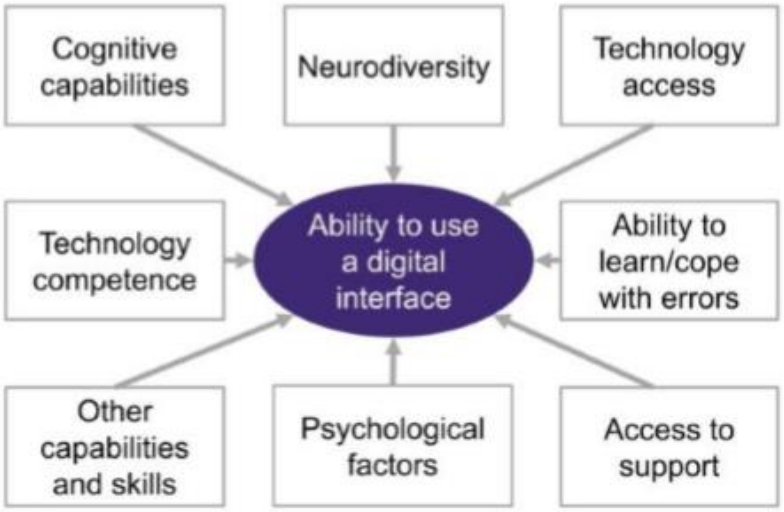

Figure 6 Key user characteristics that affect a person's ability to use digital interface (Goodman-Deane et al, 2020a)

Focusing on demographic risk factors for digital exclusion, the Human Capital section of the DESI Report 2019 highlights that 31% of people with low education levels or no education have at least basic digital skills, whereas 57% of the total population has at least basic digital skills (data based on year 2017). Furthermore, gender seems to be a critical factor; in fact, more men have at least basic digital skills (60%) then women (55%). There is also a difference between living in rural areas (49% have at least basic digital skills) and living in urban areas, where 63% have at least basic digital skills (European Commission, 2019). Vincente and Lopez (2011) reported that "Population size, density and the degree of urbanization are also correlated with the digital divide. The urban density theory highlights the negative association between ICT adoption costs and population size and density. The access to these technologies is easier and cheaper in cities (than in rural areas) because they have better telecommunications infrastructure, and the costs of the deployment of new infrastructure are lower."

Age was also revealed as a relevant factor for digital skills. Less than 1% of individuals from 16-24 years old have never used the internet and 37% of the 65-74 year olds have never used it (European Commission, 2019, section Use of internet services), as shown in Figure 7. Besides, the Report highlights a gender gap between individuals who use the internet at least once a week (regular users): here are less woman regular users although the gap has decreased over the last few years (see Figure 8). "These figures imply serious risks of digital exclusion in a context of rapid digitalization" (European Commission, 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

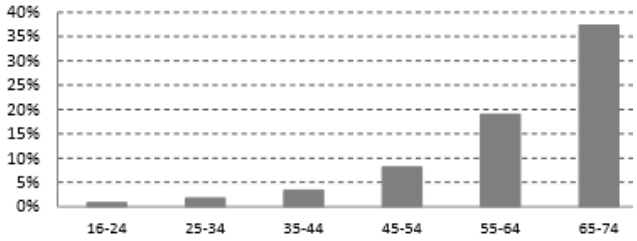

Figure 7 Individuals who have never used the internet by age, 2018 (European Commission, 2019)

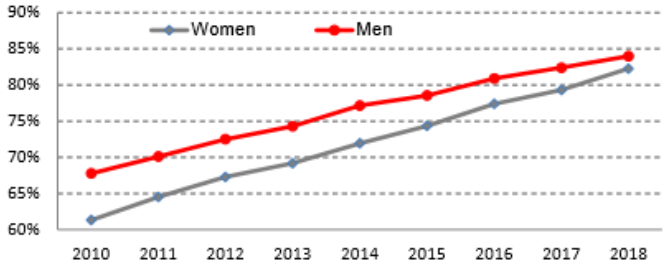

Figure 8 Gender gap between individuals who are regular internet users between 2010-2018 (European Commission, 2019)

In 2015 the European parliament (European Union, 2015) stated that, although the digital divide has decreased in the last ten years, the digital gap still exists. "According to the 2015 European Commission's Digital Agenda Scoreboard, two related targets have already been met (all EU households can access basic broadband and 75% of all Europeans are regular internet users). However, there is a danger that targets related to fast and ultra-fast speed broadband will be missed, especially in rural areas."

A study in Barcelona shows the importance of education: 90% of the citizens with a middle or high level of education are connected to internet daily in comparison with 60% of the citizens with a low level of education. However, the differences are smaller in high income districts. Besides, neither age nor gender seem to be factors leading to a digital divide in this study (Barcelona Mobile World Capital, 2016). In Goodman-Deane et al (2020b)'s study there was no correlation between gender and digital skills either. In their study digital competence declined with increasing age and decreasing social grade. Social grades are based on the occupation of the head of the household and for this study they are grouped into middle class and working class.

3.5 Conclusion

The focus of interest in the digital divide has changed over the years. In the early nineties the biggest concern regarding exclusion from digital society was access to the internet and digital devices. Nowadays the definition of the digital divide is much more complex and includes skills, frequency of use, availability of digital technology and the internet and more.

In Europe, the Digital Economy and Society Index shows the digital performance for European countries. The differences in countries are clear in the figures. Not every country has a good internet connection for their citizens and not all citizens have good digital skills. Measuring people's digital skills is a complex topic. Although some good methods have been developed, it is still a difficult task.

Based on results from studies, some characteristics can be indicated as risk factors for digital exclusion. There is clear evidence that older people have more difficulties with using digital technology. Furthermore, level of education, level of income and social grade (based on

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

occupation) seem to be related to digital skills and/or frequency of internet use. The percentage of people having connection to the internet is much higher in urban areas then in rural areas. Therefore, mobility solutions that communicate via internet connection might be less effective in rural areas. In chapter 5 the vulnerable groups for digital exclusion will be described in more detail.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

4. Digital exclusion and mobility poverty

4.1 Transport-related social exclusion

In chapter 3 the issue of digital exclusion and the risk factors for it have been discussed. In the world of built environment and transportation the issue of transport-related exclusion has already been an issue for many years. This social exclusion is considered as a possible result of transportation /mobility poverty.

The consequences of having no available transport for people were studied "in terms of their (in)ability to access key life-enhancing opportunities, such as employment, education, health and their supporting social networks" (Lucas, 2012). Transport research has developed from a transport provision perspective to a policy perspective, based on people and their needs. It directed the discussion to the concept of equity. Lucas emphasized that transport disadvantage and transport-related social exclusion are not identical. In Figure 9 she tried to show that transport disadvantage and social disadvantage interact directly and indirectly to cause transport poverty.

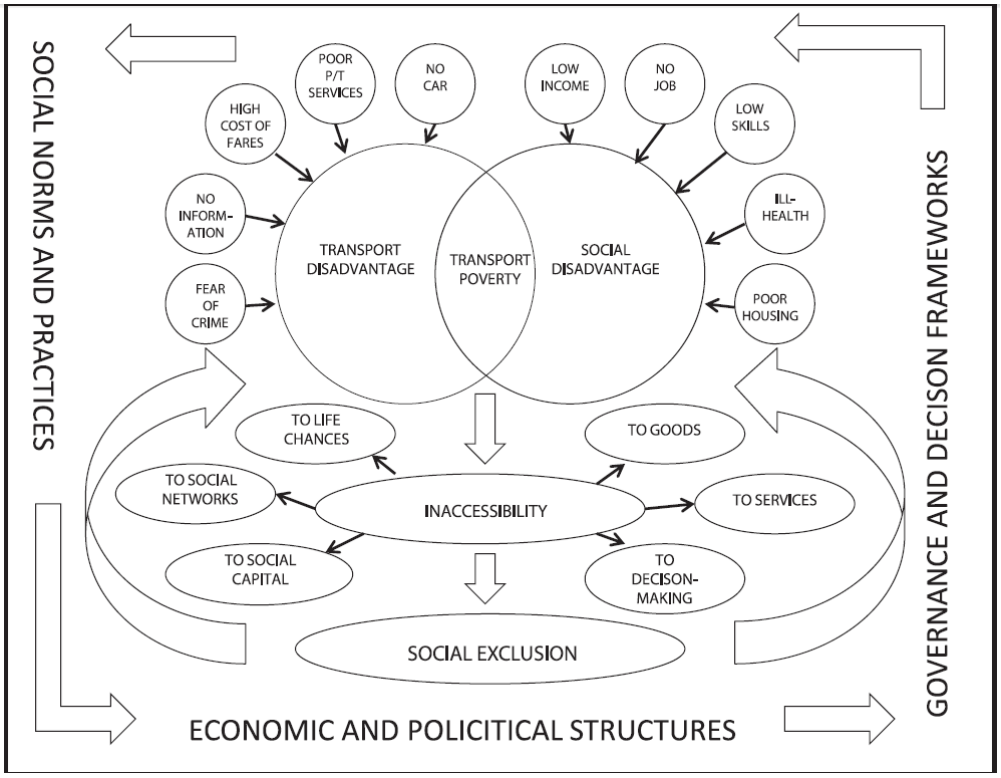

Figure 9 Diagram to illustrate the relationship between transport disadvantage, social disadvantage and social exclusion (Lucas, 2012)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

Martens comes close to Lucas' theory of social exclusion when talking about a transportation policy based on principles of justice. "A transportation policy based on principles of justice thus goes beyond small gestures to the low-mobile population groups" (Martens, 2014). From a legal perspective, he tried to convince responsible authorities to include justice in transport and mobility policies and to design fair transportation systems with sufficient accessibility for all citizens. For him it was important to measure the risk of transport poverty. He considered the lack of accessibility as the risk of participation poverty; in other words as the chance that someone will experience a lack of activity participation due to problems in accessibility (Martens, 2017). Martens developed a transport poverty indicator (index of basic accessibility), based on the size of the potential accessibility problem and the number of people thus affected, to help governance on a local and regional level to organize a fair transportation system (Martens, 2016).

4.2 Transport poverty and the digital divide

Partly based on Lucas and Martens, a new conceptual model for transport poverty has been developed by Jorritsma et al. (2018). In this model (the risk of) transport poverty is central. Transport poverty can be caused by three factors: perceived and / or objective (inadequate) transportation options, the specific socio-economic and spatial environment and the skills someone has for using the transportation options. The interaction and interplay between these factors cause inaccessibility. This creates a risk of a degree of social exclusion. In this model there is also room for digital skills as part of all skills that are needed for using transportation options. Zooming in to mobility and digitalization, Durand, Zijlstra and van Oort (2019) mention the example: "in order to benefit from services where a connected device is needed as a digital key (e.g. to unlock a vehicle), as a proof of payment or as a travel assistant, one needs to have the appropriate device and digital skills." When mobility services are digitalized even more in the future, digital skills and being connected will play an even more important role in using these services. Figure 10 shows the interplay of digital-related and mobility-related exclusion.

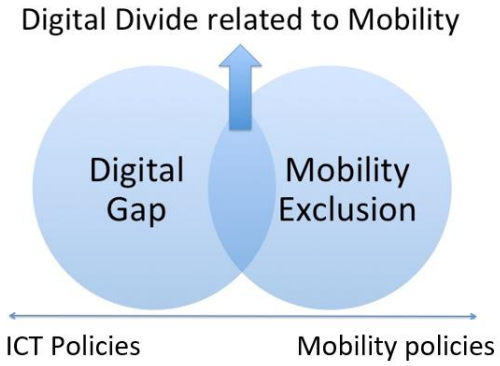

Figure 10 Interplay of digital-related and mobility-related exclusion

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

4.3 A plea for policy-making

Banister (2019) argued that, in financial situations like a recession, rich people get wealthier and poor people become poorer. In other words, inequality grows. He discovered that this inequality also applies to transport. Nowadays everyone is travelling more and over a greater distance than 60 years ago, but that growth is larger for the rich than for the poor. So rich people benefit more from investments and subsidies than poor people. Banister pleads for a transport policy that improves social wellbeing for everyone. His plea for social policy-making aims at greater independence for all people. Poor people often drive a car but cannot chose an alternative as they live in peripheral areas. Rich people have more opportunities to choose (Banister, 2019).

"There is a huge potential for increasing the efficiency of transport through new forms of sharing and access, principally based on new technology and the use of 'empty space' within vehicles. But this opportunity will be mainly available (at least initially) to those people with access to smartphones. Technology offers the means to provide more opportunities for all travellers, and probably at a lower price than currently, but there is a long way to go before the poor have equivalent levels of access through technology as the rich currently have. As with many innovations that have huge potential to benefit all society, it is the rich and those with the necessary knowledge and supporting infrastructure who are the main gainers. However, if the objectives of transport policy are to reduce levels of relative and absolute inequality, then priority needs to be given to providing the means by which all members of society can benefit from innovation." (Banister, 2019).

Also Ranchordas (2020) dedicates her study to the connection of smart mobility, poverty and the right to inclusive mobility. Ranchordas gives a critical look at the concept of smart cities and smart mobility because these concepts are based on the assumptions that citizens have financial, intellectual, and physical access to technology and transportation infrastructures. In her paper she explains that not everyone benefits from the advantages of the new concepts. She refers to people affected by transport poverty for reasons as low-income, disabilities and reduced digital literacy. If mobility is seen as an 'essential utility' to which all citizens should have equal access, policies may change. A public-interest, equal, inclusive and equitable design of smart mobility requires taking into account a number of considerations, she states. Transport poverty is, in her opinion, the result of the unequal treatment of citizens. "Citizens should not be excluded from access to transportation or information on accessibility on the grounds of their lack of digital literacy, physical or psychological place of residence or low-income." She considers the concept of 'inclusive mobility' broader than the right to travel; travelling should be possible under fair and reasonable conditions. In several European countries, some groups, such as low-income households, senior citizens and students, benefit from a public transport subsidy. Free public transport is a possibility that meets the needs of the poor. It is already common in several French cities, in Portugal, Tallinn in Estonia and Luxembourg. The challenge is to find a solution for the last mile, which is especially a problem for people who are impaired (Ranchordas, 2020).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

Smart mobility could be an answer for transport poverty as long as it serves not only the educated and tech-savvy people, living close to their job location. Now, smart mobility solutions often require a level of digital literacy which people that are affected by transport poverty do not have.

Ranchordas ends her article with the conclusion "Digital technology can nowadays reduce transport poverty at a lower cost to governments than some decades ago as platforms can aggregate supply and demand data, develop better pricing systems, and ensure that unused transport capacity is reallocated to those who need it. Nevertheless, smart mobility will only deliver full social value when technology and transport policies are designed with the vision that citizens, regardless of their income, physical ability, and digital literacy, are entitled to equal access to mobility." (Ranchordas, 2020).

4.4 Conclusion

As the mobility industry undergoes digitalization, people who have no access to digital technology or lack in digital skills are potentially excluded from access to transport modes. This is particularly serious if this group of people also suffer from transport poverty as they will become further excluded from the use of mobility services. This means that in cases where transport poverty and low access to digital technology co-exist the effect is amplified. The next chapter will dive into the target groups that might face digital 'poverty' due to several factors.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

5. Vulnerable groups for digital exclusion

Digitalization of mobility solutions for different population groups is not a straightforward process. It needs to respond to the user needs of the category and consider the digital literacy of the population group. Section 3.4 of the current deliverable identified several user groups for which the digital gap in regard to the digitalization of mobility services might be the largest. Those user groups are:

- Older people
- People with disabilities
- Inhabitants of rural areas
- Women (gender inequity)
- People with low education levels and/or low income

These vulnerable groups are not equally well documented in the literature, which might indicate a need for an additional research focus in the future. Chapter 5 provides a short description of each group, summarizing their specific user needs, key challenges in relation to the digitalization of urban mobility for them and potential solutions to cover this gap.

5.1 Older people

Several studies show that there is a negative correlation between age and the use of digital tools (e.g. van Deursen and van Dijk (2009), European Commission (2019), Goodman-Deane et al (2020b)). Nevertheless, when considering the use of digital services and tools in mobility it is important to note that older people, as a user group, are a large heterogeneous group of people both in needs and behaviour. Consider for instance, older people that are still actively working versus retired older people: they will naturally have different mobility needs (Fiedler, 2007). According to the same author, there will also be a difference in whether these persons are still active and fit or if they have health problems or decreased mobility.

As people age, the probability of impairment increases. There are several impairments to be considered (Fiedler, 2007):

- Decrease in senses: vision and hearing loss can result in reduced ability to read timetables or to hear and follow directions.
- Functional constraints: these can cause difficulties entering or exiting public transport, standing while in motion or carrying things like groceries.
- Physical stress: requirements to be on time for public transportation or to change modes during a journey can be very demanding for an older person.
- Intellectual/cognitive constraints, language and speech: Activitites such as planning, decision making orientation, and coping with unexpected changes, amplified by the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

frequent lack of personnel to guide them, can lead older people to refrain to use public transport.

- Psychological constraints: these include things like fear of falling, or of catching the wrong bus.
- Deceleration of activities: many things seem to happen at a pace that is too fast for many older people. This includes short periods of time available to change transport mode, journeys starting before users have time to sit down, and having to quickly change platforms unexpectedly.

Similarly, Meurer et al. (2018) argue that even "minor health issues and concerns do impact on young elderly people's way-finding choices", and that the lack of information on "reachability and environmental access" can lead to "insecurities" and even prevent older people from travelling. This factor is of course more important when travelling to destinations that are not familiar. As a result, not only do we need to have good accessibility, we also need to make this accessibility clear to this user group when they are planning their journey. Another interesting finding of Meurer et al. (2018) is that older people often focus on single transportation modes, restricting themselves due to their physical and cognitive limitations.

Harvey, Guo and Edwards (2019) note that the transport system still presents difficulties for many older people and "there are considerable gaps in support needed for older travellers compared with what is presently the case". They also see a lot of potential in technology that can remove some of the barriers: "innovations providing a seamless, door-to-door experience could simplify the process of planning and making journeys and potentially increase levels of independent mobility for older people. In relation to public transport, journey information that may be particularly beneficial includes: availability of all supporting features such as toilets, seating, refreshments, physical accessibility, route-mapping, walking distances, not to mention all necessary trip information including what to do if services are disrupted, and displayed information that is accurate in real time" (Harvey, Guo and Edwards, 2019).

However, even though digitalization has a lot of potential to facilitate older people's access to and usage of mobility services, several studies indicate that older people's digital literacy does not follow the pace of the world's technology development (e.g. Van Dijk, Hacker and Van Dijk, 2003). Therefore, older people may not be able to fully benefit from all the potential benefits that digitalization can offer. For example, as a result of their survey on internet usage in Germany, Koch and Frees (2016) indicate that age is still the major factor for smartphone usage. They found that, whilenearly 90% of 15 to 29 year olds used a smartphone on a daily basis in 2016, only 11% of people older than 70 did.

Harvey, Guo and Edwards (2019) identify many of the barriers that older people have in engaging with technology in the context of mobility services. It is important to note that many of these barriers are psychological barriers:

- lack of trust,
- alien jargon,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- privacy and security issues,
- not wanting to lose face-to-face contact and social interaction in daily lives,
- fear of not being able to keep up,
- lack of confidence,
- perceived lack of need,
- visual and cognitive decline, and
- potential cognitive load.

Harvey, Guo and Edwards (2019) also mention "cost, battery life, not printing out tickets and not wanting apps, keypads or displays too small, out-dated programmes that require upgrades to work" as important ergonomic and technical barriers that slow down successful uptake of digital mobility solutions among the elderly. Finally, they highlight that "the lack of trusted places to buy technology, and the lack of formal tech support were also problems" (Harvey, Guo and Edwards, 2019).

There are also ergonomic issues that cannot be ignored, including making design easy to understand and simple to operate (Harvey, Guo and Edwards, 2019; Cambridge Engineering Design Centre, 2017). Harvey, Guo and Edwards (2019) pointed out that the participants in their study found issues in the use of smartphones, such as the letters being displayed being at too small a size to read and press. This also applies to buttons that might be too small to interact with. It is also important to pay attention to the options provided to revert in case of mistakes, "hiding unused over-functionality, using pictorial-style algorithms, in relation to personal IT and better design of buses and other transport to accommodate better those who are older and slower" (Harvey, Guo and Edwards, 2019).

Over the last few decades there has been increasing attention to designing interfaces which can make the use of digital tools easier for older people. See, for instance, Hawthorn (2000), Subasi et al.(2011) and Johnson and Finn (2017), which seem to be heading along the right path.

5.2 People with disabilities

People with disabilities is another group of people that might experience difficulties related to the digitalization of mobility services. Although the difficulties and barriers encountered by this group may have a lot of overlap with the ones faced by the older population, it is important to understand its own specific characteristics and user needs. As confirmed by Graham et al. (2019) "while many older travelers may be disabled due to the consequences of ageing, there are also many disabled passengers that are of a younger age". These groups of people might have difficulties travelling but it could be that younger people with disabilities may not have as many difficulties with digital solutions as the older generation. However, the situation is not simple, as there are many different kinds of disabilities: mobility difficulties, visual or hearing impairments,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

cognitive impairment and mental health problems (OECD, 2009). Another dimension should also be considered: "reach and dexterity" as "many products and services rely on the user's hands and arms to manipulate controls, move objects and exert force, e.g. to turn a lever or push open a door" (Cambridge Engineering Design Centre, 2017).

For example, for people with physical disabilities it is essential to know if they can reach a mobility solution (e.g. public transport or any other) safely; to have specific information on whether respective solutions are accessible for people with disabilities and equipped with proper infrastructures; and, once out of the mobility solution, if and how they can reach their final destination safely. They might need information on walking distances, gradients, the existence of steps, seats, wheelchair access, etc (Hounsell et al., 2016). Some simple measures such having audible and visual information in parallel are very important for people with visual or hearing loss (OECD, 2009).

For people with cognitive impairment and mental health problems "the main problem can be characterized as difficulty in coping with a fast-moving and constantly-changing environment. Using public transport involves processing information quickly and taking decisions based on that information" (OECD, 2009). OECD (2009) summarizes the problems that people with cognitive impairment and mental health problems might experience when faced with regular travel requirements:

- getting one's bearings,
- tiring easily,
- being unable to concentrate or remain vigilant,
- being anxious,
- becoming stressed as a result of hurrying/coping with deadlines,
- struggling to cope with information in small print, poor acoustics, fast speech etc,
- remembering information,
- dealing with unexpected or stressful situations,
- lack of information during the journey,
- fear of falling,
- lack of understanding/empathy from transport staff (cognitive impairment and mental health problems may not be visible), and
- stigma, discrimination, abuse.

For this target group, tailored information may provide the highest benefits in increasing mobility. Bjerkan and Øvstedal (2018) state that "even relevant, understandable, easy-to-find information in accessible formats, may not be sufficient for some travelers with cognitive disabilities. For them to travel without a companion, the information may need to be presented in a tailor-made way as well as sequenced and timed for each relevant step in the travel chain". Moreover, "people

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

with disabilities are often eligible for different support schemes, price schemes, assistance etc., but different criteria might apply on different parts of the travel chain, depending on the transport provider or in what municipality or county the travel is conducted" (Bjerkan and Øvstedal, 2018). Digitalization of the mobility system can also play a role in the creation of the most optimal and cost-efficient travel advice for the them, contributing in this way to the increased mobility of this target group.

The EU pays growing attention to the mobility needs of physically disabled people, on the level of both policy and infrastructure (including digital) (European Disability Forum, 2020). Of course, there is still a long way to go and the level of the mobility infrastructure accessible to physically disabled people varies a lot between EU member states (Muñoz et al., 2016).

5.3 Inhabitants of rural areas

There are several main challenges of mobility digitalization within rural areas. Velaga et al. (2012) summarizes them in four main groups:

- "Service area: Rural transport agencies often serve large areas with long trips. As a result, assisting passengers' needs is not easy and attending immediately to a problem that arises on the road is difficult (e.g., rescheduling trips when an incident occurs).
- Service coordination: There are different basic public services (e.g., health care, education) with overlapping areas of service provision. It is challenging to co-ordinate services and resources among the agencies and other providers.
- Infrastructure: Rural areas often suffer a lack communication infrastructure (e.g., wireless communications services). Real-time communication from and to rural passengers is one of the major issues.
- Fleet size: Although technologies can solve several transportation problems in remote rural areas, it might be difficult to fund and develop at a small scale (for example, funding and establishing mobile data terminals in a remote rural area)."

First, the remote location of rural areas and the limited number of potential users might result in a decreased attractiveness of those areas for new mobility service providers and in limited inclusion of related offers in mobile applications. Rural areas usually have lower populations, which also complicates the efficiency of travel and traffic information collection.

Next, access to the internet and problems with mobile communications, which are crucial for the efficiency of the mobility digitalization, is not similar in all rural areas. This results in a barrier to digital mobility. Almost 60% of all rural households in Europe have access to fast fixed broadband compared to 90% of households in urban areas (OECD, 2019b). Having an internet connection affects the frequency of using the internet. This might lead to diversity in the level of digital skills among citizens who have internet access and who have not. According to Eurostat Statistics Explained (2019) "There is a considerable digital skills divide in EU between adults living in cities

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

and those living in rural areas". In rural areas 49% of people had basic or above basic digital skills whereas 63% of adults living in cities possess that level of digital skills.

For example, as Velaga et al. (2012) indicate, "the reduced signal coverage inhibits communications with devices, meaning there could be a delay in data being received from devices, and the device receiving data". However, the same authors stress the importance of an accurate and reliable passenger information system in these areas: "passengers from suburban, rural and remote areas need more reliable and sophisticated travel information compared to urban areas; because, unlike in urban areas, passengers in rural areas are provided with very limited transport facilities, generally make longer journeys, have problems with social exclusion and limited exposure to media and other communications" (Velaga et al., 2012).

Rural areas might also increasingly suffer from a lack in the provision of the necessary infrastructure, e.g. bus stop displays and vehicle tracking systems. For example, Velaga et al. (2012) state that "in rural areas, vehicle positioning/tracking systems are not always available as many rural buses are not fitted with GPS devices due to cost and even traditional information dissemination technologies (e.g., bus stop display boards) can be scarce".

Development of targeted solutions is necessary to address these challenges. New mobility services, such as demand responsive transport, can provide flexibility in choosing route, time, mode of transport, service provider and payment system. Fàbregas & Villalante (2017), for example, say that "through public management of mobility policies and the new tools of mobility services, sustainable displacements can be promoted, with greater efficiency and capillarity than public transport, especially in areas of low density, at times of low demand and in the final and initial stages of displacement".

5.4 Women (gender inequality)

Although gender is mentioned several times as an issue in the bibliography, both in the literature on public transport inequality (e.g. Thynell, 2016; Ranchordas, 2020) and in the digital gap literature (e.g. Ajuntament de Barcelona, 2017), there is a lack of detail on how much it really affects the mobility patterns of the female population and how. In 2018 the OECD issued a report about the digital gender divide, by which they meant the "gender differences in resources and capabilities to access and effectively utilise ICTs within and between countries, regions, sectors and socio-economic groups" (OECD, 2018). From that global report we would like to point out several factors that seem to affect the digital gender divide (OECD, 2018):

- Ease of access
- Affordability: affordability is, of course, important for everyone, but it seems to be one of the key barriers for females to use ICT worldwide. On the other hand "the cost of accessing the Internet varies across countries and regions and partly depends on the level of development of the country" (OECD, 2018)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- Education (or lack thereof): According to UNESCO (2017) about 83% of women worldwide are literate, compared to 90% of men. "Intel and Dalberg's (2012) survey shows that more than half of the women having no formal education said they were not familiar or comfortable with the technology. However, this percentage fell to 15% in the case of women with at least high school education." (OECD, 2018)
- Digital literacy (or lack thereof): "often translates in lack of comfort in using technology and accessing the Internet. Such 'technophobia' is often a result of concurrent factors including education, employment status and income level." (OECD, 2018)
- Inherent biases and socio-cultural norms: Women seem to have less awareness of the potential benefit that use of the internet could provide: "25% of the women who do not engage online are generally not interested in using the Internet, and almost all of them believe that accessing the Internet would not bring them any benefit" (OECD , 2018).

As a result of these factors, the digital gender gap is definitely not the same around the globe (see Figure 11).

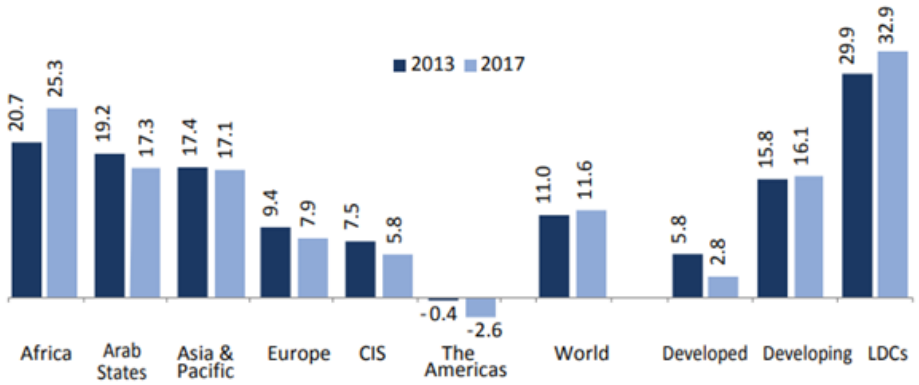

Figure 11 Internet user gender gap (%), 2013 and 2017.
Note: 2017 are estimates. The gender gap represents the difference between the internet user penetration rates for males and females relative to the internet user penetration rate for males expressed a percentage. CIS refers to the Commonwealth of Independent States (ITU, 2017)

Although the digital gender gap in Europe is decreasing, it is still significant and it would be interesting to have a comprehensive study assessing this gap in the different European countries. For instance, in the UK (Goodman-Deane 2020b) there was no correlation found between gender and digital skills, while a study of the digital divide in Barcelona has concluded that the most detrimental profile in terms of digital skills would be the one of a woman between 65 and 74 years old, with a low level of education, residing in a neighbourhood with low income in a situation of unemployment or that works in housework (Barcelona Mobile World Capital, 2016). Nevertheless, in the report is stated that there are only considerable differences regarding internet usage

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

between men and women in certain cases and in general they conclude that there is no gender divide in internet access in Barcelona.

5.5 People with low education levels and/or low income

Despite it being mentioned in the literature that people with lower levels of education and low income households would be more affected by the digital gap, there are not many studies focusing on these particular topics.

Van Deursen and van Dijk (2009) tried to establish correlations between three factors (age, gender and educational levels) and found co-relations between education and digital skills in terms of formal skills, informal skills and strategic skills. In fact, van Deursen and van Dijk (2009), concluded that "Educational level attained is the most important correlating factor. All performances, both in the number of tasks completed and amount of time spent on tasks with all four types of digital or internet skills, are significantly different for people with high, medium and low education." The Digital Economy and Society Index, section Human Capital, highlights that 31% of people with low education levels or no education have at least basic digital skills, whereas 57% of the total population has at least basic digital skills (European Commission, 2019).

Other recent interesting surveys at national level sustain the claim that low levels of education and income are important factors for the digital gap:

- The Barcelona study (Barcelona Mobile World Capital, 2016) shows the importance of education: 90% of the citizens with a middle or high level of education are connected to internet daily in comparison with 60% of the citizens with a low level of education. However, the differences are smaller in high income districts.
- The city of Barcelona quantified access to technology in households attending social services. From the households surveyed, 58.4% do not have a home computer because they cannot afford it, compared to 86% of households that do have it in the city of Barcelona as a whole. This phenomenon is especially important in single-parent families and households with dependent children (Ajuntament de Barcelona, 2017).
- In the UK, the study by Goodman-Deane et al (2020b) shows that digital competence declined with increasing age and decreasing social grade. Social grades are based on the occupation of the head of the household and for this study they are grouped into middle class and working class.

It does look like low education levels and low income go hand in hand, understandably so. But in an inclusive society we cannot risk that people with less economic capacity may be left out of public transport systems. Digitalization cannot be a process in which people that were already facing transport poverty are further excluded due to economic stress or lack of digital skills (Ranchordas, 2020).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

5.6 Conclusion

In the chapter several 'risk factors' for digital exclusion were described. Age, gender, disabilities, geographical location of household, income and education appeared to be related to possible digital exclusion. For some variables more evidence can be found in literature then for others. Some might decrease in coming years as we have seen with the gender divide regarding digitalization in the last few years in Europe (European Commission, 2019). With European efforts and the agenda for better internet connection for rural areas may have an impact. At higher risk of digital exclusion are those who 'fit' multiple vulnerable groups, such as an older woman with disabilities living in rural area. Besides that, there are also risk factors for being mobility excluded (chapter 4). Therefore it is very important to have a good understanding of the characteristics of vulnerable groups that may be excluded.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

6. Digital gap policy in Europe

6.1 Closing the digital gap

As stated in chapter 3, Europe's focus on closing the digital gap has shifted in the last decade from introducing broadband for everyone to a focus on digital skills. The European commission has designed a leaflet about shaping Europe's digital future with a clear goal: "The Commission wants a European society powered by digital solutions that are strongly rooted in our common values, and that enrich the lives of all of us: people must have the opportunity to develop personally, to choose freely and safely, to engage in society, regardless of their age, gender or professional background. Businesses need a framework that allows them to start up, scale up, pool and use data, to innovate and compete or cooperate on fair terms. Europe needs to have a choice and pursue the digital transformation in its own way" (European Commission, 2020b). To facilitate digital transformation, education and skills are the key. It is stressed that these skills are not only important for jobs but also for private lives: " having at least basic digital literacy and skills has become a precondition for participating effectively in today's society."

Two of the actions for 2020 are:

- A Digital Education Action Plan to boost digital literacy and competences at all levels of education (Q2 2020).
- A reinforced Skills Agenda to strengthen digital skills throughout society and a reinforced Youth Guarantee to put a strong focus on digital skills in early career transitions (Q2 2020).

The focus on an education plan is understandable even if it is often heard that young people are already skilled because they are online all day. Research shows that only a small proportion can be considered as 'digitally fluent': people who use digital technologies in an active way, specifically to support learning, and are critical with sources. On the other hand, there are a lot of students, who spend a lot of time online, but less using the internet in an active way. In addition, not all educators and trainers have enough digital skills for their work (Scientific Foresight Unit, 2020). Advice is given for formal and informal learning, including lifelong learning and the provision of high-quality (open) educational resources.

Making lifelong learning a reality for all is also stressed by the European Commission in a recent document about building a new industrial strategy for Europe. That strategy lays the foundations for an industrial policy that will support the twin ecological and digital transitions, to make EU industry more competitive globally and enhance Europe's strategic autonomy. In that strategy, lifelong learning is a key factor to keep Europe's leading role while making the transition towards climate neutrality and digital leadership. According to the European Commission, retaining a qualified workforce (besides recruiting new personnel) requires upskilling or reskilling 120 million Europeans in the coming years. In 2019 the percentage of employees in European countries with above basic overall digital skills was between 14% and 68%, with an average of 43% (Eurostat 2020).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

The ultimate goal of becoming the world's first climate-neutral continent by 2050 needs a strategy for industry with many targets like reducing its carbon footprint or contributing to a more circular economy. The strategy also contains actions for sustainable and smart mobility industries. "The sector's entire value chain must help shape new international standards for safe, sustainable, accessible, secure and resilient mobility. The Comprehensive Strategy for Sustainable and Smart Mobility will put forward comprehensive measures to help make the most of the sector's potential." (European Commission, 2020a).

Regarding the future of Public Transport, The International Association of Public Transport (UITP, from the French: L'Union internationale des transports publics) has already written a paper in 2017 exploring the meaning of "digitalisation" in the field of Public Transport with the aim of helping UITP members to better understand what it is in the context of public transport, what opportunities it provides and the challenges it brings (UITP, 2017). The public transport sector should show an innovative attitude and have an eye for the numerous opportunities digitalization offers. Besides, it should prepare itself for its role in the future mobility market. "Public transport must remain the backbone of mobility in urban areas in order for them to be sustainable" (p.13). Therefore it is necessary for public transport operators and authorities to develop 'digitalisation strategies'; this requires collaboration, sharing and learning. In this way it can look beyond the sector to see in which way and where mobility can fit into society and the 21st century urban environment (UITP, 2017). It is recommended that the public transport sector invest in technology but also in studying the behaviour of people: to study their mobility behaviour and understand their specific needs. This is in line with the expectation that new mobility services will emerge. "Personal mobile devices, such as the smartphone, are and will remain key in terms of ticketing, journey planning and inter-modality, and although customer connectivity is not yet ubiquitous it is just a question of time. Multi-modal platforms with app-based services for real-time travel planning are set to stay and the autonomous vehicle will have its place" (UITP, 2017).

Governments all over Europe have adopted initiatives to support the uptake of digital technologies and strengthen their industries. In order to support digital transformation, the Digital Transformation Scoreboard (DTS) as part of the Digital Transformation Monitor (DTM) presents reports about digital transformation in Europe. By sharing the developments, challenges and policy initiatives related to digital transformation, the DTM fosters the knowledge base on the state of play and evolution of digital transformation in Europe. The report in 2018 (Probst et al., 2018) shows that of all the EU member states,

- "68% of them have already put in place comprehensive digital transformation policies."
- "70% of digitisation initiatives are driven by domestic industry, yet only 15% are majority-financed by industry."
- "Most digital transformation initiatives lack clear targets, effective monitoring tools and KPIs."
- "57% of the companies surveyed believe that they have the necessary skills to adopt new digital technologies, while the remaining 43% are either unaware or lacking the necessary skill set for digital transformation."

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

Errore. L'origine riferimento non è stata trovata. shows a clustering analysis of enabling conditions for digital transformation. This analysis had the objective of grouping Member States based on their similarities in terms of enabling conditions leading to digital transformation. Four groups of Member States were identified.

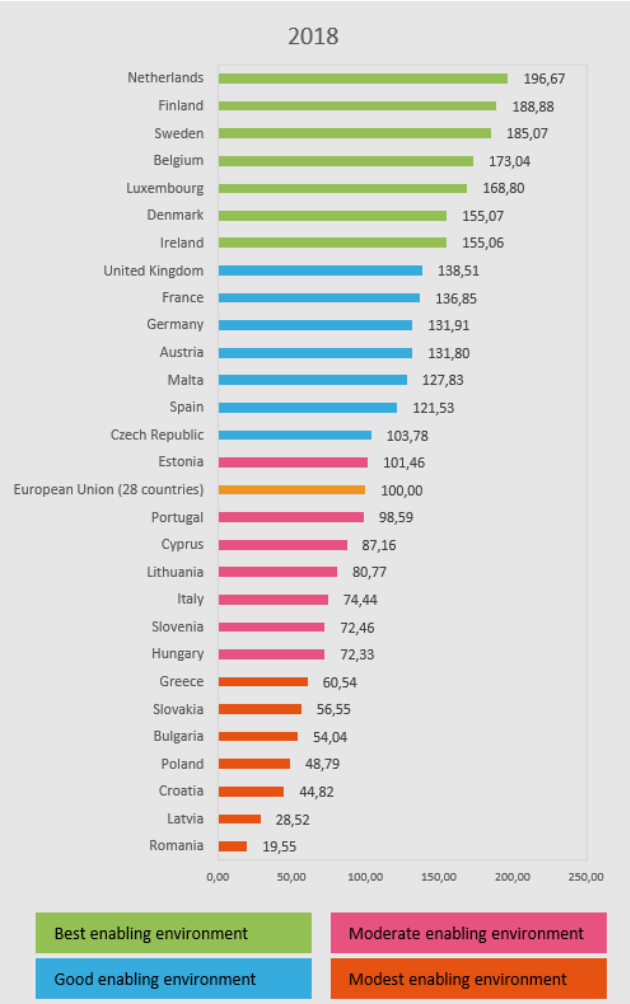

Figure 12 Clustering of Member States' enabling environment in comparison to the EU average (Probst et al., 2018)

6.2 Challenges for good policy

From a government perspective, a key to successful digital transformation is developing an integrated and coherent policy for citizens, governments and businesses across all areas. It requires policies that have an eye for the opportunities and can use challenges while maximizing benefits and minimising costs. The OECD Committee on Digital Economy Policy (CDEP), has

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

recently prepared a publication in which areas and issues are mentioned that need to be taken care of in the context of the current digital transformation of the economy and society. It is important to ensure that this digital transformation guarantees benefits for all from an economic and societal perspective with an important eye on well-being (OECD, 2019a). There are some policy actions to be taken:

- reduce and prevent negative impacts of digital transformation, like work-life imbalance, depression, screen addiction or privacy reduction.
- reduce any inequalities that may be the result of technological progress by education and training.

A Going Digital Integrated Policy Framework has been designed to support governments in Europe with developing digital policies. This framework contains 7 dimensions:

1. enhance access;
2. increase effective use;
3. unleash innovation;
4. ensure good jobs for all;
5. promote social prosperity;
6. strengthen trust;
7. foster market openness.

Although access to internet has been increased in the last decade (see chapter 3 Digital Gap), there are still disparities between rural and urban regions. "However, entrenched divides in broadband connection across geography persist across the OECD. The rural-urban divide not only includes access to broadband, but also access to broadband that is of sufficient quality. The persistence of this divide raises questions about inclusiveness and opportunity in the digital age" (OECD, 2019a). There were differences between Member States, especially between southern and northern countries. Non-users are mainly the elderly and people with disabilities. In addition, the digital divide with respect to internet use is strongly determined by age and education levels. The privacy issue needs some attention. Moreover, it is recommended to refresh education systems. Childhood education is important, as well as training for students. Because many adults lack sufficient problem-solving skills for technology-rich environments, it is recommended to train low-skilled workers. They definitely need training and it is expected that the greatest diffusion effects will come from training this group. Besides, education and training would be more effective when using digital technologies for teaching and learning. Furthermore, low-income individuals, women and the elderly are mentioned: "Policies should reduce divides by strengthening foundational skills and life-long learning and include everyone – notably women, the elderly and low-income individuals – while tackling risks like cyberbullying and disinformation." To manage risks and enlarge the opportunities of digital transformation, governments must get a clear understanding of the individual evolution of needs and the way public policy should

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

respond to it. Data driven solutions must be found to tailor services to individuals' needs (OECD, 2019a). This is important for the provision of healthcare but also for the supply of transportation.

"It is recommended to integrate policy dimensions because they are interrelated. It also highlights that all policy dimensions are needed to make digital transformation work for prosperity. Recommendations emerging in these policy dimensions need to be considered by policy makers when putting the framework into practice, including for the development of a digital transformation strategy." Table 1Table 2 summarises the most important policy recommendations.

Table 2 Policy recommendations for 7 dimensions as mentioned in the Going Digital report (OECD, 2019a)

Dimension	Facts based on work undertaken in the OECD's Going Digital project over 2017-18 as well as other relevant OECD work on digital transformation	What matters most for policy?
1. **enhance access** p. 36 and 37	By 2022, three devices per person will be connected around the globe. Only 7% of people across the OEC have a fiber broadband subscription 56% of rural households have access to fast fixed broadband, in comparison to over 85% of households in urban and other areas. Access to data drives innovation, new products, organisational models and markets.	invest in broadband to prepare for ever more people, things and technologies going online promote competition and remove barriers to investment to boost connectivity Expand access in rural and remote places to connect everyone Enhance access to data to unleash its potential
2. **increase effective use** p. 50 and 51	74% of people use e-mail ... 31% of adults have sufficient problem-solving skills for technology-rich environments. Great potential could be unleashed if more firms, especially SMEs, would perform big data analysis. Less than 60% of people visit or interact with public authorities' websites.	Foster more sophisticated Internet usage for al Realise the potential of digital government Boost adoption, diffusion and effective use of digital tools in firms, especially small and medium-sized enterprises Address mistrust to increase online engagement
3. **unleash innovation** p. 66 and 67	Almost one third of business R&D expenditure is in information industries. All start-ups attracted 12% of worldwide private equity investments in the first half of 2018, up from 3% in 2011. Over 2013-16, about 33% of OECD countries' patents were ICTs, compared to about 60% of China's.	Promote start-ups and young firms Mobilise the public and private sectors to support science and digital innovation Provide support and incentives to all innovators Realise open government data's potential to drive digital innovation Prepare to reap the promises of digital innovation in sectors
4. **ensure good jobs for all** p. 84 and 85	Over the past decade, 4 out of 10 new jobs in the OECD were created in highly digital-intensive sectors. An estimated 14% of jobs face high likelihood of automation and another 32% are likely to face significant change in how they are carried out. Despite high returns on training the low-skilled, firms provide more training to high-skilled workers.	Prepare workers for many new jobs and changes to existing ones Empower people with a mix of skills to succeed in a digital world of work Get ready for a massive training challenge Improve social protection to ensure that no one is left behind

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

	Only 0,13% of GDP on average is spent on training of the unemployed and of workers at risk of involuntary unemployment.	Address concerns around emerging forms of work
5. **promote social prosperity** p. 102 and 103	About 12% of people post opinions on civic or political issues online. More than twice as many young men than women are able to program. About 9% of 15-year olds say they are subject to cyberbullying. Digital technologies can help tackle key domestic and international issues, e.g. improve environmental protection and health care for all.	Address digital divides to increase inclusiveness Use digital tools to tackle collective challenges Boost civic engagement through digital government strategies Assess the societal impacts of digital technologies by striking a balance between opportunities and risks
6. **strengthen trust** p. 118 and 119	Almost 30% of internet users mistrust social and professional networks. One in four internet users users in the European Union is concerned about payment security. Only 17% of peer platform users read terms and conditions in full. A majority of privacy measures aims to raise awareness and empower individuals.	Adopt a risk management approach to ensuring trust Develop strong, inclusive and interoperable privacy frameworks Manage digital security risk rather than trying to eliminate it Protect consumers as the online and offline worlds converge
7. **foster market openness** p. 132 and 133	Firms in the most digital-intensive sectors enjoy a 55% of higher mark-up than firms in less digital-intensive sectors. Digitally deliverable services make up about a quarter of total services trade. 45% of EU firms undertook cross-border e-commerce sales in 2016, up from 42% in 2010. Cross-border acquisitions of digital- intensive firms grew by 20 percentage points more than those in other sectors over 2007-15.	Prepare for digital technologies to continue reshaping international trade Reduce barriers to investment and promote open financial markets Monitor changing competitive dynamics Address tax challenges arising from the digitalisation of the economy

To evaluate the efficiency and effectiveness of policy actions, measurement is key. The OECD provides policy makers and analysts with key indicators for each of the dimensions of the Going Digital integrated policy framework. In the Going Digital Toolkit, countries in Europe are benchmarked across the 7 policy dimensions and 33 indicators. It is an assessment for countries regarding their digital development and policy strategies and approaches are formulated in response to it (OECD, 2020).

6.3 Conclusion

The two main points of attention for Europe are sustainability and digitalisation. Europe's focus for closing the digital gap shifted from introducing broadband for everyone to a focus on digital skills and broadened further to issues such as trust, managing digital security risk and digital technologies for reshaping international trade. There is one overarching goal: to make EU industry more competitive globally and enhance Europe's strategic autonomy. Plans are developed from

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

the perspective of people, firms and governments. Member states are encouraged to develop their own plans. By monitoring the efficiency and effectiveness of policy actions, support can be given regarding policy strategies and approaches.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

7. Conclusions

Based on this literature review, we can draw some conclusions about digitalization in mobility and its consequences. ICT tools enable new functionalities, services and innovations. New business opportunities and stakeholders appear due to digital development. Digitalization enables citizens to access information anywhere at any time. The advantages of digitalization are, however, not experienced by everyone to the same extent, leading to a so called 'digital gap' or 'digital divide'. Over the years the focus of the digital divide has changed from access and internet connection to frequency of use and digital skills. In Europe, the digital adaption of countries is quite diverse. Where some of the countries in Northern Europe are global leaders in the field of digital technology, other countries in the east of Europe still face a lot of difficulties regarding digital development.

While digitalization in mobility is growing, studies focusing on people who face difficulties have revealed several risk factors for digital exclusion such as age, gender, level of education and income, living in rural areas and disabilities. It seems that older people do face some of the same difficulties as disabled people such as mobility issues, visual impairments and cognitive and mental issues: all problems that can come with age. In addition, special information needs before and during a journey and difficulties dealing with technology may lead to a lack of confidence and motivation to use public transport. While digitalization in mobility has grown, these people not only have a high risk of digital exclusion, they also might be excluded from transport modes. Mobility services that improve a service or product using digital technology, such as reservation of a seat or vehicle, buying a ticket, travel information and digitally unlocking a vehicle, build a barrier for vulnerable groups who have difficulties using digital technology.

People living in rural areas may still face a lack of reliable internet provision at a competitive price and in addition may have infrequent public transportation options. These people will probably rely on their own means of transportation (car, bicycle, etc.). There is also not much literature focusing on the digital gap and people with a low income and/or education. These citizens do face problems in mobility and are vulnerable groups with respect to transport poverty. However, in respect to the digital gap there is not much evidence that these people also experience difficulties with internet access, digital devices and connection.

The European Commission acknowledges the importance of a digitally inclusive society and therefore developed the Skills Agenda to develop digital skills training and education. Furthermore, tools to help countries improve their national policy strategy regarding digital performance are developed on a European level. By using predefined indicators, countries can monitor and benchmark their digital policy against other European countries.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

References

- Aguiléra, A. (2019) Smartphone and Individual Travel Behavior Urban Mobility and the Smartphone (pp. 1-37): Elsevier.
- Ajuntament de Barcelona (2017) L'enquesta de condicions de vida de les persones usuàries dels Centres de Serveis Socials.
- Banister, D. (2019) 'Transport for all', Transport Reviews, 39(3), pp. 289–292. doi: 10.1080/01441647.2019.1582905.
- Barcelona Mobile World Capital (2016) The Digital Divide in Barcelona. Available at: https://mobileworldcapital.com/escletxa-digital/index_eng.php
- Barnard, Y., Bradley, M., Hodgson, F., Lloyd, A. (2013) Learning to use new technologies by older adults: perceived difficulties, experimentation behaviour and usability. Computers in Human Behavior 29(4): 1715-1724
- BIS (2009) Digital Britain, Department for Culture, Media and Sports and Department for Business, Innovation and Skills.
- Bjerkan, K.Y. and Øvstedal, L.R. (2018) 'Functional requirements for inclusive transport', Transportation. Springer US, (1). doi: 10.1007/s11116-018-9939-7.
- Cambridge Engineering Design Centre (2017) Inclusive Design Toolkit. Available at: http://www.inclusivedesigntoolkit.com
- Ceechini, S. (2002) 'Information and communications technology for poverty reduction. lessons from rural India', in IEEE 2002 International Symposium on Technology and Society (ISTAS'02). Social Implications of Information and Communication Technology. Proceedings (Cat. No.02CH37293). IEEE, pp. 93–99. doi: 10.1109/ISTAS.2002.1013801.
- Durand, A., Zijlstra, T. and van Oort, N. (2019) 'Toegang geweigerd : Digitale ongelijkheid in het slimme mobiliteitstijdperk', Contribution for Colloquium Vervoersplanologisch Speurwerk 2019, pp. 1–15.
- European Commission (2019) DESI, The Digital Economy and Society Index (DESI). Available at: https://ec.europa.eu/digital-single-market/en/desi
- European Commission (2020a) A New Industrial Strategy for Europe. Brussels,. Available at: https://ec.europa.eu/info/sites/info/files/communication-eu-industrial-strategy-march-2020_en.pdf.
- European Commission (2020b) 'Shaping Europe's digital future', p. 9. doi: 10.2759/48191.
- European Disability Forum (2020) Available at: http://www.edf-feph.org/eu-framework-rights-persons-disabilities
- European Union (2015) 'Briefing Bridging the digital divide in the EU', European Union, (December), pp. 1–8. Available at: http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/573884/EPRS_BRI(2015)573884_EN.pdf.
- Eurostat (2020) 'Individuals using mobile devices to access the internet on the move'.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- Eurostat Statistics Explained (2019) Digital economy and digital society statistics at regional level. Data extracted in March 2019. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Digital_economy_and_digital_society_statistics_at_regional_level#Digital_skills
- Fàbregas, C & Villalante, M. 2017. Mobility as a service: the emergence of digital transformation in mobility. In: NEW CHALLENGES IN QUOTIDIAN MOBILITY. PUBLIC POLICIES FOR A MOST EQUITATIVE AND SUSTAINABLE MODEL. Journal Papers, 59, p.152-163.
- Fiedler, M. (2007). Older people and public transport challenges and chances of an ageing society. Retrieved from https://www.emta.com/IMG/pdf/Final_Report_Older_ People_protec.pdf. page 9
- Goodman-Deane, J., Bradley, M., Waller, S. and Clarkson, P.J. (2020a). Quantifying exclusion for digital products and interfaces. In Langdon et al (eds). Designing for Inclusion. Springer.
- Goodman-Deane, J., Bradley, M. and Clarkson, P.J. (2020b). Digital technology competence and experience in the UK population: who can do what. In Proceedings of Ergonomics and Human Factors 2020. Stratford-upon-Avon, UK. Available at: https://publications.ergonomics.org.uk/uploads/Digital-technology-competence-and-experience-in-the-UK-population-who-can-do-what.pdf
- Graham, A. et al. (2019) 'Airports and ageing passengers: A study of the UK', Research in Transportation Business and Management, 30(October). doi: 10.1016/j.rtbm.2019.100380.
- Harvey, J., Guo, W., & Edwards, S. (2019). Increasing mobility for older travellers through engagement with technology. Transportation Research Part F: Traffic Psychology and Behaviour, 60, 172–184. https://doi.org/10.1016/j.trf.2018.10.019
- Hawthorn, D. (2000). "Possible implications of aging for interface designers." Interacting with Computers 12: 507-528.
- Hounsell, N. B. et al. (2016) 'Open Data and the Needs of Older People for Public Transport Information', Transportation Research Procedia. Elsevier B.V., 14(0), pp. 4334–4343. doi: 10.1016/j.trpro.2016.05.355.
- ITU (2006) World Telecommunication / ICT Development Report 2006: Measuring ICT for Social and Economic Development, International Telecommunication Union. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:World+Telecommunication+/+ICT+Development+Report+2006:+Measuring+ICT+for+Social+and+Economic+Development#0.
- ITU & UNCTAD (2007) World Information Society Report 2007; Beyond WSIS. Available at: https://www.itu.int/osg/spu/publications/worldinformationsociety/2007/WISR07_full-free.pdf
- ITU (2017) ICT facts and figures 2017. Available at: https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf
- Johnson, J. and K. Finn (2017). Designing user interfaces for an aging population: Towards universal design, Morgan Kaufmann.
- Jorritsma, P. et al. (2018) 'Mobiliteitsarmoede: vaag begrip of concreet probleem?', p. 45. Available at: https://www.kimnet.nl/publicaties/rapporten/2018/10/31/mobiliteitsarmoede-vaag-begrip-of-concreet-probleem.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- Koch, W., & Frees, B. (2016). Dynamische Entwicklung bei mobiler Internetnutzung sowie Audios und Videos. Ergebnisse der ARD/ZDF-Onlinestudie. Media Perspektiven, 9, 418–437. http://www.ard-zdf-onlinestudie.de/index.php?id=567
- Lucas, K. (2012) 'Transport and social exclusion: Where are we now?', Mobilities: New Perspectives on Transport and Society, pp. 207–222.
- Martens, K. (2014) Blog: Fair mobility make no small gestrures. Available at: https://worldstreets.wordpress.com/2014/04/08/fair-mobility-make-no-small-gestures/
- Martens, K. (2016) 'Index voor basisbereikbaarheid : kompas voor mobiliteitsbeleid', Verkeersspecialist, 223, pp. 18–21.
- Martens, K. (2017) Transport justice: Designing fair transportation systems. Available at: https://www.researchgate.net/publication/305398785_Transport_Justice_Designing_Fair_Transportation_Systems.
- Meurer, J., Stein, M., Randall, D., & Wulf, V. (2018). Designing for way-finding as practices – A study of elderly people's mobility. International Journal of Human Computer Studies, 115(January 2017), 40–51. https://doi.org/10.1016/j.ijhcs.2018.01.008
- Muñoz, E. et al. (2016) 'SIMON: Assisted Mobility for Older and Impaired Users', Transportation Research Procedia, 14, pp. 4420–4429. doi: 10.1016/j.trpro.2016.05.364
- OECD (2009) Cognitive Impairment, Mental Health and Transport, Cognitive Impairment, Mental Health and Transport. doi: 10.1787/9789282102183-en.
- OECD (2013). OECD Skills: First results from the survey of adult skills. Published by OEDC. Available from: https://www.oecd.org/skills/piaac/Skills%20volume%201%20(eng)--full%20v12--eBook%20(04%2011%202013).pdf
- OECD (2016). Skills Matter: Further results from the survey of adult skills. Published by OECD. Available from: http://www.oecd.org/skills/piaac/Skills_Matter_Further_Results_from_the_Survey_of_Adult_Skills.pdf
- OECD (2018). Bridging the digital gender divide: Include, upskill, innovate. http://www.oecd.org/internet/bridging-the-digital-gender-divide.pdf
- OECD (2019a) Going Digital: Shaping Policies, Improving Lives, OECD Publishing, Paris. doi: 10.1787/9789264312012-en.
- OECD (2019b) OECD urges more action on bridging digital divides, boosting skills and enhancing access to data at Going Digital Summit. Available at: https://www.oecd.org/newsroom/oecd-urges-more-action-on-bridging-digital-divides-boosting-skills-and-enhancing-access-to-data-at-going-digital-summit.htm
- OECD (2020) Going Digital Toolkit Available at: https://goingdigital.oecd.org/en/
- Pangbourne, K., Stead, D., Mladenović, M., & Milakis, D. (2018). The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance. Governance of the Smart Mobility Transition (pp. 33-48).
- Probst, L. et al. (2018) Digital transformation scoreboard 2018 - EU businesses go digital: Opportunities, outcomes and uptake. doi: 10.2826/691861.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

- Ranchordas, S. (2020) 'Smart Mobility, Transport Poverty, and the Right to Inclusive Mobility', SSRN Electronic Journal. doi: 10.2139/ssrn.3520525.
- Scientific Foresight Unit (STOA) (2020) Rethinking education in the digital age. doi: 10.2861/84330.
- Sengpiel, M. and D. Dittberner (2008). The computer literacy scale (CLS) for older adults – development and validation. Mensch & Computer: 7-16.
- Subasi, Ö. et al. (2011) 'Designing accessible experiences for older users: user requirement analysis for a railway ticketing portal', Universal Access in the Information Society, 10(4), pp. 391–402. doi: 10.1007/s10209-011-0223-2
- Thynell, M. (2016) 'The quest for gender-sensitive and inclusive transport policies in growing Asian cities', Social Inclusion, 4(3), pp. 72–82. doi: 10.17645/si.v4i3.479.
- UITP (2017) Digitalisation in public transport, UITP advancing public transport.
- UNESCO (2017), "Literacy rates continue to rise from one generation to the next", Fact Sheet No. 45, September, FS/2017/LIT/45, http://uis.unesco.org/sites/default/files/documents/fs45-literacy-rates-continuerise-generation-to-next-en-2017.pdf.
- Van Deursen, A. J. A. M., & Van Dijk, J.A.G.M. (2009). Improving digital skills for the use of online public information and services. Government Information Quarterly, 26(2), 333–340. https://doi.org/10.1016/j.giq.2008.11.002
- Van Dijk, J., Hacker, K. and Van Dijk, J.A.G.M. (2003) 'The Digital Divide as a Complex and Dynamic Phenomenon THE MULTIFACETED CONCEPT OF ACCESS', The Information Society, 19(September 2000), pp. 315–326. doi: 10.1080/01972240390227895.
- Van Dijk, J.A.G.M. (2013) A theory of the digital divide. in M Ragnedda & GW Muschert (eds), The digital divide: the internet and social inequality in international perspective. Routledge advances in sociology, no. 73, vol. 73, Routledge, pp. 29-51.
- Velaga, N. R., Beecroft, M., Nelson, J. D., Corsar, D., & Edwards, P. (2012). Transport poverty meets the digital divide: Accessibility and connectivity in rural communities. Journal of Transport Geography, 21, 102–112. https://doi.org/10.1016/j.jtrangeo.2011.12.005
- Vicente, M. R. and López, A. J. (2011) 'Assessing the regional digital divide across the European Union-27', Telecommunications Policy, 35(3), pp. 220–237. doi: 10.1016/j.telpol.2010.12.013.
- Wagner N, Hassanein K, Head M (2010) Computer use by older adults: A multi-disciplinary review. Computers in Human Behavior 26: 870-882
- WEF (2017) Unlocking Digital Value to Society: A new framework for growth. Available at: http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/dti-unlocking-digital-value-to-society-white-paper.pdf.
- WEF (2020) Digitizing and Transforming Mobility Systems : Lessons from the Detroit Region. Available at: http://www3.weforum.org/docs/WEF_Digitizing_Transforming_Mobility_Systems_2020.pdf%0A.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°875542.