D1.1 – Analysis Framework of User Needs, Capabilities, Limitations & Constraints of Digital Mobility Services

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INDIMO Consortium

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1	VRIJE UNIVERSITEIT BRUSSEL	BE
2	VDI/VDE INNOVATION + TECHNIK GMBH	DE
3	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	BE
4	CAMBIAMO S.C.M.	ES
5	DEEP BLUE SRL	IT
6	TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY	IL
7	MOZGASSERULTEK BUDAPESTI EGYESULETE	HU
8	FUNDACION ZARAGOZA LOGISTICS CENTER	ES
9	POLIS - PROMOTION OF OPERATIONAL LINKS WITH INTEGRATED SERVICES, ASSOCIATION INTERNATIONALE	BE
10	EUROPEAN PASSENGERS' FEDERATION IVZW	BE
11	DOOR2DOOR GMBH	DE
12	VIVERO DE INICIATIVAS CIUDADANAS	ES
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Copyright Statement

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Executive summary

INDIMO's main goal is to expand the use of existing and emerging digital mobility services to populations that are currently excluded due to physical, cognitive or socio-economic barriers. Fulfilling this goal requires a holistic point of view that will take into consideration a variety of digital services and an extensive data collection from end-users, developers, operators and policy makers in order to establish policies and guidelines for developing digital information systems and applications for inclusive transportation. The outcome of the project will be a comprehensive digital mobility deployment toolkit, which will be comprised of:

- A universal design manual (UDM) for digital mobility services
- Guidelines improving the design of interface between transport users and digital mobility systems (i.e. Universal interface language icons)
- Guidelines for cybersecurity and personal data protection
- A policy evaluation tool and recommendations for policy makers.

The current report is the first deliverable (D1.1) of Work package 1: 'Framework for analysis of user needs, capabilities, limitations & constraints of a digital mobility service'. It describes the methodological framework of the data collection and analysis and the detailed work plan of WP1 tasks.

The work presented in the report has three important outcomes:

1. A preliminary set of user profiles of the pilot projects was selected to collect data from (see table).
2. A definition of the scope of information collection from users, developers, operators and policy makers (see table).
3. A work plan for data collection and analysis for WP1 (see figure).

#	Pilot project owner	Pilot name	User profile(s)	User characteristics/Target groups included (all or most) in the profile
P1	Emilia Romagna	Introducing digital technology to enable e-commerce in rural areas	**1st user profile: Older people who receive/ send parcels**	• Age: older • Lack of digital knowledge • Residing in peripheral locations • Lack of digital services • Lack of dedicated network infrastructure • Limited access to transport services and commercial delivery services
			2nd user profile: Migrants or foreign people who receive/ send parcels	• Low economic conditions (assuming migrant from out of Europe) • Low level of education (assuming migrant from out of Europe) • Language barrier

#	Pilot project owner	Pilot name	User profile(s)	User characteristics/Target groups included (all or most) in the profile
				• Lack of digital knowledge • Residing in peripheral locations • Lack of digital services • Lack of dedicated network infrastructure • Limited access to transport services and commercial delivery services
P2	Antwerp	Inclusive traffic lights	**Vulnerable pedestrians**	• Age: older (over 60) • Permanently impaired or with disabilities: visual disability, wheelchair mobility
P3	Galilee	Informal ride sharing in ethnic towns	**Informal ride sharing users**	• Ethnic minority man/women • Residing in the periphery • Insufficient public transport services • Language barrier • Lack of digital skills
P4	Madrid	Cycle logistics platform for delivery	**Healthy food delivery users**	• Permanently impaired or with disabilities • Socially isolated (unwanted loneliness) • Not-connected people (e.g. Low digital skills, lower technology availability) • Low income • COVID19 isolated with none or reduced number of daily trips allowed
P5	Berlin	On-demand ride-sharing integrated into multimodal route planning	**On demand ride sharing users**	• Care-takers of children/ impaired/ elders • Gender: women • Lack of services (reduced mobility) • Lack of digital skills • Residing in peripheral locations

A preliminary set of user profiles of the pilot projects

Scope of information collection from users	Scope of information collection from developers, operators and policy makers
Goals /purposes/ value of using the service	Perception of the value of the service to the users
Accessibility and inclusion: reasons for not using the service (for profile fit non-users only)	Reasons for not using the service
User's needs	Needs addressed by the services
Description of the workflow when using the digital mobility service	Service characteristics
Usability of the service's digital interface	Demands from users
Usability of the service's physical interface	Business demands: demands for developing, operating and maintaining the service

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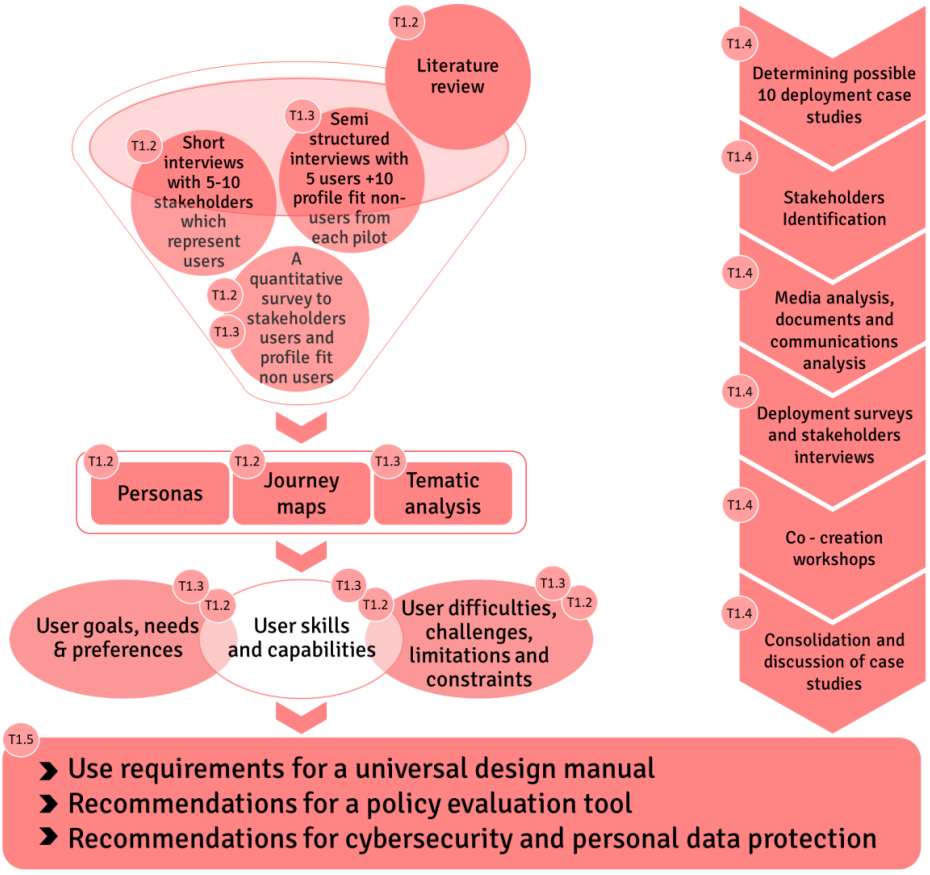
Scope of information collection from users	Scope of information collection from developers, operators and policy makers
Skills / capabilities	Accessibility and inclusion
Difficulties, limitations, challenges and constraints	Difficulties, limitations, challenges and constraints
User's perception of the service use demands and their ability to meet the demands	Growth potential and strategy of the digital mobility service
Self-use, assist other or group use	Service's resilience to crises like Covid-19
Perception of personal data privacy and security	
Safety perception	
Perception of the service's resilience to crisis like Covid-19	
Attitudes, feelings/ emotions, preferences and opportunities	

The scope of information collection



WP1 Work plan

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List of Acronyms

ACRONYM	
AVG	Average
COP	Communities of practice
EU	European Union
DRT	Demand-responsive transport/transit
GDPR	General data protection regulation
ICT	Information and communications technology
IoT	Internet of Things
MaaS	Mobility as a service
RFID	Radio frequency identification technology
SSI	Semi-structured interview
UMD	Universal design manual
WP	Work package
WNS	Wireless sensor network

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1. Introduction

1.1 Overview and Objectives

Tapping the full potential of digital mobility services has many facets. Growth of existing and emerging services to extend their benefits to a variety of populations is one of the most important of them, especially for those who are vulnerable-to-exclusion due to physical, cognitive or socio-economic barriers. INDIMO team was brought together to fulfil this important goal with the understanding that concepts such as accessibility, inclusiveness, equity, personal safety, information security and privacy lie at the basis of the opportunity to accomplish such growth.

Pursuing the mission of expanding the use of digital mobility services, and assist these services in their attempt to become inclusive and accessible to all users, INDIMO will explore the goals, needs and limitations of vulnerable-to-exclusion users on the one hand, and the challenges that developers, operators and policy makers face, on the other hand. The exploration will focus on **common** aspects and challenges of the use of a variety of digital mobility services for forming **a conceptual methodology** for development and evaluation of accessible and inclusive digital solutions that will include a series of tools. Accordingly, the outcome of the project will be a comprehensive digital mobility deployment toolkit, which will be comprised of:

- A universal design manual (UDM) for digital mobility services
- Guidelines improving the design of interface between transport users and digital mobility systems (i.e. Universal interface language icons)
- Guidelines for cybersecurity and personal data protection
- A policy evaluation tool and recommendations for policy makers.

In this context, Work package 1 (WP1) is intended to establish the foundations for INDIMO's conceptual methodology. It will focus on information collection and analysis for defining the use requirements of the digital mobility deployment toolkit (that will be developed in work package 2). To that end, the work will involve collection and analysis of information on (1) existing and emerging digital mobility services; (2) vulnerable-to-exclusion users' goals, needs, capabilities, challenges, limitations etc.; and (3) developers', operators' and policy makers' challenges of the deployment of digital mobility services.

1.1.1 D1.1 description

The current document, D1.1, presents the outcomes of the first task (T1.1) of work package 1: 'Framework for analysis of user needs, capabilities, limitations & constraints of a digital mobility service'. It presents the methodological framework of the data collection and analysis and the detailed work plan of WP1 tasks.

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1.1.2 Relationship of D1.1 with other relevant deliverables

The work presented in D1.1 will mainly contribute to the development of work packages 3 and 2. Work package 3, 'Pilots and demonstrations', will have a close cooperation with WP1 by constant sharing of data. The framework of data collection and analysis will enable (1) to identify users and stakeholders (for data collection, communities of practice, etc.), (2) to create the tools for data collection, (3) to analyze the data and so on. Work package 2, 'creating the INDIMO Inclusive Digital Mobility Toolbox' will base the development of the digital mobility deployment toolkit on the information collected and analysed according to the framework described in the current report.

1.2 INDIMO Analysis Framework Rationale

The developed framework of information collection and analysis mainly focuses on:

- Accessibility, inclusion and equity of digital mobility services
- Physical, digital and regulatory aspects of the digital mobility services
- Co-creation process (including users, developers, operators and policy makers)
- User-centric design process

The following sections explore each of these elements further.

1.2.1 Equity, accessibility and inclusion of digital mobility services

Although equity has been introduced in the field of spatial planning and land use assessment a long time ago, the transportation sector remained behind in this debate by separating social and technical issues (Aparicio, 2017). This separation allowed planners and technical experts to deal with technical issues and put aside the socio-economic impacts of transport. During the 70s in the Netherlands, planners and experts started with developing the cost-benefit analysis tools for social assessment of transport infrastructures and services. However, later on in the 2000s, cost-benefits-analysis revealed its weakness in assessing transport systems and services from a social equity point of view. The consideration of travel time and financial costs is not enough for capturing different aspects of social equity issues (Di Ciommo and Shiftan, 2017; Martens and Di Ciommo, 2017).

The transport equity concept states that benefits and costs of the mobility and transport system should be distributed in a fair way (Litman, 2002). Concretely this means that certain vulnerable to exclusion groups need more resources compared to other groups in order to be able to use the same mobility service. Social research has shown that accessible and inclusive mobility - where people have the same opportunities to access key activities - contributes to an equal society (Hackl, 2018) especially for vulnerable groups such as older people (Musselwhite et al., 2015; Schwanen et al., 2012; Ziegler & Schwanen, 2011). An older person with high income can still be excluded from digital mobility services due to poor digital skills. Although these studies focus on people aging in society, the findings can be linked to other vulnerable

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groups that have limited access to different mobility modes (e.g. people with disabilities, people with low level of education, etc.).

In the INDIMO project, two essential components of equity are considered: *accessibility* and *inclusivity.* Both of them are explained briefly below.

1.2.1.1 Accessibility of digital mobility services

Accessibility of digital mobility services covers the physical and cognitive aspects of being able to access mobility services through digital interfaces. While previously, the focus of research was on how the physical aspects of transport (i.e. the vehicles, stations, roads) can be made more accessible to people with disabilities; the digitalisation of the transport system has brought new types of accessibility issues to light. For example, how persons with disabilities can access digital mobility interfaces to search for routes and timetables, purchase tickets, order goods or simply to cross a 'smart' traffic light. The interface the travellers can encounter can range from smartphone screens, through computers, tablets and self-service touchscreen terminals to virtual voice assistants. The limitations of access (inaccessibility) can result from not being able to physically operate the interfaces (e.g. because the ticket machine screen is too high or unreadable) (physical accessibility) or getting confused by complex instructions and screens (cognitive accessibility).

Smart mobility is widely conceived as an inductor for multimodal mobility, which in turn is seen as a crucial aspect in the transformation from a unimodal car-oriented society towards a more sustainable multimodal personal mobility. The concept of multimodality, combined with smart mobility, has a lot of potential, but can also deepen the digital divide between groups of people, creating a gap.

This gap can be explained by people lacking the physical and cognitive means, or tools to access ICT as a key aspect for using these digital mobility services and therefore having limited or no access to these services. This gap can also be explained as the differences between two groups of users, both having access to mobile phones, but not being to be able to use them in the same way. The first group is the mobile on-liners who have full access to all functions. The second group is the mobile off-liners, who can only access limited functions (Brandtzæg et al., 2011). The lack of skills and abilities to access the online functions of the digital world creates a fundamental difference in access to mobility, especially smart mobility. With the rise of smart mobility options, which should make the transformation towards multimodal, more sustainable mobility services easier, this gap may get even bigger.

1.2.1.2 Inclusivity of digital mobility services

Other aspects of ensuring equity are the socio-economic and demographic barriers that may prevent people from using digital transport services (INCLUSION, 2019), which will be covered

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by the term inclusivity or inclusiveness used interchangeably in INDIMO. While definitions vary (Miller, 2007), within inclusivity, accessibility[1] is used in the spatial-activity context of the ease with which transport needs of users are covered (i.e. need to reach and carry out an activity). This can be constrained by a lack of transport services or the lack of the financial means of people to use the available services (transport poverty) (Cascetta et al. 2016). Others have proposed the concept of inaccessibility to understand when a lack of accessibility produces a transport poverty situation (Di Ciommo et al., 2019). Transport poverty can be a result of any number of different factors of which many focuses on inaccessibility to physical infrastructure and are rather well known. Less known are the barriers, which result in inaccessibility to digital services.

Over 35% of the EU population is at risk of exclusion from the digital single market: 80 million Europeans with disabilities, and 190 million people aged over 50. This large population, which need these digital services, cannot use them in the current configuration due to a variety of socio-economic, demographic or spatial aspects such as barriers through education, residence in peripheral locations, gender, language, ethnicity, migration etc.

For example, shared mobility (car sharing, bike sharing, etc.) with digital booking platforms is primarily used by people with higher education, living in urban areas, with high income and a younger age than the general population (Shaheen et al., 2017).

1.2.2 Physical, digital and regulatory aspects of digital mobility services

In the past, almost all the mobility related aspects (organization, infrastructure, services, etc.) were physical. Yet, since the rise of the internet, the invention of the smartphone and corresponding applications, this has changed at a very fast pace, which has fundamentally changed the way people and freight move. Contemporary mobility consists of three interacting principles, the physical infrastructure for the actual movement of people and freight, the digital aspects related to the connectivity between provider and user and the regulatory systems (e.g. rules of the government). The physical and regulatory parts of mobility have already been extensively studied, however, the digital part still lacks insight into the implementation of these services in a way, so they are accessible to all members of society (Rodrigue, 2020).

Considering concepts such as accessibility, inclusion and transport equity, one cannot treat the digital aspect of the service separately. It needs to be considered in a holistic way that addresses both physical, digital and regulatory aspects of the service.

[1] In order not to confuse the two different meanings of accessibility (i.e. a: accessibility to digital interfaces and b: spatial accessibility to services and activities) the INDIMO project considers spatial accessibility to services and activities under the umbrella term of inclusivity.

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1.2.3 Co-creation process

Applying a co-creation process with in-depth involvement of users, developers, operators and policy makers will ensure that we consider multiple points of view and receive comprehensive information about digital mobility services. In fact, co-creation establishes a common ground to all the stakeholders to interact and create a solution that addresses the needs of the users, while also taking into account the abilities and constraints that the developers, operators and policy makers face.

1.2.4 User-Centered Design process

User-Centered Design (UCD) places the user at the centre of the design, in a way that optimizes a product or a service around how people use it, rather than forcing them to change behaviour and to accommodate to the service. The designer's role is to create a system, application or product that enables the user to easily learn and use it as intended and perform a desired task with minimum effort (Norman, 1988).

The implementation of user centred design, which supports vulnerable-to-exclusion users, requires understanding the users' needs and desires, the task to complete and the intended use of the application. In addition, it is important to capture the context of use, and the limitations and constraints of the use. In a user-centric design process, users are involved in each phase of the iterative design process, from the user-experience research to the service evaluation and implementation.

In order to acquire this knowledge on users and the context of use, we must define who are these vulnerable-to-exclusion users and what are their characteristics. This definition should consider the literature and experience of INDIMO partners concerning mobility services and user research and their relation to questions as segmentation of the population by modes of transportation use, age, gender, skills, education, socioeconomic status, place of residence, etc.

1.2.4.1 Personalization of digital mobility services

Personalised mobility is an implementation of user centred design process since the essence of it is the adaptation to user needs. Personalization of services is a concept, which was primarily used in the field of marketing to give possible customers a feeling of importance. Many definitions for personalized services have been created, but most fitting for our project is the definition created in 2005 by the Personalization Consortium (Vesanen, 2007). This definition focuses on personalization as a technology-based aspect, as follows:

> *"Personalization is the use of technology and customer information to tailor electronic commerce interactions between a business and each individual customer. Using information **either** previously obtained or provided in real-time about the customer, the exchange between the parties is altered to fit that customer's stated needs as well as needs perceived by the business based on the available customer information (Vesanen, 2007, p. 410)."*

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This definition states that a service is personalized if the business providing the services adapts the service to fit the customers' needs/demands. This implies that there is or has been an exchange of information between both parties in order to provide that specific service to the customer.

1.2.4.2 On demand service

On-demand service also puts into practice the user-centered design method. This concept has various definitions. Two of them which suit INDIMO are:

> *"An on-demand service platform connects waiting-time-sensitive customers with independent service providers (agents) (Greenblatt & Shaheen, 2015, p. 77)."*
>
> *"Services are on-demand in the sense that upon experiencing a need for service, a customer desires service immediately and is sensitive to delay (Taylor, 2018, p. 1)."*

Both definitions give somewhat different explanations, but both focus on an immediate time sensitive service for a user upon his/her need. According to Greenblatt and Shaheen (2015), on-demand services also require a platform where demand and supply meet. This means that there is a digital interface, which people can use to reach the platform where they communicate with each other in order to match supply and demand.

1.3 INDIMO and other EU mobility projects

The INDIMO-project is not the only project focusing on mobility, inclusion and digitalization. There are several European Union (EU) projects recently completed or in progress, each with slightly different foci. In the Horizon 2020 (H2020) project 'INCLUSION', the emphasis is on transportation solutions for citizens of rural and peri-urban areas. It has several pilot areas in which physical inaccessibility of mobility services, mostly public transport, prevent the service from being inclusive (INCLUSION, 2019). 'HiReach', another H2020 project, is focusing on transport poverty. It aims to help entrepreneurs in a start-up lab to deliver solutions to transport poverty problems up to minimum viable product level. The goal of the project is "to build on innovative components, which do not rely solely on the knowledge base of experts, but also entail a combination of bottom-up initiatives with new operational schemes and IT applications. The Start-up Lab is used as the perfect background to explore unknown, yet viable, business models for small scale, modular and easily replicable mobility services." (HiReach, n.d.). This aspect of the HiReach project is similar to the INDIMO-project, i.e. the easily transferable, if possible modular solutions, which can be implemented in different spatial and sociological contexts. There is also a significant difference between both projects, HiReach does not specifically focus on developing inclusive digital mobility applications or interfaces, but the bottom-up involvement of vulnerable to exclusion user groups is expected to contribute to the development of 'inclusive' services.

Apart from these two H2020 projects, there are other projects such as 'transport-links' (UNECE), TEA COST Action, etc., that have focused on inclusive mobility for disabled people,

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minority groups, children and women, but as was the case for the INCLUSION and HiReach projects, they primarily focused on the physical inclusion (High Volume Transport, n.d.).

Exploring these projects leads to the conclusion that there is indeed an interest to create more inclusive and accessible mobility, but the development of applications and digital interfaces is still lagging behind. In light of the above, the INDIMO project gives an analysis of the requirements, barriers and problems users and non-users experience when using these services. There will be a specific focus on the profiles in society which have no or limited access to certain services to try and provide a framework for developers and operators to reach these profiles.

1.4 Outline of Current Report

In line with the rationale presented above, the current report presents the detailed framework for data collection and analysis in Work Package 1. Section 2 describes the pilot projects and the case studies by which we collect information. Section 3 presents the vulnerable-to-exclusion user characteristics and user profiles that will be in the focus of the information collection. Section 4 reviews the current and future digital mobility services and presents the services that will be included in INDIMO. Section 5 lists the dimensions of information that will be collected from users and from developers, operators and policy makers. Section 6 introduces the work plan of data collection and analysis of WP1.

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2.The Living Laboratory of Information: Pilot Projects and Case Studies

WP1 is mainly focused on information collection and analysis, as described above. For that, it will carry out 10 user case studies and 10 deployment case studies. Data on user needs will be collected from ***10 user case studies***, including the five INDIMO pilots as well as 5 additional cases from Europe representing specific user profiles. In addition, ***10 deployment case studies*** will be carried out that will investigate how new digital mobility or logistics solutions have been introduced in European cities or regions.

'A Case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a "real life" context' (Simons, 2009). For socio-economic research, case studies are one of the principal means used to collect data. Research showed that case studies are being widely used and are even thriving (Bates et al., 1998; Robinson et al., 2003).

In combination with his definition, Simons (2009) claims that a case study should not be seen as a method in and of itself. More accurately, it can be described as a framework that may incorporate several methods. Therefore, case studies are pure theoretically variable-led research, which means they do not investigate a small number of variables in a large number of cases, instead a significant number of variables are studied in few cases (Thomas, 2011).

5 case studies will be covered by the 5 INDIMO pilot projects which belong to work package 3 (WP3). The 5 additional user and deployment case studies will be selected and carried out in Task 1.2.

The pilot projects, which have active or in-development digital mobility services, have a direct connection to users, developers and operators. Therefore, WP1 partners and the pilot partners (WP3) will cooperate throughout the information collection and analysis. A short description of each pilot project is presented in Table 1. More details on the pilot projects will be delivered in D3.1, 'Pilot handbook' that will be submitted in June 2020.

#	Pilot Project Owner	Pilot Name
P1	Emilia Romagna	Introducing digital technology to enable e-commerce in rural areas
P2	Antwerp	Inclusive traffic lights
P3	Galilee	Informal ride sharing in ethnic towns
P4	Madrid	Cycle logistics platform for delivery
P5	Berlin	On-demand ride-sharing integrated into multimodal route planning

Table 1: INDIMO WP3 Pilot projects

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The selection of the additional 5 INDIMO users case studies will be finalized by the end of June 2020. They will try to address user characteristics that were not included in the pilot projects user profiles[2]. Possible identified options for case studies are presented in Table 2. Similarly, the additional 5 deployment case studies will be identified as part of Task 1.4 by the end of June 2020.

#	Case Study	Case Study Description
CS1	Budapest (Hungary)	Public transport use of people with physical disabilities
CS2	Brussels (Belgium)	Inclusiveness of multimodality journey planner for people with low-income and/or unemployed

Table 2: INDIMO WP1 possible identified options for case studies

[2] See section 3.4.4 of this document for further explanation on user characteristic of case studies

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3.End-User[3] Characteristics & Profiles

3.1 Overview and Terminology

Assessing goals, needs, challenges, limitations and capabilities of vulnerable-to-exclusion users using digital mobility services, starts with defining users' characteristics & profiles. These profiles should be formulated before the information collection begins and evolve as the study progresses.

The term 'USER CHARACTERISTIC' refers to any specific attribute or trait (permanent, temporary or situational) of a user that can influence the use of a digital mobility service as well as the user's goals and needs concerning the use of the service. Since the use of digital mobility services is complex, a specific user can have several characteristics that effect his or her use and needs. This combination of characteristics, which is linked to the use of a particular service, is defined as a 'USER PROFILE'[4]. Accordingly, if there is a group of people who share a common user profile or a common user characteristic this group is called a 'TARGET GROUP'. Table 3 presents examples of the terms.

	User Characteristics	User Profile Name	Target group
Definition	Any specific attribute or trait (permanent, temporary or situational) of a user that can influence the use of a digital mobility service as well as the user's goals and needs concerning the use of the service.	A combination of characteristics, which is linked to the use of a particular service.	A group of people who share a common user profile or a common user characteristic
Example	• Ethnic minority • Man/women • Residing in the periphery • Insufficient public transportation services • Language barrier • Lack of digital skills	**Informal ride sharing users** (this profile includes all user characteristics presented on the right column)	People who meet the informal ride sharing user profile

Table 3: Terminology Definitions and Examples

[3] In this report the term 'user' relates to an end-user

[4] In special cases, a user profile can include a single user characteristic, as is the case of Covid-19, a user profile that refers to the sole user characteristic of isolated people. INDIMO will not use single profiles, except in Covid-19 unique case.

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As mentioned in the introduction, vulnerable-to-exclusion users are extensively studied within the European Union (e.g. H2020-INCLUSION, HiReach, TEA Cost Action). However, collecting information from users is usually targeted to meet specific research objectives. Thus, from the same population, different information can be gathered according to different research questions. Indeed, a comparison of H2020-INCLUSION, HiReach, TEA cost action and INDIMO indicates that although they research the same population, each project has different foci. H2020-INCLUSION's emphasis is transportation solutions for citizens living in rural and peri-urban areas. HiReach focuses on transport poverty and studies the difficulty to access transport and destinations, for many reasons. TEA cost action centres on equity assessment of transport investments and policies to support transport decision making. And INDIMO is engaged in establishing policies and guidelines for developing a variety of digital information systems and applications for inclusive digital mobility services.

INDIMO will collect information from several vulnerable-to-exclusion user groups, in line with the research objectives. There may be overlap in the information gathered between the various European Union's projects, however if INDIMO would collect information only from unexplored sections of this population the data gathered could be biased and as a result we might develop a digital mobility deployment toolkit that is not inclusive.

The sections below describe the actions taken to explore and select the vulnerable-to-exclusion users' characteristics and profiles.

3.2 Methodology

Vulnerable-to-exclusion users' characteristics and profiles were explored and selected using the following methods:

3.2.1 User characteristics questionnaire

The project partners, who are all experts in the field of transportation, accessibility, inclusion and transport equity, received a questionnaire in which they were asked to list any relevant vulnerable-to-exclusion user characteristics, based on existing literature and their own (research) experience. Please see below annex 1 for the questionnaire.

The information gathered has resulted in a common list of forty potential vulnerable-to-exclusion user characteristics and target groups as a starting point for further research in INDIMO.

3.2.2 User characteristics and target groups prioritization

In order to prioritize the relative importance of each of the identified vulnerable-to-exclusion user characteristics and target groups included in the common list, the project partners had a joint discussion at the kick-off meeting held in Brussels on 12-13 February 2020. In the meeting, the project partners were divided into seven groups. Each group was asked to evaluate each of the user characteristics and target groups, presented on separate stickers, and their

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importance level on a scale of 1 (not important) to 4 (highly important). The scale description is shown in Table 4.

While discussing the rank of each characteristic and user group the partners were asked to consider the following parameters:

- Perceived frequency of occurrence (in the vulnerable-to exclusion population)
- Can this user characteristic or target group be addressed?
- The impact on service type design
- The impact on system/app user interface design.

Figure 1: User characteristics group discussion and output presents the groups' discussion and output.

Importance Level	Description
1	It is **not important** to gather data from users with this characteristic or from this target group
2	It is **ok** to gather data from users with this characteristic or from this target group
3	It is **important** to gather data from users with this characteristic or from this target group
4	It is **highly important** to gather data from users with this characteristic or from this target group

Table 4: Importance Scale

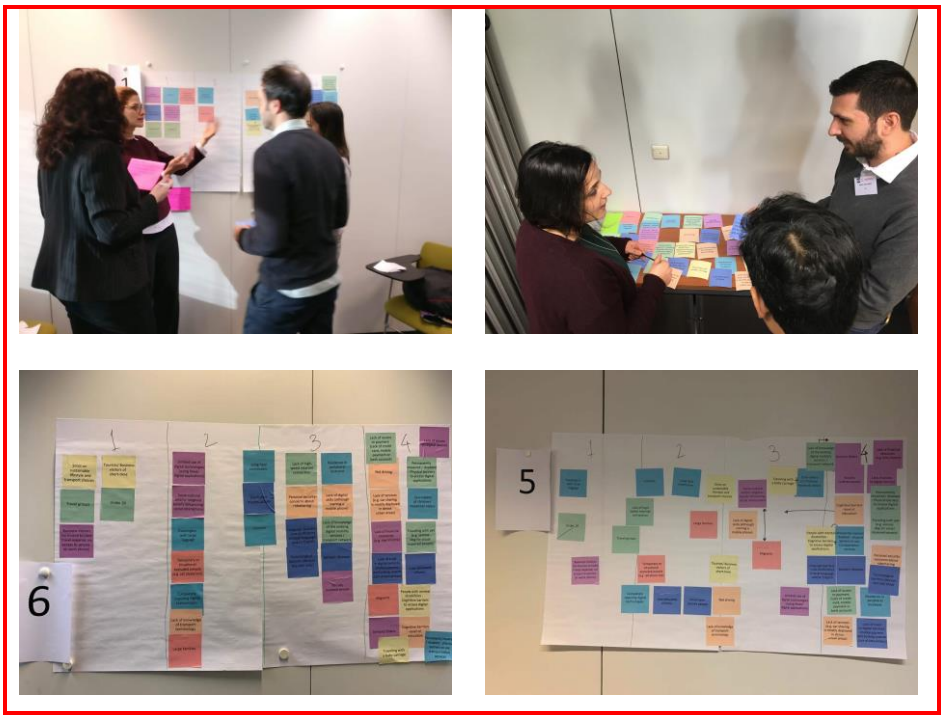

Figure 1: User characteristics group discussion and output

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3.2.1 Covid-19 isolated user characteristic / user profile

After completing the work on defining the user characteristics to be included in INDIMO, we were asked by the European Union to consider the effects of the Covid-19 pandemic on digital mobility services availability and usage. Therefore, in the scope of user characteristics and profiles[5], we decided to address Covid-19 isolation in two manners - either by adding Covid-19 isolation as a user characteristic (Covid-19 isolated with none or reduced number of daily trips allowed), or by adding a Covid-19 isolated user profile.

Sections 3.4.2 to 3.4.4. discuss how the user characteristics are integrated into the research methodology.

3.3 Results

3.3.1 User characteristics questionnaire results

The data collection via the questionnaires produced 40 vulnerable-to-exclusion user characteristics and target groups that were categorized as follows:

Physical barriers to use transportation services:

- Permanently impaired or with disability
- Short-term injuries
- Travel with large family
- Travel with a baby carriage
- Travel with a large luggage
- Travel with an assistance animal
- Travel in a group
- Residing in peripheral locations

Physical barriers to access digital applications:

- Permanently impaired or with disability
- Technological barriers (devices that are too old or too slow)

Cognitive barriers

- A lower level of education
- A mental or cognitive disability

[5] Other references to the Covid-19 pandemic are presented throughout the document.

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- Lack of knowledge of the existing digital mobility services /transport network
- Lack of knowledge of transport terminology
- Lack of digital skills (despite owning a mobile phone)
- Language barriers - low proficiency in local language and/or English

Situational barriers

- Low income
- Lack of access to methods of payment (don't have a credit card, mobile payment or bank account)
- Lack of services (e.g. car sharing is mostly deployed in dense urban areas)
- Lack of high-speed internet connection
- Lack of access to digital devices
- Temporarily or situationally excluded (e.g. cell phone lost)
- Limited use of digital technologies (not using or barely using digital applications)
- Commute for long haul

Personal and lifestyle related barriers

- Socially isolated
- Socio-cultural and/or religious beliefs influencing social interactions
- Complete rejection of digital technologies
- Strict on sustainable lifestyle and transport choices
- Lack of trust in digital services (mobile payment and booking systems, data-privacy)
- Personal security concerns (e.g. about ridesharing)
- Don't have a driving licence or do not drive

Target Groups

- Gender: women
- Migrant
- Caregiver of children/ people with disabilities/ older people
- A short time visitor (e.g. tourist/ business visitor)
- Business visitor (no invoice to claim travel expense, no access to service on the work phone)

Age

- Older age
- Child
- Under 20

3.3.2 User characteristics and target groups prioritization results

In general, there was an agreement between the groups on the relative importance of most user characteristics and target groups. Some characteristics were rated as important in terms

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of information gathering, while others were rated as marginal in that respect. Table 5 presents a summary of the findings (see below for the complete results table).

1- It is **not important** to gather data from users with this characteristic or from this target group

2 -It is **ok** to gather data from users with this characteristic or from this target group

3- It is **important** to gather data from users with this characteristic or from this target group

4- It is **highly important** to gather data from users with this characteristic or from this target group

Evaluated Level of Importance	User Characteristics or Target Group
User characteristics rated as **4** by 6 or 7 groups	• Permanently impaired or with disability - physical barriers to access digital applications • Lack of access to digital devices • Low income • Lack of access to methods of payment (don't have a credit card, mobile payment or bank account) • Age: older
User characteristics rated as **3** OR **4** by 7 groups	• Lack of trust in digital services (mobile payment and booking systems, data privacy) • Lack of digital skills (despite owning a mobile phone) • Residing in peripheral locations • Caregiver of children/ people with disabilities/ older people • Migrant • Gender: women • Lack of services (e.g. car sharing is mostly deployed in dense urban areas)
User characteristics rated as **3** OR **4** by 6 of the 7 groups	• Permanently impaired or with disabilities - physical barriers to use transportation services • A mental and cognitive disability • Lower level of education • Personal security concerns (e.g. about ridesharing) • Language barriers - low proficiency in local language and/or English • Travel with a baby carriage
User characteristics rated as **2** OR **3** by 7 groups	• Travel with a large family • Limited use of digital technologies (not using or barely using digital applications)

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1- It is **not important** to gather data from users with this characteristic or from this target group

2 -It is **ok** to gather data from users with this characteristic or from this target group

3- It is **important** to gather data from users with this characteristic or from this target group

4- It is **highly important** to gather data from users with this characteristic or from this target group

Evaluated Level of Importance	User Characteristics or Target Group
User characteristics with no agreement concerning the level of importance of gathering data on them Please note that in user characteristics marked with an asterisk (*), at least 4 of the 7 groups rated the characteristic as 3 OR 4, and in user characteristics marked with a number sign (#), at least 4 of the 7 groups rated the characteristic as 1 OR 2	• (*)Socially isolated (range: 1-4) • (*)Technological barriers (devices that are too old or too slow) (range: 1-4) • Don't have a driving licence or do not drive (range: 2-4) • (*)Socio-cultural and/or religious beliefs influencing social interactions (range: 2-4) • (#)Travel with large luggage (range: 2-4) • (*)Complete rejection of digital technologies (range: 2-4) • (*)Lack knowledge of transport terminology (range: 2 & 4) • (*)Travel with an assistance animal (range: 1-4) • (*)Lack of high-speed internet connection (range: 1-4) • (*)Lack knowledge of the existing digital mobility services /transport network (range: 1-4)
User characteristics rated as **1** OR **2** by 7 groups	• Temporarily or situationally excluded (e.g. cell phone lost) • Short-term injuries • Business visitor (no invoice to claim travel expense, no access to service on the work phone) • Commute for long haul • Strict or sustainable lifestyle and transport choices
User characteristics rated as **1** OR **2** by 6 of the 7 groups	• Age: child • Travel in a group • Age: under 20 • A short time visitor (e.g. tourist/ business visitor)

Table 5: User Characteristics Importance Evaluation

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3.4 Discussion & Implications for User Profile Selection

3.4.1 Results summary

In general, the project partners agreed that it is **important OR highly important** to collect data on the following user characteristics and user groups:

- Permanently impaired or with disability (physical barriers to use transportation services)
- Permanently impaired or with disability (physical barriers to access digital applications)
- Gender: women
- Older age
- Migrant
- Caregiver of children/ people with disabilities/ older people
- Travel with a baby carriage
- Residing in peripheral locations
- Low income
- A lower level of education
- Technological barriers (devices that are too old or too slow)
- A mental or cognitive disability
- Lack of digital skills (despite owning a mobile phone)
- Language barriers - low proficiency in local language and/or English
- Lack of access to methods of payment (don't have a credit card, mobile payment or bank account)
- Lack of services (e.g. car sharing is mostly deployed in dense urban areas)
- Lack of access to digital devices
- Lack of trust in digital services (mobile payment and booking systems, data-privacy)
- Personal security concerns (e.g. about ridesharing)
- Don't have a driving licence or do not drive

There was no consensus regarding the following user characteristics and user groups. However, **a majority of INDIMO project partners considered them important**:

- Socially isolated
- Technological barriers (devices that are too old or too slow)
- Lack of high-speed internet connection
- Lack knowledge of the existing digital mobility services /transport network
- Socio-cultural and/or religious beliefs influencing social interactions
- Complete rejection of digital technologies
- Lack knowledge of transport terminology
- Travel with an assistance animal

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Collecting information from the following user characteristics or user groups was considered **less or not important**:

- Temporarily or situationally excluded (e.g. cell phone lost)
- Short-term injuries
- Business visitor (no invoice to claim travel expense, no access to service on the work phone)
- Commute for long haul
- Strict or sustainable lifestyle and transport choices
- Age: child
- Travel in a group
- Travel with large luggage
- Travel with large family
- Age: under 20
- A short time visitor (e.g. tourist/ business visitor)
- Limited use of digital technologies (not using or barely using digital applications)

3.4.2 Implications on user profiles selection for INDIMO

As explained above, INDIMO is engaged in the use of digital mobility services, which may be complex. Users can have more than one characteristic that may affect the usage of the service. For example, a user can be a migrant, who lives in the periphery, faces language barriers, has a low income and limited access to technological means.

The importance of gathering information from complex user profiles also comes to the fore when thinking about the purpose of INDIMO: developing and examining guidelines for designing inclusive digital solutions for mobility. This means inclusive solutions for the entire population, with a focus on vulnerable to exclusion target groups, rather than dedicated solutions designed for a specific segment of users. Accordingly, information collection on users' goals, needs, challenges, limitations, capabilities etc., should be based on complex profiles that allow for a broader, more accurate representation of the reality.

3.4.2.1 Selection Criteria

In order to make sure that the data collected in WP1 and WP3 (via pilot projects and case studies) is gathered from users that represent our target population (vulnerable-to-exclusion users), the following selection principles were defined:

- User characteristics or target groups rated as important OR highly important (including those on which there was no full consensus) **CAN BE** included in the INDIMO user profiles;
- Covid-19 isolated profile **CAN BE** included in the INDIMO user profiles in two manners: (1) as a user characteristic (Covid-19 isolated with none or reduced number of daily trips allowed), or (2) as a user profile (Covid-19 isolated), which has one or more user characteristics (related to the pandemic) that affect the use of mobility services.

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- User characteristics or target groups that were rated as ok OR not important **CANNOT** be included in the INDIMO user profiles.

This selection criteria do not mean that if the user profile has additional characteristics - it is not accepted; however, it is recommended that the key characteristics will be from the list.

3.4.3 Current identified user profiles for information collection

For each of the five INDIMO pilots[6], the pilot leaders have preliminarily identified user profiles to focus on in the further research on user needs as the first 5 user case studies. These profiles were found to meet the defined principles since they comprise user characteristics and target groups that can be included in the user profiles. Accordingly, the user profiles in the additional 5 case studies[7] to be identified in the future will also meet the defined criteria.

All user profiles can be updated, refined or replaced by more suitable profiles (as part of the natural dynamics of an applied research), as long as they continue to meet the above criteria. Table 6 presents the pilots' preliminary identified user profiles:

[6] See section 2 of this document for further explanation on pilot projects.

[7] See section 2 of this document for further explanation on case studies.

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#	Pilot project owner	Pilot name	User profile(s)	User characteristics/target groups included (all or most[8]) in the profile
P1	Emilia Romagna	Introducing digital technology to enable e-commerce in rural areas	**1st user profile: Older people who receive/send parcels**	• Age: older • Lack of digital knowledge • Residing in peripheral locations • Lack of digital services • Lack of dedicated network infrastructure (e.g. bus stops, postal office, petrol stations.) • Limited access to transport services and commercial delivery services
			2nd user profile: Migrants or foreign people[9] who receive/send parcels	• Low economic conditions (assuming migrant from out of Europe) • Low level of education (assuming migrant from out of Europe) • Language barrier • Lack of digital knowledge • Residing in peripheral locations • Lack of digital services • Lack of dedicated network infrastructure (e.g. bus stops, postal office, petrol stations.) • Limited access to transport services and commercial delivery services

[8] In case a user participating in the research does not meet all of the user characteristics, but he or her meet most of them – he or her can be included in the research.

[9] This user characteristic is based on reports of CMBO (2017) which state that the median income of foreigners in Bologna was about half, compared to that of Italians in Bologna. We have used the term "foreign population" and "immigrants" indicating people (both of Italian of foreign citizenship) that changed their residence from an external municipality to that of Bologna or one of municipalities in its area.

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#	Pilot project owner	Pilot name	User profile(s)	User characteristics/target groups included (all or most[8]) in the profile
P2	Antwerp	Inclusive traffic lights	**Vulnerable pedestrians**	• Age: older (over 60) • Permanently impaired or with disabilities: visual disability, wheelchair mobility
P3	Galilee	Informal ride sharing in ethnic towns	**Informal ride sharing users**	• Ethnic minority man/women • Residing in the periphery • Insufficient public transport services • Language barrier • Lack of digital skills
P4	Madrid	Cycle logistics platform for delivery	**Healthy food delivery users**	• Permanently impaired or with disabilities • Socially isolated (unwanted loneliness) • Not-connected people (e.g. Low digital skills, lower technology availability) • Low income • COVID19 isolated with none or reduced number of daily trips allowed
P5	Berlin	On-demand ride-sharing integrated into multimodal route planning	**On demand ride sharing users**	• Care-takers of children/ impaired/ elders • Gender: women • Lack of services (reduced mobility) • Lack of digital skills (although owning a mobile phone) • Residing in peripheral locations

Table 6: Pilots' preliminary identified user profiles

3.4.4 Division of the chosen user characteristics among the pilots

Table 7: Division of the selected user characteristics among the pilots presents the division of the chosen user characteristics among the pilots. As can be seen in the grey rows, not all the characteristics are addressed. The 5 additional user case studies and the extensive literature review planned in Task 1.2 will try to address the user characteristics that were not included in the pilots.

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#	User Characteristic/ Target Group	P1 Emilia Romagna Introducing digital technology to enable e-commerce in rural areas	P2 Antwerp Inclusive traffic lights	P3 Galilee Informal ride sharing in ethnic towns	P4 Madrid Cycle logistics platform for delivery	P5 Berlin On-demand ridesharing integrated into multimodal route planning
1	Permanently impaired or with disability (Physical barriers to use transportation services)		X		X	
2	Permanently impaired or with disability (Physical barriers to access digital applications)		X			
3	A mental or cognitive disability					
4	Older age	X	X			
5	Gender: women					X
6	Migrant	X				
7	Socially isolated				X	
8	Covid-19 (isolated with none or reduced number of daily trips allowed)			X	X	
9	Caregiver of children/ people with disabilities/ older people					X
10	Residing in peripheral locations	X		X		X
11	Don't have a driving licence or do not drive					
12	Travel with a baby carriage					
13	Travel with an assistance animal					
14	Language barriers - low proficiency in local language and/or English	X		X		
15	Low income	X			X	
16	A lower level of education	X				
17	Personal security concerns (e.g. about ridesharing)					
18	Socio-cultural and/or religious beliefs influencing social interactions					

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#	User Characteristic/ Target Group	P1 Emilia Romagna Introducing digital technology to enable e-commerce in rural areas	P2 Antwerp Inclusive traffic lights	P3 Galilee Informal ride sharing in ethnic towns	P4 Madrid Cycle logistics platform for delivery	P5 Berlin On-demand ridesharing integrated into multimodal route planning
19	Lack of services (e.g. car sharing is mostly deployed in dense urban areas)	X		X		X
20	Lack knowledge of the existing digital mobility services /transport network	X				
21	Lack knowledge of transport terminology					
22	Technological barriers (devices that are too old or too slow)				X	
23	Lack of access to digital devices				X	
24	Lack of high-speed internet connection				X	
25	Lack of digital skills (despite owning a mobile phone)	X		X	X	X
26	Lack of access to methods of payment (don't have a credit card, mobile payment or bank account)					
27	Lack of trust in digital services (mobile payment and booking systems, data-privacy)					
28	Complete rejection of digital technologies					

Table 7: Division of the selected user characteristics among the pilots

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4.Analysis of the Status and Opportunities of the Digital Mobility Services

4.1 Introduction

This section aims to define the status and opportunities of digital mobility services i.e. the 'digitally interconnected transport system' that will be investigated in the INDIMO project. These services are then compared and prioritised based on a set of parameters that define their importance in the current and future transport system and their relevance for vulnerable-to-exclusion populations. A digital mobility service refers to services that have (1) the ability to move people or freight and (2) have any sort of digital interface.

4.2 Methodology

The methodology used for mapping existing digital mobility services consisted of three steps.

The first step identified a pool of mobility and logistics services based on the literature and previous European projects concerning mobility, such as Mobility4EU (2017), HiReach (2019), city-HUB, Coexist and Inclusion.

The second step was the identification of parameters of importance to vulnerable-to-exclusion populations in order to compare these services. For this stage, the first source of information used was previous related projects funded by the European Union such as MIND-SETS (n.d.), HiReach, TRANSFORuM, NOVELOG, STRIDE, DIGNITY, MOBILITY4EU (2017) and INCLUSION (2019). The second important source of information was the academic literature.

In the third step each of the identified digital service was evaluated based on the identified parameters. The evaluation started with determination of the importance or weight of each parameter by the project partners (experts in the field of digital mobility). Then, each of the digital services was evaluated on each parameter using a Likert scale range from 1 (very bad) to 5 (very good). All the partners' evaluations were calculated into a total score.

4.3 Results

We have identified 29 digital mobility services and digitally enabled traffic applications as relevant for evaluation by INDIMO based on the relevant literature and European projects (see Table 8 for the complete list).

4.3.1 Active traffic management

Active traffic management can be considered as the approach used for dynamically managing and controlling traffic demand, keeping in mind the available capacity of the infrastructure (Fuhs, 2010). The main goal of this technique is to decrease the average travel time during peak

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hour. One case in the Netherlands showed a 7 to 8 percent decrease in average travel time (Fuhs, 2010). A decrease in travel time can be associated with a higher average travel speed, which means less congestion and leads to a decrease in negative environmental, economic and social externalities (Sutandi, 2009).

The management of traffic consists of these repeating aspects (Kurzhanskiy & Varaiya, 2010):

- Continuous traffic measurement and analysis. Trying to manage road networks without the continuous input of data would be futile.
- Planning different operations, which includes evaluating the network in multiple scenarios.
- Operations planning, which includes evaluating the road network performance under various parameters (increasing demand, lane closures, special events, etc.), developing control strategies that improve performance and performing cost-benefits assessments.
- Installing hard-end software
- The system is running in real-time, which includes filtering the measurement data, providing short-term prediction of the traffic state and selecting the best available control strategy for the next 1–2h.

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Personal mobility	Freight transport
Active traffic management	(E-)Bicycle goods delivery
Adaptive, flexible lanes (peak hour)	(E-) moped goods delivery
Automated vehicles (individually owned)	Automated drone delivery
On demand autonomous vehicles (collective or individual)	On-demand freight delivery (e.g. UBER Eats, Deliveroo, Coopcycle)
Bike sharing (free floating)	Freight delivery drone (no automated flight)
Bike sharing (station based)	Crowd Logistics platforms
Car sharing (free floating)	Smart boxes for parcel delivery
Car sharing (peer to peer)	
Car sharing (station based)	
Demand responsive transit with online booking system	
Digital parking applications	
E-scooter (shared)	
E-Step sharing (free floating)	
E-ticketing and booking systems (mobile, web and terminal applications)	
Smart payment systems (smartcards, mobile payments, wearables)	
Multimodal route planners (e.g. Google Maps, Mappy)	
Mobility as a Service (MaaS)	
Real-time information services (station displays, information terminals)	
Ride hailing (e.g. Uber, Lyft	
Ridesharing platforms (e.g. Drivy, RideConnect)	
Smart traffic-lights	
Unimodal route planners (Waze, TomTom, Routenet)	

Table 8: Digital mobility services & digital enabled traffic management

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4.3.2 Adaptive, flexible lanes

Adaptive lanes, also known as dynamic lane reversal, is a strategy where traffic lanes could be adapted to the traffic demand. Figure 2 shows how adaptive lanes can be useful to relieve some of the pressure on the mobility infrastructure during peak hours (Hausknecht et al., 2011). In many places, adaptive lane control has already been introduced, in many cases this system is used for managing traffic going in or out of a city (Federal Highway Administration, US Department of Transportation, 2020). This can be a very useful technique if combined with traffic management systems. In that case, the lanes can adapt in real-time to actual traffic. The positive advantages of active traffic management are also applicable to dynamic lane reversal.

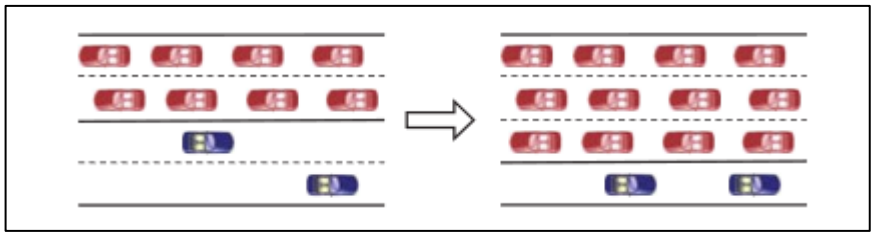

Figure 2: Dynamic lane reversal (Hausknecht et al., 2011)

4.3.3 Automated vehicles

Research on automated vehicles, or at least partially automated vehicles, has been ongoing for a while. In 1977, Japan was the first country to invest in these kinds of vehicles, followed by Germany, Italy, European Union and the USA (Greenblatt & Shaheen, 2015). Currently five levels of automatization have been defined (Table 9). It is predicted that it will provide society with a range of new transport methods and create multiple social benefits (Cunningham & Regan, 2015). The reason for including automated vehicles here is the expected impact they will have on person and freight transport in the future. Many of the shared services, which are now provided, will change into more automated services. In the case of car sharing, one would not have to pick up cars at certain designated areas, but the car will pick you up at your house or working place. Transport related social exclusion is one of the main aspects developers and policy makers want to tackle with the introduction of autonomous cars. This could have a positive effect on inclusion, since people not able to drive could use a car for their personal transport. On the other hand, there are as many, or even more voices warning against the opposite result. The exclusion because of lacking financial means to access these services could create an even wider transportation gap (Lucas, 2019).

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Level of automation	Description
Level 0	No automation
Level 1	Autonomy of one primary control function (e.g. adaptive cruise control, self-parking, lane-keep assist, autonomous braking).
Level 2	Autonomy of two or more primary control functions "designed to work in unison to relieve the driver of control of those functions".
Level 3	Limited self-driving; driver may "cede full control of all safety-critical functions under certain traffic or environmental conditions", but it is "expected to be available for occasional control" with adequate warning.
Level 4	Full self-driving: driver "is not expected to be available for control at any time during the trip" (included unoccupied vehicles).
Level 5	Full self-driving without human control.

Table 9: Vehicle automation level definitions (Greenblatt & Shaheen, 2015)

4.3.4 On-demand autonomous vehicles (collective or individual)

The rise of new mobility services and the introduction of level 2-3 automation (Table 9) in cars has opened the automotive industry to new forms of mobility business. Combined with the rise of services in mobility, a transformation might be made towards a situation where a person can use an autonomous vehicle trip-by-trip to be transported from point A to B after which the car drives back to its parking location or drives to a next user. As with many new mobility services, it is expected that there will be a platform or service available for ordering these kinds of mobility. Although this might sound very promising it's very important that the 'advantages in use' are considered higher by users than using their own privately-owned car (Larsson, 2018). If collective autonomous on-demand cars get to level 4 or 5, they can have a significant effect on pollution, congestion, road-safety and public space compared to private (autonomous) vehicles. For the future, it would be considered favourable if autonomous cars are used as shared cars instead of private cars. In the latter case the effects on the environment, congestion would be limited. Depending on where the cars park, in or outside the city, there would not be an increase in occupancy of public space in urban regions (Zhang et al., 2015).

4.3.5 Bike sharing (station based and free-floating)

Modern bike sharing programs refer to an organisation that provides short-term bicycle rental to the public. The bikes are picked up and dropped off at designated drop-off zones in station-based schemes and can be left everywhere within a service area in free-floating schemes. Compared to 'rented bikes', shared bikes are usually used for shorter periods of time and do not

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have to be returned to the same place they were picked up from (Midgley, 2009). In most cases, the bike contains technology to track its position or at least indicates to the operator where it has been docked. For free-floating bikes, a global positioning system is used to track their location at all times (Fishman, 2016). The process of renting a bike also differs between a station based and free-floating system. The station-based systems provide the possibility of booking online (via the providers' application or webpage) or via an interface present at the docking station. This interface provides the possibility to use this service without having access to a smartphone. For free-floating services this is not possible, since bikes can be left anywhere within the designated city or region, only booking via applications (or in some cases via the webpage) is possible.

Although bike-sharing programs in general have a positive influence on mobility there are some disadvantages. In some cities, there are shared bikes only in certain neighbourhoods; which means that not all people can access them. Free-floating bikes also have disadvantages: their location can change, which might create difficulties for people with disabilities trying to access them and collecting these bikes costs a lot of time and money.

4.3.6 Car sharing

Both the station-based and free-floating forms of car sharing provide the user with short-term access to a vehicle. The user gains the benefits of having a private vehicle to use, without the standard costs and responsibilities of ownership. For use of these shared cars, usually a monthly fee and/or fee per use is paid. Individuals typically access these vehicles by joining a commercial organization that maintains the fleet located in different spots around the city or region.

Most of the time, commercial operators provide roundtrip services, where the car has to be returned to its original location. This is not the case for peer-to-peer car sharing. In this case, individuals usually meet on an online platform and organize the sharing of a private car by themselves, but it is also possible to organize it without such platform (e.g. a group of friends or people who live in the same neighbourhood who share one or more vehicles (Greenblatt & Shaheen, 2015).

Booking a car in both schemes (free-floating and station-based) requires the use of an appropriate application or website. Some of the systems, mostly the station-based ones, provide in addition a booking service by phone, but this comes at an extra cost. Once a reservation is confirmed, there is no need for a key retrieval. For example, in the case of Cambio (Flanders, Brussels, Wallonia and Germany) the car can be opened using a slide button in the application. This only works when your reservation is active and you are in close proximity to the car, the same principle works for locking the car and ending your reservation (Cambio.be, 2020).

Same as with the bikes, a GPS is used to track the location of the vehicles, this provides real-time information about bookings, locations etc. for the provider and provides information for

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users. In the case of free-floating systems, the availability of real-time GPS data is crucial for users to locate the vehicle they want to use.

There are several benefits in car sharing schemes: first, there is a social profit for society, it provides people who do not have the financial means to own a car the possibility to use one occasionally. Secondly, it has a positive effect on congestion, on parking pressure, especially in cities and it also leads to a lower environmental impact of personal mobility (Litman, 2015). As was the case for bike sharing, shared cars are not available everywhere. Some areas, mostly rural, have no access to car sharing.

4.3.7 Demand responsive transit (DRT with online booking system)

Demand-responsive transport or transit (DRT) is a flexible mode of transportation that adapts to the demands of its user groups. In the past, it has been used primarily for its social benefits, increasing opportunities for people with limited mobility, or those who are socially marginalised (Interreg Europe, 2018). DRT can help solve the first and last mile issue, as part of a multimodal combination. For example, using DRT for the first mile can be combined with public transport for the rest of the trip, afterward one can use a shared bike to ride to the desired destination (Interreg Europe, 2018). DRT-systems have existed for a long time and mostly these used to be bookable by phone, but today almost all of the DRT make use of a digital interface, with the availability of real-time information. The reduction of the number of privately-owned cars and the support for more active, multimodal transport in urban, and lately more and more in rural areas, are some of the biggest advantages of using demand-responsive mobility services (Alonso-González et al., 2018).

4.3.8 Digital parking applications

Digital parking (smart parking) is a method developed for a more efficient parking policy in cities and carparks. It uses real-time data, mostly low-cost sensors and an application to enable users to observe the possible (un)availability of parking spots.

One technology which is easy and cheap in use is a wireless sensor network. A wireless sensor network (WNS) usually consists of a large number of nodes that are deployed in the sensing area and are equipped with different kinds of sensing, computation and communication units. These units enable WSN nodes to cooperatively collect, process, and transmit information to the database (Srikanth et al., 2009). Next to WSN, literature also suggests other possibilities to solve the parking problems in cities such as Internet of Things (IoT) and Radio Frequency Identification technology (RFID) (Abdulkader et al., 2018).

A simpler version that is still being used, are the digital screens along the road or at strategic places in a city, so visitors know in advance if there are any free parking spots and how many there are in specific parking garages. In a parking garage these applications can be combined with light-strips or other methods to indicate which exact spots are free, so driving around the parking lot, looking for that one free spot is not needed. The digital parking applications can save a lot of time for users, but also makes city traffic more fluent since useless driving around

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for parking lessens (Morelli, 2017). Currently some digital parking applications are available. Bepark[10] for example is a platform where car-owners can meet providers of parking space in their neighbourhood. The functionality of these digital services depends on the availability of real-time information in order to provide the service effectively.

4.3.9 Shared E-scooters and E-mopeds

The principles used for sharing both the scooters and mopeds are very similar to bike sharing schemes. For the most part E-scooters are being used as a free-floating service within urban areas. This means they can be dropped in the public space within the designated service area. For the E-mopeds the sharing scheme is mostly based on a round trip, station-based principle, where the user has to return the moped to the original station.

The availability of real-time information for free-floating e-scooters is similar to that of a free-floating bike-system, the provider needs constant updates about the location and use of the scooter. The user needs the location of a scooter so he or she can find and use it, but also the real-time information about availability can be useful. The information is provided via the application of the specific e-scooter provider and in many cases a QR-code is used to unlock the device with a smartphone.

The e-moped is mostly station-based so reservations are possible using an application or an interface at the docking station. Again, a GPS-tracking device is used so the provider of the moped is always aware of the location and who is using it.

4.3.10 E-ticketing

E-ticketing, which is used in public transport (for example) is gradually replacing the old tokens or paper tickets, which have been used for the last decades. In the beginning, E-ticketing was not very popular and mostly based on SMS to send tickets to users. But since the introduction of the internet and mobile applications, the e-tickets became wider in use (Mezghani, 2008). The service provides a paper-free and fast method to book your place on a bus, tram, train etc. and pay for your ticket.

4.3.11 Mobility as a Service

Mobility as a Service (MaaS) aims to restructure the mobility distribution chain, by creating mobility integrators which bundle all the offerings of providers and supply them to users as a single service. A digital platform creates and manages trips which users can pay for via a single

[10] http://www.bepark.eu/en/belgium

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account. A crucial part of MaaS is giving users the option to purchase MaaS products, such as monthly subscription plans, which best fit their need (Hietanen, 2016). Combining different transport modes in one app, might increase the use of less popular modes of transport such as car sharing by combining them with the more popular modes such as public transport (Headicar, 2009).

MaaS can be a very important factor for integrating different services, which can lead to multimodal mobility, as well as integration of information, booking, ticketing and payment, route planning, etc. Currently, users need different apps for different mobility services, this creates difficulties for many people. The integration of these services will take away many of those barriers. MaaS systems assume that all users have access to mobile internet, a smartphone and payment methods (credit or debit card or bank account that can be accessed electronically). Lacking any of these will result in a limited possibility to make use of this service. It should be considered that in order to achieve transport equity, these limitations must be addressed.

4.3.12 Route planners (multimodal and unimodal)

A route planner[11] can be considered as a specialized form of a search engine. It is a search engine that is used for finding the best way of travel between two or more locations, using one or more transport modes depending on the use of a multi- or unimodal planner (Li et al., 2012; Zografos et al., 2008). Most unimodal route planners focus on the use of private cars, but there are some which focus on one form of public or shared transport (e.g. carpool.be). Multimodal route planners also give the opportunity to combine both private and public transport methods, which gives the user a larger pool of possible means and routes of travel.

Both forms of route planning (unimodal and multimodal) can be used via a web browser or a smartphone application and, in most cases, real-time information is available. For the unimodal route planner with a focus on car use this information could be congestion, traffic jams or accidents. For multimodal route planners the information is available for multiple different modes.

Defining the best route in a route planner can mean several things, it can be the fastest, shortest, cheapest, or it can mean that the user can modify the trip according to his or her personal needs.

[11] Although there is a small difference between a route planner and trip planner, they are considered as similar in this analysis since they can both can be uni or multimodal.

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4.3.13 Ride hailing

A shared ride is considered ride-hailing when a rider "hails" or hires a personal driver to take them exactly where they need to go. The transportation vehicle is not shared with any other people, nor does it make other stops along a route. As the name suggests, one signals a taxi to stop (Ecolane, n.d.; Freed, 2015). In the past, this happened through a flag-down, or by calling an organisation providing this service, but more recently the preferred way to do this is by using an application to contact either a professional ride hailing organisations such as eCabs and Bolt, available in more than 150 cities (Bolt, n.d.) or by using a peer-to-peer platform such as Uber, which is already present in more than 700 cities worldwide (Uber, n.d.)

4.3.14 Ridesharing platform

Ridesharing, also referred to as carpooling, is the process in which a person shares a vehicle with other riders. It is not a personal form of transport, as the space in the vehicle is shared, and there is the possibility that the driver will make extra stops to pick up other people. Most of the current carpool schemes, apart from those with family, are used for commuting (Texas Transportation Institute, 2011). Those trips can be planned quite a while in advance, but with the introduction of online applications, last-minute trips can also be performed using ride sharing platforms. This concept is known as dynamic ridesharing, because of its real-time character. It aims to bring together people with similar itineraries and time schedules on short notice. Effective and efficient optimization technology that matches drivers and riders in real-time is one of the necessary components for a successful dynamic ride-share system.

A ridesharing scheme is frequently organized from within an organization as a service for their employees. An actual or digital meeting place is created to facilitate connecting riders and drivers. On a larger scale, outside one specific organization, such a scheme usually needs an online platform where both parties meet. Such platforms can be accessed using an application or the website provided by the operator.

There is not one specific way in which ridesharing or carpooling is organized. The information needed to share a ride, can be provided in real-time, but many of the rides are organized some time before they take place. On the platform 'carpool.be', for example, rides are organized in advance so commuting can happen in a more fluent manner.

This principle has strong societal benefits because it provides mobility to people who may not have a car, but also has environmental benefits by reducing the number of cars used for personal travel and improving the utilization of available seat capacity (Agatz et al., 2012).

There are some services that combine different forms of shared mobility. UBER X (car-sharing) and UBER Pool (ride-hailing) for example. This way UBER creates the possibility for the users to choose dynamically which service they prefer.

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4.3.15 Smart payment

Smart payment was applied in mobility to overcome the limitation of conventional payment methods by reinventing the payment method for parking meters and other older technologies (Faria et al., 2017). Smart payment uses information technology to complete payments. When using digital mobility services, smart payment is crucial to achieve fluent and fast service. There are several methods of smart payment: using your bank account app; using quick response payments (using QR-code); using digital wallets on smartphones, using remote credit card payment, etc. (Sorensen, 2018). Although most manners of smart payment happen using an application of the smartphone, smartwatch or a web browser, some providers also give the possibility to use smart payment on their ticket machines (e.g. in public transport).

4.3.16 Smart traffic lights

Currently many traffic light systems are quite old and based on outdated technology. These lights use pre-set time cycles which are based on "old" (not real-time) data, which most of the time does not present the current traffic flows at the junction. Real-time traffic lights use a dynamic control technology based on sensors embedded in the road (University of Calabria & SOMOS, n.d.).

4.3.17 On-demand goods delivery

On-demand goods delivery includes any form of freight, bookable using a digital platform, delivered using a car, a bike or a moped (electric or normal). This service is frequently used, especially in urban regions.

Users can order food from a very large database of restaurants and have it delivered at their door. Many of these services also have a specific way of delivery: Deliveroo, for example, guarantees its customers that the delivery would happen by bike, not by car. The delivery of goods such as electronics from online websites and the delivery of food from local restaurants are both becoming very large businesses. Companies like Uber are not only transporting people but also use bikes and mopeds to deliver food at the door. An application or a website is used in most cases to order the food. On-demand freight delivery at home is also very popular. People order goods using websites or applications as Amazon and Bol. During the Corona crises these methods are being used more frequently, both for ordering food and other foods at home (Van Oost & Vanacker, 2020).

4.3.18 (Automated) drone delivery

Automated drone delivery is a new way of delivering goods via air transport. The drone would fly by itself via pre-determined routes, but human supervision would still be necessary in case of problems (McFarland, 2019). Currently, (automated) drone delivery is not yet a viable option for freight delivery, but more and more organisations are starting to test the option of drone

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delivery for different kinds of goods (7-Eleven, Domino's, UPS, Airbus, DHL, Posti, Google Wing, and Swiss Post) (Business Insider Intelligence, 2020).
UPS and CVS are working together to deliver medicine faster, especially in more rural areas, where certain services are not easily available yet. Although many of the current developments focus on crucial aspects as medicine delivery, many other services could be performed using drones: small goods delivery, food delivery and delivery from and to difficult to reach areas. Drones can also provide freight delivery on an irregular basis (e.g. during wet season when roads are not accessible in some regions or in case of natural disasters or wars). Combined with mobile applications and connections, drones can deliver goods in difficult to reach areas much faster and in a more reliable way, compared to road transport. In urban areas these drones could help to relieve pressure on the transport network, this would provide a solution which is much cheaper than installing new road infrastructure and would also deliver goods faster in cities (Raptopoulos, 2013).

4.3.19 Crowd logistics platforms

Crowd logistics (CL) - sometimes also called crowd-shipping, crowdsourced delivery, cargo-hitching or collaborative logistics - is one of the many promising concepts considering a more sustainable freight transport (Buldeo Rai et al., 2017). Crowd logistics uses online platforms and mobile applications where demand and supply of mobility can meet.

Both individuals and firms are connected to peers, which can be defined as the group of individuals offering some form of transport (travellers, movers, etc.). A big difference with standard freight transport is that crowd logistics calls on individuals, mostly amateurs to perform these transport services (CSCMP's Supply Chain quarterly staff, 2018).

4.3.20 Smart boxes

Smart boxes or intelligent locker-systems are a new concept for package delivery or retrieval. A locker-station consists of a set of lockers, each with an electronically controlled door latch. The station also has an internal computer that controls the opening and closing of the locker based on different methods. The input/output method (quick response code, SMS-code, barcode, a smartphone, etc.) permits the control of the smart locker to deliver or retrieve a package. Depending on the type and brand of the locker, at least one courier-organization can deliver or retrieve its parcels in these lockers. Via electronic communication (SMS, QR-code, applications) the user can retrieve a package from the locker, after which the locker can be used for a new package (Torres & Suggs, 2015). Since the business to consumer market is growing exponentially, this is the most frequent use of these lockers. However, more and more systems also allow peer-to-peer delivery and retrieval of packages. There are several obvious advantages of these lockers, the decrease of missed package deliveries because residents are not at home, the decrease of single order deliveries and the decrease in couriers driving around the city (Lemke et al., 2016).

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4.4 Parameters for the evaluation of services

In order to evaluate the relevance of digital mobility services identified for the INDIMO project, we created a list of parameters. The list was compiled based on academic literature, previous EU projects (presented above), and the experience of experts at the MOBI research centre at the Vrije Universiteit Brussels as well as INDIMO partners.

The list of parameters is presented in Table 10 and all the parameters are explained in detail below.

Parameters for evaluation of digital mobility / freight services	
Current level of inclusion	Seamless connection between modes/ begin-to-end trip
Current level of accessibility	Financial feasibility
Future potential	Real-time information accessible
Availability of data on user needs	Level of co-creation in development
Transferability potential	Consumer service (person vs AI)
Sharing of mobility-data	Emotional, sensorial and cognitive effort
Level of personalized transport	Climate-/environmentally neutral
Comfort, ease-of-use	

Table 10: Parameters for evaluation of digital mobility/freight services

4.4.1 Seamless connection between modes

A seamless connection is a connection between two or multiple (mobility) options, which can take place without investing a significant effort by the user. A seamless connection seems obvious but is quite hard to achieve when using multiple different forms of mobility. Interchanges play a key role in the integration of the urban mobility system and in enabling good intermodal solutions. Their efficiency and sustainability are therefore essential to achieve sustainable transport objectives in Europe (UITP, 2014).

Seamless integration of different mobility services is not only difficult on a physical level, but also creates a lot of digital challenges. The most significant one is the difference of data-sources and the incompatibility of protocols (Willing et al., 2017). Many forms of public and shared mobility struggle with the first and last mile just because they lack the seamless connection to offer a complete trip from start to end. Seamless mobility is not only 'shared-mobility', it is the creation of blurred or non-existing boundaries between shared, private and

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public transport in which travellers have cheap, clean and flexible transport available (Hannon et al., 2019).

4.4.2 Current level of accessibility and inclusion

As defined in section 1.2.1.1, accessibility is generally described as the ease with which a transport user can access the interfaces that enable the use of digital mobility services. This is especially important for specific user profiles, i.e. persons with physical, visual, cognitive or auditory limitations. Ideally, digital mobility services should be universally accessible to people with all types of abilities rather than creating tailor-made applications that target specific user groups with specific limitations (e.g. a general purpose route planner versus a route planner developed for people with visual impairments).

The concept of inclusion as outlined in section 1.2.1.2 means we strive to be able to offer the same benefits to all layers of society. In recent years, several indicators for capturing inclusion issues in transportation have been defined. Among them, and probably most widely used, are those dealing with accessibility (Geurs and Van Bee, 2004, Páez et al., 2012, Di Ciommo and Lucas, 2019). By doing so, they can provide a comprehensive assessment of the accessibility 'service' received by the users (Martens, 2015). Therefore, they have long been introduced in the transportation planning literature as indicators of the quality of services (Ben Akiva and Lerman, 1979).

4.4.3 Future potential (critical mass)

The future potential of a mobility service is the potential to gather enough critical mass so the service is viable. Critical mass can be described as a mass of individuals and resources accumulated and directed toward the achievement of a collective goal so a service can be provided in a satisfying way for all its participants (Marwell & Oliver, 1993). Critical mass is not only an economic way of measuring if enough resources have been contributed to a specific cause so it is viable, but it also has a strong social affiliation. A critical mass is needed for 'social proof' and acceptance towards other potential users who might have been reluctant at first (Dillahunt & Malone, 2015). If a service does not have enough critical mass, it will be very hard to create a profitable business model. A lack of critical mass is one of the most important criteria which depict the viability of a service, especially with platforms for shared mobility it is crucial, and even more so for peer to peer services. It is very hard to match providers and consumers of a service if there are too few users. For urban freight delivery services (e.g. Uber Eats, Deliveroo, Amazon, etc.) critical mass is also very important. A critical mass of buyers will attract drivers and vice versa: a critical mass of drivers will ensure a fast-qualitative service that will attract the buyers (Qi et al., 2018).

4.4.4 Availability of user data

The availability of user data means two things. Firstly, the operator, the authority or another organization should gather data. Secondly, the data must be available. If the responsible

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organization does not want to share the data, there is not much that can be done. If there is good data available about a certain mobility service, then this provides us with crucial information about the use of the service, and on the users (e.g. why do they use this service, how do they pay for the service etc.). This data is important for real time decisions as well as for longitudinal research (e.g. analyse which changes had a positive or negative effect on usage, accessibility and or inclusion). However, the data collection, storage, protection, retention, destruction, privacy and safeguarding of rights of data subjects must comply with national and EU legislation on data protection and privacy, General Data Protection Regulation (EU GDPR).

4.4.5 Potential for transferability and modularity

Transferability describes the process of applying the results of research of one situation to other similar situations. The key idea about transferability of measures from one city or region to another is that such transfers can be predicted with a detailed understanding of its enabling context. The compatibility of context, not on a macro level, but much more specifically, is pivotal in successful transfer of measures.

Depending on the difference between two cities or regions, there may be need for a certain amount of adaptation so that certain services can be introduced in a successful way. For mobility services there can be a lot of difference in the way in which a service has to be modified to fit in another setting. The transferability of services is very important for INDIMO that wants to create universal guidelines for digital mobility services.

4.4.6 Sharing of mobility data

Sharing mobility data, such as travel time delays and usage of the services, can help different actors in the mobility landscape. First, it provides data for researchers to analyse the situation and suggest adaptations. Second, different forms of services can be made complementary based on the accessible data (Opendatasoft, 2018). Sharing of mobility data has some similarities with criteria such as ‘user data’ and ‘seamless mobility. Sharing mobility data among providers and operators is considered crucial in order to achieve seamless mobility solutions and therefore is mentioned as a separate criterion.

Sharing of mobility data is already happening, but on a very low level. Most new mobility providers (from public transport to peer-to-peer sharing platforms) do not like to share data about the usage of their service. The reason for this lack of sharing of information may be due to competition among different operators where any data that gives information about the revenues, success and failure is deemed confidential. In addition to that, many mobility providers might not want to share their specific information about usage, services, delays etc.

4.4.7 Level of personalized transport

Personalization can be described as a process that changes the functionality, interface, information content, or indistinctiveness of a system, which can be a system of providing services or goods, to increase its personal relevance to an individual (Blom, 2000). From a

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provider's point of view, personalization is largely driven by the expected benefits one to one relations with users have (Vesanen, 2007). Personal forms of transport are very popular, the European car fleet consisted of 248 million cars in 2014, in 4 years this amount increased with 8%, to 268 million cars (ACEA, 2019). One of the main reasons for this popularity can be explained by the degree of personalization. People experience a sense of freedom while using private modes of transport. That sense of freedom might however be rather limited. Imagine taking your car out of a city during peak hour, in this case your freedom is limited to standing still in traffic jams. This indicates that if people can at least choose the mode by which they travel, their experience will be rated higher. The rise of smart mobility can have a significant impact on the way in which travel is personalized. There is an increase in digital services which give the user the opportunity to choose between a range of services that can make the trip a better fit to the demands and expectations of the users. A disadvantage of the rise of personalized transport is the complexity. Producing personalized services is much more complex and creates more problems for standardisation with other present mobility services.

4.4.8 Comfort and ease-to-use

'Comfort' and 'ease-to-use' are among the most mentioned aspects which determine modal choice in mobility research. Comfort and convenience are considered two of the main advantages a private car has compared to other transport modes. This explains why the use of a private car still remains the most popular for transport (Chng et al., 2019; Sopjani et al., 2020). Research into the smart card, as precursor for a MaaS-system, showed that changes in mobility patterns can, in 90% of the cases, be brought back to increasing ease of use and comfort. The main reason why the ease of use of public transport and other sustainable options increased was because of the reduction in ticket purchasing time caused by the integration of ticket- and payment integration (Kamargianni et al., 2016). In the INDIMO-project it is considered crucial to make the digital mobility services easier to use and thus more comfortable.

4.4.9 Climate/environmentally neutrality

Environmental awareness is becoming more and more apparent among the younger generations, which can, for a part, explain the decline in car ownership in developed countries (Hopkins, 2016). Research has shown that climate awareness is not the largest contributor to modal choice, although some mobility choices might be linked with a person's view on the environment. Most of the time there are many other factors such as travel time, cost and comfort which have a much larger influence on modal choice (Simons et al., 2013, 2014).

There is already some research which states that environmental awareness is a motivator to overcome certain services' difficulties in use (Cheng & Chen, 2015). It means that, although the environment has some influence, it currently does not motivate enough for a change in modal choice, but other factors do. However, it cannot be ignored that in modern society, the environmental awareness, especially among young people, is growing. It is anticipated that in the future, the influence of this criterion will gain influence and therefore climate awareness is considered a criterion in this project.

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4.4.10 Financial feasibility

The financial feasibility is the degree to which a concept, program, company or service is financially possible and attractive. It is in the interest of the project to select mobility services, which have a certain degree of financial feasibility or health. Only if services have entered the market very recently it is not possible to make an evaluation based on this criterion. This however does not mean that a service or provider has to be profitable to have future potential.

Services which are not profitable now but have high potential to be so in the future, will also be analysed in this framework. It is most likely that many of the services provided are not yet financially feasible since they are still immature in a very variable and young market (e.g. a lot of the shared mobility providers in Flanders, Belgium are not making any profit yet). Table 11 shows that, except for Cambio, which has had break-even results since their start, none of the other providers make profits in Belgium (Vanacker, 2019).

New mobility services appear in the market as quickly as they disappear. Significant scale is needed for a ride-hailing platform to be profitable and sustainable in the longer term. Ride-hailing platforms need fresh cash to finance their customer and driver expansions and secure the required technological development to drive differentiation in competitive markets. Significant scale is needed for a ride-hailing platform to be profitable and sustainable in the longer term. Ride-hailing platforms need funds to finance their customer and driver expansions and secure the required technological development to drive differentiation in competitive markets. Aggressive growth strategies require large amounts of liquidity due to the high “cash-burn”. That is why many new mobility services have large companies or investors behind financing it, but no one has found a sustainable business model yet. Not only Belgian smart mobility providers are suffering financially, worldwide, even the largest providers have a very hard time turning a profit. Uber reported losses over 5 billion in the three months preceding august 2019, Lyft fared better but still lost over 500 million in the same period (Hawkins, 2019).

As described above, it is not possible to select only services which already turn a profit or which are at least break-even.

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Operator	Net profits /-losses	Losses carried forward	Number of cars	Number of users	Cities
Cambio Flanders	0,5	/	727	21 000	40 cities
Cambio Brussels	0,1	/	527	15 500	Brussels
Cambio Wallonia	01,	/	112	2 500	12 cities
Bolides**	-0,3	-1,4	15	1 000	Antwerp
Zencar**	-0,9	-5,6	86	3 000	Brussels
Ubeqo*	-2,2	-4,2	/	/	Brussels
Zipcar*	-2,7	-4,3	/	/	Brussels, Antwerp
DriveNow***	-2,9	-8,4	310	26 000	Brussels & 13 cities
Poppy**	-4,6	-4,6	285	20 000	Brussels
Total	**-12,9**	**-28,5**	**2062**	**89 000**	

(in million euros, 2018)

Table 11: Profits of car sharing in Belgium (Source: www.tijd.be)
***Stopped; **Downsized; ***Merged**

4.4.11 Affordability of digital mobility services

Affordability refers to the 'financial burden households bear in purchasing transportation, particularly those required to access basic services and activities such as healthcare, shopping, school, work and social activities' (Litman, 2017). Many of the urban transport evaluations do not take affordability of a modal option into account. An evaluation is mostly based on the travel-time principle, which is considered the principal economic benefit for urban transport projects (Cervero, 2011).

Digital mobility services will have a major impact on mobility and on the sustainability aspect, but it is important to keep in mind that these services have to be inclusive. Therefore, affordability will be a crucial concept, it will be pivotal to avoid conflicts between the sustainability-argument and its economic counterpart. It is very important to maintain affordable mobility so also the less economically strong social groups maintain access (Gohla-

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Neudecker et al., 2013). The affordability should have a big influence on inclusiveness, both physical and digital inclusiveness will increase if the digital services are more affordable (Poynder, 2014). Research in Madrid has shown that examples such as road pricing have an effect on the way mobility is conducted but has a significant higher impact on unskilled and lower income individuals (Lukas et al., 2015). This vision on accessibility created a renewed perspective, the accessibility of people instead of the accessibility of places (Neutens, Schwanen, Witlox, & De Maeyer, 2010). If this approach is considered, then the financial aspect should have a far greater impact when measuring accessibility.

If applied in a proper manner, measuring affordability can lead to re-evaluation of digital mobility and result in adopting equitable mobility services.

4.4.12 Access to real-time information

Real-time multimodal information is becoming more and more apparent in contemporary mobility. Almost all forms of public transport provide real-time information at their stop, on their applications and websites. Also, many of the smart mobility-services provide constant updates about location and availability of the service. Services providing this real-time information are increasingly interesting for cities as potential means to manage mobility of people and freight (Pronello et al., 2016, 2017). It is expected by a lot of policy makers that these services will help the shift from unimodal car use to multimodal, more sustainable mobility (Pronello et al., 2016). Nevertheless, research shows that, for most daily trips, the access to real-time information has little or no effect on the way people behave. Use of public transport on the other hand is affected by the accessibility of real-time information, although not many comprehensive studies have been done to assess the size of the impact of data on public transport use (Abdel-Aty, 2002). For occasional trips, the results differ, people tend to use more multimodal mobility options (Pronello et al., 2016). There is not enough information about the actual effects real-time information has on travel behaviour. However, with a rise in multimodal digital mobility services it is certain that accessibility of information for users will have a significant impact on the way we move. For delays and cancellations, the presence and accessibility of this information is crucial.

4.4.13 Co-creation & participation

Co-creation is the concept where a development process is not only done by the developers, but significant user input is also considered. For this project, the possibility for co-creation of certain services can provide the developers with a better view of the user expectations. The product/service tends to be more in line with the users' expectations. The process of co-creation is important within the INDIMO-project, because, if done correctly, it will create a more inclusive product or service. In general, co-creation increases user-acceptance. If people feel being left out, there is a greater chance for resentment towards a measure. The Mobility4EU project, and many others, suggest stakeholder-involvement to co-create new tools or measures. Co-creation processes are often also digitally accessible, via an online platform, so a significant number of possible stakeholders can be reached, this will also be the case

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during the INDIMO-project. In the Netherlands, it is mandatory for larger cities (e. g. Amsterdam, Rotterdam) to discuss their plans for mobility with different user groups. These digital platforms are used as well when looking for people to test new trains or buses (for example Mobility4EU, 2018; Gabrielli et al., 2014). Therefore, for both the users and the providers it is in their common interest to take part in a co-creation process.

4.4.14 Customer service

Costumer service is the possibility for users to get in contact with the service provider or operator. If people use a digital service they have never used before, problems are likely to occur. In that case the possibility to call a helpdesk can provide people with the help needed. There is a chance that, if the help is not available, people will quit using the services immediately. For the INDIMO-project, it is crucial that users experiencing problems using a service could receive assistance.

The Belgian branch of the car sharing company 'Cambio', for example, has several people operating a service not only for complaints and requests, but also for reservations, whereas these are possible also via a web browser or application. They still provide this service because many older people who use Cambio are more inclined to use the telephone customer service if they can. For other groups in society, who have less access to these services, a service provided by a person has a significant influence on the ability to use the service. During the last few years, another type of helpdesk has emerged: a service desk where a Chatbot answers questions of users. This approach is more inclusive since an AI can understand many more languages and also does not have any cultural barriers. At the same time, the questions a Chatbot can answer and the processes they can carry out are still quite limited. Nevertheless, it is expected that in the future, many more AI-based user service desks will be integrated.

4.4.15 Emotional, sensorial and cognitive effort

Designing mobility services for all types of people, including people with physical, sensory or cognitive disabilities, implies considering all the sensory, affective and cognitive elements, which underlie cognitive and behavioural processes. The effort invested in the use of a new service differs between users with different characteristics and it may have an effect on the inclusion of a digital service.

4.4.16 Cybersecurity

Privacy and protection of user information has become a significant issue in the last few years. The question of the level of cybersecurity a digital service provides, may affect user behavior and the willingness to use a service. Therefore, this aspect has an important role in the future of digital mobility services.

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4.5 Evaluation of digital mobility services

Creating the list of existing and relevant digital interconnected transportation services (Table 8) and defining the criteria for evaluation of the services' suitability to INDIMO goals (Table 10), enable us to create a status analysis and compare the different systems based on the above criteria.

4.5.1 Providing weights for parameters

As described in the methodology section (4.2), before starting evaluation of the services, the project partners rated the relative importance of each parameter. The weights of the parameters are presented in Table 12.

Parameter	Weight
Current level of inclusion (sum of score 'Universal design')	1,0
Seamless connection between modes/ begin-to-end trip	0,9
Current level of accessibility	1,0
Future potential (critical mass)	1,0
Availability data on user needs (user focused)	0,7
Transferability potential (& interoperability)	1,0
Sharing of mobility-data (service focused)	0,3
Level of personalization of transport	0,7
Comfort, ease-of-use	1,0
Climate-/environmentally neutral	0,3
Financial feasibility	1,0
Accessibility of real-time information	0,8
Level of co-creation in development (crowdsourcing)	0,2
Customer service (person vs AI)	0,4
Emotional, sensorial and cognitive ease of use	1,0
Cybersecurity (may leave blank if not applicable)	1,0

Table 12: Parameter weights

4.5.2 Evaluation of digital mobility services

20 mobility experts from the INDIMO project and the VUB MOBI Research Centre evaluated each of the digital services by the weighted parameters[12]. The partners' evaluations on each parameter

[12] Likert scale ranging from 1 (very bad) to 5 (very good)

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were averaged and multiplied with the weight of the specific parameter to create a parameter score.

Table 13 presents the average parameter scores of each digital mobility service. This evaluation will enable WP1 and WP3 partners to compare services according to one or more parameters. Later on, as more data will be gathered from users, non-users, developers, operators and policy makers – the integration with this evaluation may provide a deeper understanding of the use of a digital mobility service.

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Weights	1,0	0,9	1,0	1,0	0,7	1,0	0,3	0,7	1,0	0,3	1,0	0,8	0,2	0,4	1,0	1,0
Digital services / Criteria (score 1 to 5: very bad - bad - neutral - good - very good)	Current level of inclusion (sum of score 'Universal [illegible] * AVG	Seamless connection between modes/ begin-to-end trip* AVG	Current level of accessibility * AVG	Future potential (critical mass) * AVG	Availability data on user needs (user focused) * AVG	Transferability potential (& interoperability) * AVG	Sharing of mobility-data (service focused) * AVG	Level of personalization of transport* AVG	Comfort, ease-of-use	Climate-/environmentally neutral* AVG	Financial feasibility* AVG	Accessibility of real-time information* AVG	Level of co-creation in development (crowdsourcing) * AVG	Consumer service (person vs AI) * AVG	Emotional, sensorial and cognitive ease of use * AVG	Cybersecurity (may leave blank if not applicable) * AVG
MaaS	3,9	4,4	4,0	5,0	3,5	5,0	1,3	3,4	4,9	1,3	3,8	3,8	0,7	1,7	5,0	3,0
Automated drone delivery	3,9	3,9	2,0	5,0	2,8	3,5	1,0	3,4	4,9	0,9	3,3	3,4	0,4	1,3	4,0	3,0
Freight delivery drone	3,9	3,9	2,0	5,0	2,8	3,5	1,0	3,4	4,9	0,9	3,3	3,4	0,4	1,3	4,0	
On demand human-driven vehicles (bus)	4,3	3,1	3,0	4,0	2,1	4,0	0,8	2,7	4,4	1,3	3,8	3,4	0,6	2,1	3,0	
(E-)Bicycle freight delivery Madrid	3,8	3,9	3,0	5,0	2,1	3,5	1,0	2,7	3,9	0,6	3,8	2,3	0,4	1,7	4,0	
Ridesharing Galilee Berln	3,2	3,5	3,3	4,8	2,3	4,3	0,8	2,5	3,9	0,8	2,5	3,0	0,5	1,5	3,7	3,3
Active traffic management	2,6	3,5	2,5	4,5	2,8	4,0	1,0	2,7	4,4	0,8	2,9	3,4	0,4	1,3	4,0	3,0

Weights	1,0	0,9	1,0	1,0	0,7	1,0	0,3	0,7	1,0	0,3	1,0	0,8	0,2	0,4	1,0	1,0
Digital services / Criteria (score 1 to 5: very bad - bad - neutral - good - very good)	Current level of inclusion (sum of score 'Universal [illegible] AVG	Seamless connection between modes/ begin-to-end trip* AVG	Current level of accessibility * AVG	Future potential (critical mass) * AVG	Availability data on user needs (user focused) * AVG	Transferability potential (& interoperability) * AVG	Sharing of mobility-data (service focused) * AVG	Level of personalization of transport* AVG	Comfort, ease-of-use	Climate-/environmentally neutral* AVG	Financial feasibility* AVG	Accessibility of real-time information* AVG	Level of co-creation in development (crowdsourcing) * AVG	Consumer service (person vs AI) * AVG	Emotional, sensorial and cognitive ease of use * AVG	Cybersecurity (may leave blank if not applicable) * AVG
Adaptive, flexible lanes (peak hour)	2,9	3,5	3,0	4,5	2,1	4,0	0,8	2,7	4,4	1,0	2,9	3,0	0,4	1,7	4,0	3,0
Multimodal route planner (Google maps, Mappy)	3,0	3,5	3,8	4,3	2,7	4,3	1,0	2,7	3,9	0,7	3,4	2,8	0,5	0,9	3,4	2,5
Unimodal route planner (Waze, TomTom, Routenet)	3,2	2,0	2,8	4,3	2,8	3,3	0,8	2,9	4,4	0,3	4,0	3,0	0,5	1,0	4,3	3,3
Smart traffic-lights Antwerp	3,0	2,3	2,3	4,3	2,1	3,7	0,8	2,7	3,9	1,1	2,9	3,3	0,5	1,5	4,0	3,0
Smart Payment	3,4	3,1	3,0	4,7	1,8	4,0	0,8	2,0	4,6	0,8	2,9	2,6	0,5	1,3	3,0	3,0
Bike sharing (free-floating)	2,5	3,5	2,5	4,5	1,9	3,8	0,9	2,4	2,9	1,1	2,9	3,3	0,6	1,1	3,7	1,5
Bike sharing (station based)	2,5	2,6	3,0	4,3	1,6	3,8	0,8	1,7	2,6	1,2	3,8	3,2	0,5	1,2	3,8	2,3

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Weights	1,0	0,9	1,0	1,0	0,7	1,0	0,3	0,7	1,0	0,3	1,0	0,8	0,2	0,4	1,0	1,0
Digital services / Criteria (score 1 to 5: very bad - bad - neutral - good - very good)	Current level of inclusion (sum of score 'Universal [illegible] AVG	Seamless connection between modes/ begin-to-end trip* AVG	Current level of accessibility * AVG	Future potential (critical mass) * AVG	Availability data on user needs (user focused) * AVG	Transferability potential (& interoperability) * AVG	Sharing of mobility-data (service focused) * AVG	Level of personalization of transport* AVG	Comfort, ease-of-use	Climate-/environmentally neutral* AVG	Financial feasibility* AVG	Accessibility of real-time information* AVG	Level of co-creation in development (crowdsourcing) * AVG	Consumer service (person vs AI) * AVG	Emotional, sensorial and cognitive ease of use * AVG	Cybersecurity (may leave blank if not applicable) * AVG
On demand autonomous vehicles (collective or individual)	3,3	3,2	2,3	3,7	1,8	3,3	0,8	2,7	4,2	0,6	2,2	3,0	0,5	0,9	4,0	2,3
Carsharing (station based)	3,2	2,8	2,5	4,0	2,1	4,5	0,6	2,5	3,4	0,4	1,9	2,8	0,6	1,3	3,0	3,0
Carsharing (peer to peer)	3,7	2,3	3,3	4,0	2,1	4,0	0,8	2,0	3,3	0,5	2,9	1,9	0,5	1,3	3,0	3,0
(E-) Moped goods delivery	3,6	3,1	2,0	3,5	2,1	3,5	0,5	2,7	2,9	0,4	3,3	2,3	0,4	1,3	4,0	
Carsharing (free floating)	3,0	2,6	2,3	3,8	1,9	4,5	0,8	2,4	3,4	0,5	1,9	3,3	0,5	1,3	3,0	2,3
Automated vehicles	3,6	3,5	2,0	4,0	1,4	2,5	0,5	3,0	4,4	0,3	1,9	3,4	0,2	0,4	3,0	2,0
E-scooter sharing (free floating)	2,8	3,2	2,4	3,6	1,2	3,4	0,6	2,3	2,7	0,7	3,0	3,4	0,4	1,0	3,3	2,0

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Weights	1,0	0,9	1,0	1,0	0,7	1,0	0,3	0,7	1,0	0,3	1,0	0,8	0,2	0,4	1,0	1,0
Digital services / Criteria (score 1 to 5: very bad - bad - neutral - good - very good)	Current level of inclusion (sum of score 'Universal [illegible] AVG	Seamless connection between modes/ begin-to-end trip* AVG	Current level of accessibility * AVG	Future potential (critical mass) * AVG	Availability data on user needs (user focused) * AVG	Transferability potential (& interoperability) * AVG	Sharing of mobility-data (service focused) * AVG	Level of personalization of transport* AVG	Comfort, ease-of-use	Climate-/environmentally neutral* AVG	Financial feasibility* AVG	Accessibility of real-time information* AVG	Level of co-creation in development (crowdsourcing) * AVG	Consumer service (person vs AI) * AVG	Emotional, sensorial and cognitive ease of use * AVG	Cybersecurity (may leave blank if not applicable) * AVG
Smart boxes (Emilia –Romagna)	3,2	3,1	2,5	3,5	1,4	2,5	0,5	2,0	3,9	0,8	2,9	2,6	0,4	0,4	3,0	3,0
E-moped (shared)	2,2	3,2	2,0	3,7	1,4	3,7	0,6	2,3	2,6	0,8	2,5	3,0	0,5	0,9	2,5	2,5
Crowd Logistics	2,4	1,8	1,5	4,0	2,1	3,0	0,8	1,4	2,4	0,9	3,3	3,4	0,7	1,3	3,0	

Table 13: Evaluation of digital mobility services

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5.Scope of WP1 Data Collection

The first step of User-Centered Design is to know users (Beyer et al., 1998, Bridger, 2009; Holtzblatt, 2005). There are various methods of user research (e.g. interviews, focus groups, ethnography, etc.), yet they all have similar goals, as defined by Schumacher (2010, p.6):

> *"User research is the systematic study of the goals, needs, and capabilities of users so as to specify design, construction, or improvement of tools to benefit how users work and live".*

Knowing the users in terms of their goals, needs and capabilities – as well as their tasks and environment/ life context – and exploring their limitations, constraints and challenges is critical for developing accessible and inclusive digital mobility services.

Along with gathering information about users, collecting data from developers, operators, policy makers and users' stakeholder groups - people who develop, operate and deploy the service - is equally important. Understanding the challenges and difficulties in development and deployment of a digital mobility service is very significant in terms of viability of the service and its ability to evolve towards a higher level of inclusion.

The following sections describe in detail what dimensions of information will be collected from end users (section 5.1) and from developers, operators and policy makers (section 5.2).

5.1 Scope of End-User Information Collection

The following section defines the scope of end-user data collection. It includes the description of the specific type of "objects" to be investigated and the dimensions that will be used as reference to collect data.

5.1.1 Overview: four important aspects of the end user data collection

End-user data collection aims at understanding users' goals, needs, preferences and capabilities, as well as their difficulties, challenges, limitations and constraints (Holtzblatt, 2005; Schumacher, 2010) when using digital mobility services. Yet, in order to develop the INDIMO Inclusive Digital Mobility Toolbox for inclusive digital mobility services, it is recommended to collect information not only from **actual users**, but also from people who fit the users' profiles, but **do not use** these services for a variety of reasons. Collecting information from **both users and** (profile fit) **non-users** will enable comprehensive and in-depth understanding of the context of use and the potential of inclusion.

An important aspect of the data collection is the object of use. A digital mobility service has a **digital interface** and a **physical interface**. Each interface has different characteristics that may sometimes be incompatible. For example, a service like ride sharing can have an accessible digital application for people with disabilities. However, the ride itself (in a private owner car) may be not accessible to people with disabilities. This complexity requires us to collect

information from users on **both the digital interface and the physical interface** of the mobility service to capture all its aspects and make sure they are accessible and inclusive to all members of society.

Another relevant aspect is the **type of digital mobility service**. There exist a large variety of services, as described in section 4. Each of them has different characteristics, e.g. travel planning, freight delivery and smart traffic light systems are very different services. Accordingly, the information gathered from users on each of them will be partially different. In some cases, the differences between services may seem to outweigh their commonalities. However, as our goal is to develop the INDIMO toolbox including a Universal Design Manual for digital transport systems and a Universal Interface Language Icons, different services need to be considered.

The last essential aspect to take into consideration concerns the **different stages of the service use**. In a specific ride sharing service, for example, the travel process includes travel planning using a digital application, request to join a ride, receive approval/rejection, actual ride with a driver, payment and post-travel activity. Another digital mobility service, e.g. the freight delivery has a completely different process. It includes freight selection using a digital application, filling of a shipping address and other information, payment, tracking of the shipping process, receiving the freight, opening and checking the freight and returning the freight if needed. These differences underline the importance to collect data about the entire process, since this is the way to understand what is shared between different services and what is different, thus creating the INDIMO toolbox that fits the complex reality.

5.1.2 Dimensions of information collection

As customary in global user research (Holtzblatt, 2005; Schumacher, 2010), the end-user data collection will relate to their goals, needs, tasks, difficulties, capabilities etc. when using a digital mobility service. In addition, parameters that are relevant to the use of digital mobility systems will be also included. They are ease of use, access to technological equipment (hardware) and to technology (software), willingness to adopt new technologies, etc.

Table 14 presents in detail dimensions leading the data collection. It includes explanation and examples of each of them. Dimensions are general and therefore create a general framework of data collection. To the original list, we added a dimension exploring the perception of the digital mobility service's resilience to crisis, like Covid-19.

This framework can be easily adapted to explore users' (or profile fit non-users') needs when using different types of digital mobility services. Therefore, each of the pilot projects and case studies should adapt this framework to the specific digital mobility service and its user profiles.

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#	Dimension[13]	Explanation and Examples
1	Goals /purposes/ value of using the service (*) For profile fit non-users – ask to assume	A goal is the object of a person's ambition or effort, an aim or desired result. Goals differ from needs. Examples: Goals that the user wants to achieve using the service Activities that the service supports The value or advantage of using the service Integration of service into daily life Impact on other areas of your life Etc.
2	Accessibility and inclusion: reasons for not using the service (for profile fit non-users only)	The non-user avoids using the service due to (examples): • Permanent disability • Older age - physical /cognitive/ emotional barriers to use service • Lower level of education • Lack of digital skills • Language barrier • Bad service design • Bad reliability (service not running/ poor quality of info…) • Etc.
3	Needs (*) For profile fit non-users – ask to assume	A need is what a user wants or requires as a necessity. Needs differ from goals. Examples: • User's needs that the service should address (e.g. the user needs to do some tasks) • User's needs related to the physical interface of the service • User's needs related to the digital interface of the service

[13] This order of dimensions is a recommendation. It can be changed to adapt to the needs of each pilot project/case study.

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#	Dimension[13]	Explanation and Examples
		• Etc.
4	Description of the workflow when using the digital mobility service	A description of the use of the service by the user. Examples: • Entire workflow description (including both physical and digital aspects of the use) • Scope of use (weather all features of the service are used or just specific features). This is an important item: we may find that vulnerable to exclusion users are using similar features beyond the services. • Compatibility between the physical part and the digital part of the service • Etc.

5	Usability of the service's digital interface	Usability concerns the effectiveness, efficiency and satisfaction with which users achieve specified goals through the service.
		Examples:
		• Ease of use
		  • Clear interface
		  • Easy to learn and use
		  • Workflow (begin to end) logical and adequate to the process of use
		  • Etc.
		• Human computer interaction style
		  • Availability of instructions regarding the recommended order of actions
		  • Feedback provided in accordance with user actions
		  • Decision support
		  • Etc.
		• Accessibility and inclusion
		  • Adjustments for supporting vulnerable to exclusion target groups (older age, language barrier, lack of digital skills)
		• Tolerance for errors

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#	Dimension[13]	Explanation and Examples

		• Interaction with service agents (e.g. drivers, delivery person, rental agency)
		  • Convenient coordination interface
		  • Intuitive within-application
		  • An option for direct contact provided
		  • Etc.

6	Usability of the service's physical interface	Usability concerns the effectiveness, efficiency and satisfaction with which users achieve specified goals through the service.
		Examples:
		• Ease of use
		  • Convenient location
		  • Easy to use
		  • Etc.
		• Accessibility and inclusion
		  • Adjustments for supporting vulnerable to exclusion target groups (older age, language barrier, lack of digital skills, cultural barriers)
		• Interaction with service agents (e.g. drivers, delivery person, rental agency)
		  • Intuitive
		  • The nature of the interaction is defined according to the process and is clear to both parties
		  • Etc.

7	Skills / capabilities (*) For profile fit non-users – ask to assume	The skills/ capabilities of the user in relation to the use of the service. There is link between skills and use demands: the skills allow the user to meet some of the use demands. Examples: • Digital skills • Knowledge • Languages

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#	Dimension[13]	Explanation and Examples

		• Read a map
		• Terminology
		• Cognitive skills
		• Level of education
		• Physical abilities
		  • Physically fit (able to walk for a distance, go down the stairs, carry freight, etc.)
		  • Visual ability
		  • Etc.

8	Difficulties, limitations, challenges and constraints (*) For profile fit non-users – ask to assume	The difficulties, limitations, challenges and constraints of the user in relation to the use of the service (examples): • Difficulties (etc.) related to the physical interface of the service (infrastructure, safety, availability, connivance, etc.) • Difficulties (etc.) related to the digital interface of the service (hardware, software, connectivity, cyber security, etc.) • Biggest pain point related to the use of this service Etc.

9	User's perception of the service use demands and their ability to meet the demands
	
	(*) For profile fit non-users – ask to assume
		The user's perception of a service use demand refers to the user's impression of the requirements for using the service (it does not always conform to actual demands).
		There is a link between use demands and skills: the skills allow the user to meet some of the use demands. For each demand, verify the user's ability to meet the demand. Examples:
		Physical service demands:
		• Location of physical service
		• Means to reach the service
		• Etc.
		Digital service demands:
		• Technical and technological demands:
		  • Devices types
		  • Connectivity

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#	Dimension[13]	Explanation and Examples

		• Software
		• Mobile data
		• Energy consumption
		• Etc.
		• Cognitive demands:
		  • Coping with high cognitive load
		  • Multitasking
		  • Drawing conclusions
		  • Etc.
		• Financial demands:
		  • Payment methods (credit card, mobile payment, bank transfer)
		  • Medium - high income (affordability)
		  • Etc.

10	Self-use, assist other or group use (*) For profile fit non-users – ask to assume	This dimension refers to an aspect of the use scenario: self-use, assist other or group use, and its impact on the manner of use. Examples: • self-use / use to assist other person / use as a part of a group • Impact on the manner of use • Independent use versus cooperation or teamwork • Social value (if there is) • Impact on physical interface of the service • Impact on the digital interface of the service • Etc.
11	Perception of personal data privacy and security (*) For profile fit non-users – ask to assume	The user's perception that personal data are treated respecting privacy and security issues. Examples: • Security of personal data in the digital interface of the service • Payment details security • An option to control the visibility of your personal data • Etc.

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#	Dimension[13]	Explanation and Examples
12	Safety perception (*) For profile fit non-users – ask to assume	The user's perception of the safety of use. Examples: • Safety of the use of the physical interface of the service • Compliance with safety regulations (e.g. driver license, vehicle insurance) • Etc.
13	Perception of the service's resilience to crisis like Covid-19 (*) For profile fit non-users – ask to assume	User perception of the service resilience. Examples: • Service changes during the crisis • Different user needs because of the crisis • Advantages/ disadvantages of the service during the crisis • Return to service routine after the crisis • Suggested changes • Etc.
14	Attitudes, feelings/ emotions, preferences and opportunities (*) For profile fit non-users – ask to assume	User attitudes and feelings towards the service. Examples: • Meeting expectations • Emotions (e.g. satisfaction, frustration, isolation, etc.) • Trust (in the service and the service providers) • Advantages/ Disadvantages • Suggested changes • Willingness to use the product frequently • Alternative preferred services • Etc.

Table 14: Dimensions informing end-user information collection

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5.2 Scope of Information Collection from Developers, Operators and Policy Makers

Developers of digital mobility services are engaged in the creation of the future digital mobility solutions. Their vast experience in the design of such systems goes beyond the technical solution. They are an essential part of the product definition and the design of its user experience.

Operators of digital mobility services and platforms are responsible for the various aspects of service deployment, from marketing of the service, through day-to-day operations, regulation and safety, prioritisation of resources, personnel management, customer service, etc.

Policy makers can exploit the full potential of digital transport systems to deliver inclusive mobility by promoting initiatives, policies and regulations that encourage the expansion of use to vulnerable populations.

It is essential to include these stakeholders in the co-creation process of the digital mobility deployment toolkit (and specifically the INDIMO policy evaluation tool for policymakers). This will ensure that guidelines and tools developed in the INDIMO toolbox will reflect the needs of these stakeholders in the best possible way.

The following section defines the scope of the data to be collected from developers, operators, and policy makers. Table 15 presents the dimensions guiding the data collection. They create a general framework for the data collection. To the original list of dimensions, we have added a dimension that explores the perception of the digital mobility service's resilience to crises like Covid-19.

This framework can be easily adapted to explore developers, operators and policy makers' needs and challenges of different types of digital mobility services. Therefore, each of the case studies should adapt this framework to the specific digital mobility service explored.

The gathered information will enable understanding the process of development and deployment of digital mobility services including its barriers and difficulties in general and in relation to inclusion and accessibility aspects.

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#	Dimension[14]	Examples
1	Perception of the value of the service to the users	• The developer's perception • The operator's perception • The policy makers' perception
2	Reasons for not using the service	• Permanent disability • Older age - physical /cognitive/ emotional barriers to use service • Lower level of education • Language barrier • Etc.

3	Needs addressed by the services	• User's needs:
		  • User's needs related to the physical interface of the service
		  • User's needs related to the digital interface of the service
		• Municipality needs
		• Etc.

4	Service characteristics	They refer to both physical and digital interfaces of the service: • Ease of use • Adequate workflow • Compatibility of physical and digital interfaces • Cyber security and personal information privacy • Safety of use • User support • Interaction of users and service agents (e.g. drivers, delivery person, rental agency) • Tolerance for errors • Etc.
5	Demands from users	• Physical demands

[14] This order of dimensions is a recommendation. It can be changed to adapt to the needs of each case study.

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#	Dimension[14]	Examples
		• Location of the service • Means to reach the service • Etc. • Technical and technological demands: • Devices types • Connectivity • Software • Mobile data • Etc. • Cognitive demands: • Knowledge and skills • Coping with high cognitive load • Multitasking • Drawing conclusions • Etc. • Financial demands: • Availability of payment methods (credit card, mobile payment, bank transfer) • Medium - high income (affordability) • Etc.
6	Business Demands: demands for developing, operating and maintaining the service	• Development costs • Operation costs • Marketing costs • Service policy • Coordination with the authorities • Regulatory requirements • Ensuring personal security and safety of the users • Ensuring information and cyber security • Service capacity • Growth planning • Etc.
7	Accessibility and inclusion	• Of the digital system • Of the physical service
8	Difficulties, limitations,	• Of the system development

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#	Dimension[14]	Examples
	challenges and constraints	• Of the service deployment • Of the service operation
9	Growth potential and strategy of the digital mobility service	• Expected growth potential • Consumer adoption and acceptance • Advantages over competitors • Partnerships • Etc.
10	Resilience to crises like Covid-19	• Service changes during the crisis • Advantages/disadvantages of the service during the crisis • Return to service routine after the crisis • Financial considerations during and after the crisis • Etc.

Table 15: Dimensions of information collection from developers, operators and policy makers

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6. WP1 Work plan

6.1 Overview

This section presents the work plan of data collection and analysis, which comprises four tasks: tasks 1.2 and 1.3 will focus on collecting user information. Task 1.4 will focus on collecting information from developers, operators and policy makers. Task 1.5 will synthesize the analyses of all tasks to define use requirements for the universal design guide and for the policy evaluation tool. Figure 3 presents a graphic illustration of the framework of data collection and analysis of WP1.

As can be seen, task 1.2 includes a literature review and short interviews with stakeholders representing users. Task 1.3 comprises semi structured in depth interviews (SSI) with vulnerable to exclusion users and profile fit non-users. Together, the information gathered in both tasks will be analysed via three methods: personas, journey maps and thematic analysis to elicit result on: (1) users' goals, needs and preferences, (2) users' skills and capabilities, (3) users' difficulties, challenges, limitations and constraints[15].

In a parallel process, task 1.4 will engage in information collection on the challenges and opportunities of deployment of digital mobility services[16]. For that, information will be collected via media analysis of online sources, analysis of case studies, in depth interviews of stakeholders and through a co-creation workshop with stakeholders.

Information integration and synthesis will begin (task 1.5) towards the end of the information collection. Consolidation of all analyses of information performed in Tasks 1.2- 1.4 will enable an overall view of the digital mobility services USE and DEPLOYMENT needs for expanding the use of digital mobility services to additional segments of the population. This comprehensive view will lead the (1) definition of use requirements of the universal design manual for digital mobility services, (2) recommendations for the policy evaluation tool and (3) recommendations for cybersecurity and personal data protection.

The following sections present a detailed work plan of WP1 sub-tasks.

[15] For further elaboration, see section 5.1: scope of data collection from end users.

[16] For further elaboration, see section 5.2: scope of data collection from developers, operators and policy makers.

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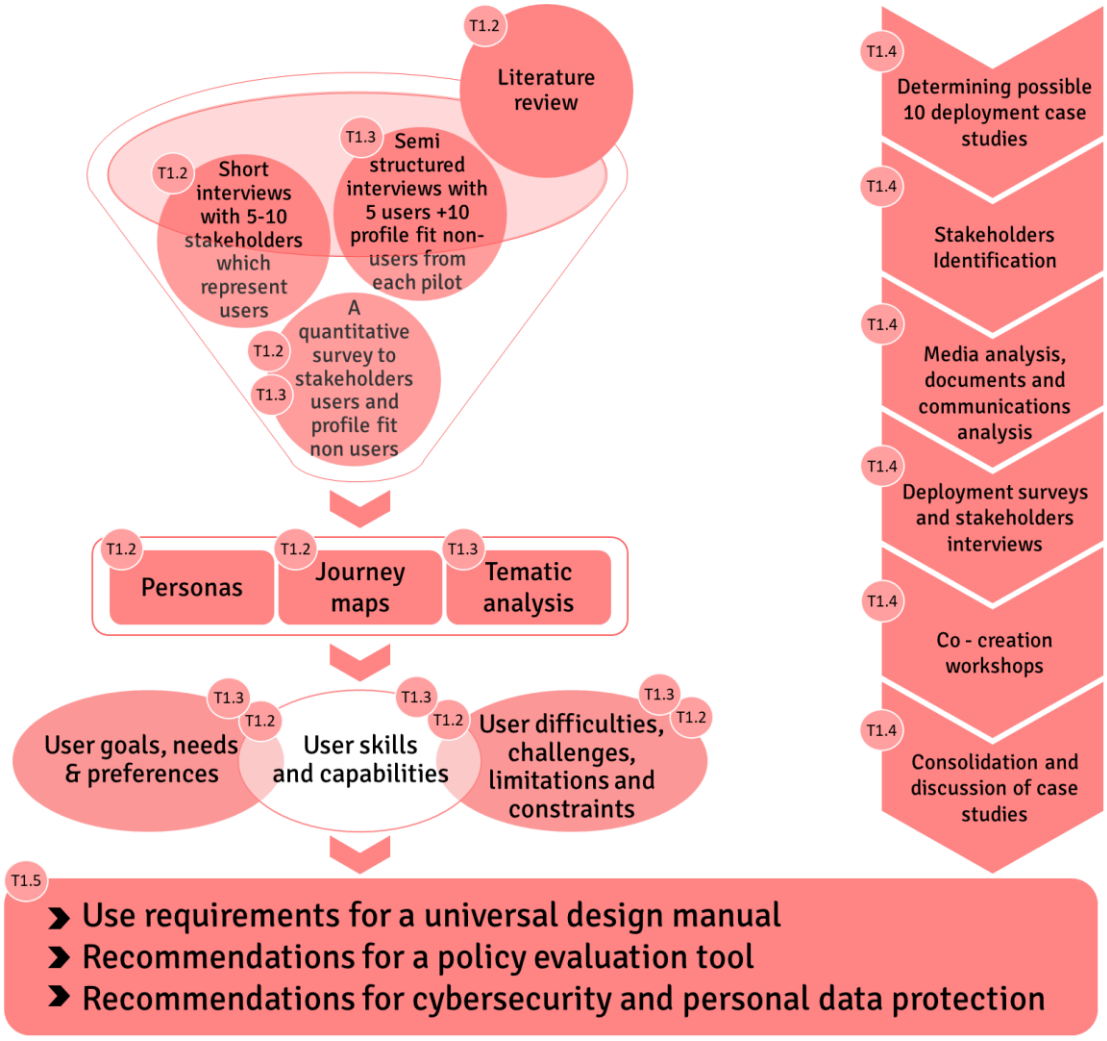

Figure 3: WP1 Framework of data collection and analysis

6.2 Analysis of the use requirements towards the digital mobility service (Task 1.2)

6.2.1 Description of the work plan

As presented above, task 1.2 aims to collect and analyse information on users' (1) goals, needs and preferences, (2) skills, capabilities and (3) difficulties, challenges, limitations and constraints. This work will enable the definition of use requirements of the universal design manual for digital mobility services and the creation of a set of recommendations for cybersecurity and personal data protection.

The task consists of two main stages. In the first stage, we will collect data on the **users' goals, needs, capabilities, limitations, etc**. with the following methods:

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1. A literature review on vulnerable-to-exclusion users and their use (or non-use) of digital mobility services (with focus on users of pilot project and case studies).
2. An analysis of the technology of each of the pilot projects and case studies will be made in order to adapt the interview questions (based on the scope of data collection for users presented in section 5.1) for the stakeholders.
3. Short interviews with stakeholders representing users allocated from 10 case studies (including 5 pilot projects).
4. A survey to vulnerable-to-exclusion users on digital mobility services use. The survey will include up to 25 items in Likert scale, and will be filled out by each interviewee.

This information collected and analysed will assist in creating a prioritized inventory of users' needs, capabilities, limitations, etc. that will enable a comprehensive view on them.

In a second stage, based on this inventory of users' information and on the data collected in the in-depth semi structured interviews (see task 1.3 below); personas[17] and journey maps[17] for the user profiles of the pilot projects will be created. These personas and journey maps will further substantiate the development of use requirements for the universal design manual as well as the recommendations for cybersecurity and personal data protection.

Task 1.2 results will be summarized in deliverable D1.2 "User needs and requirements on a digital transport system" - a report on the findings of the analysis of the requirements of the users on the digital transport system.

6.2.1.1 Personas

One of the most popular methods of user-centered design is the use of personas. A persona is an imaginative, but accurate, representation of the user profile and all of its characteristics (Harlay, 2015). This representation enables designers to think of the user as a specific person with a name, face, and life frame, instead of treating users as a faceless profile with no identity.

The template presented in Figure 4 will be used for creating and formulating the personas of INDIMO. It is a template developed by Imec-Smit and useful for INDIMO as it is conceived to support the ideation of new digital technologies. As can be seen in Figure 4, the left column presents the characteristics of the persona as well as its personality traits. The middle and right columns are task oriented and state (1) the goals to be achieved by the persona, (2) the current frustrations with reaching these goals, (3) the main motivation to use a technology as well as (4) other sources to achieve the goal and (5) the preferred information he/she wants. In the middle of the template, the persona's bio describes the user journey and makes the bridge for the creation of the persona's journey map.

[17] See further elaboration on persona and journey map creation in sections 5.2.4.

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Based on the input from the user research described above (and the information collected in task 1.3) one persona will be created for the dominant user profile of each pilot project. This persona will be co-created by Imec and the pilot project. In order to facilitate the process of personas creation, we will analyse the personas developed in the 'HiReach' project and consider adapting them according to the information collected in INDIMO. If the 'HiReach' personas will not be adequate for adaptation, completely new personas shall be created.

The persona template will be presented in two webinars with a team from pilot projects and representatives from the communities of practice[18]. The first webinar will end in a first sketch of the persona of the dominant user profile of each pilot project. This initial sketch will be refined and validated in the second webinar. The interval between the two seminars will be used to perform additional research if needed.

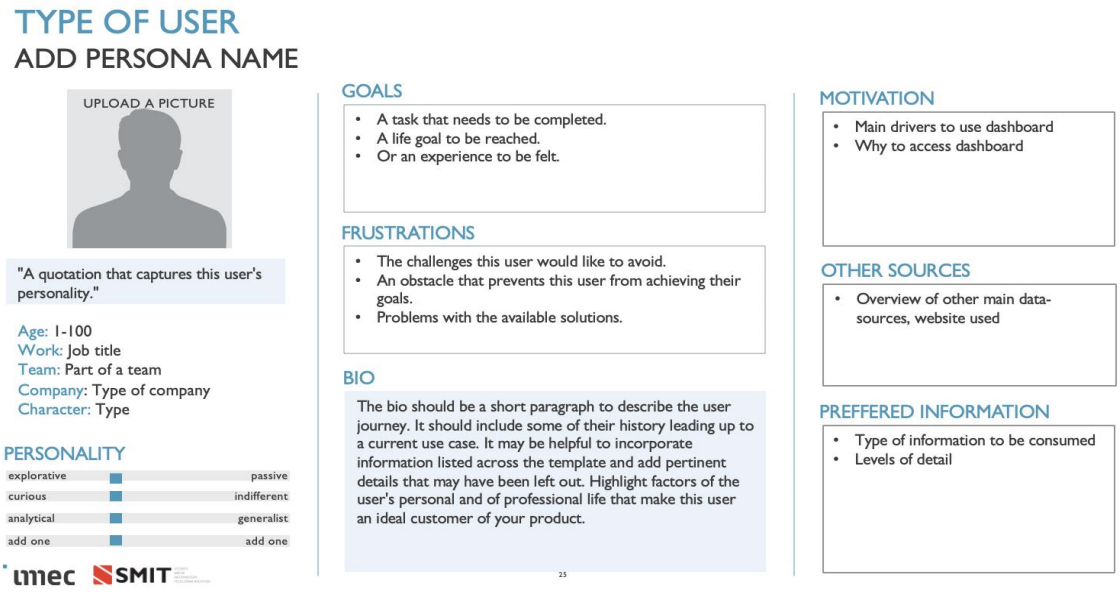

Figure 4: Persona Template (source: Imec-Smit)

[18] Communities of practice draw on the knowledge and experience of their members to propose solutions adapted to their needs and interests (Wegner, 2002). The Communities of practice can have different aims such as to develop productive services, to create common knowledge and to empower a group of people in some specific capabilities. They are groups of people who share a concern, a need or a passion for something they do and learn how to do it better as they interact regularly. For further elaboration see deliverable 3.1.

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6.2.1.2 Journey maps[19]

"A customer-journey map is an infographic visualization of the process that a persona segment goes through in order to accomplish a goal" (Flahtery, 2020). Journey mapping is a user-centred design technique that describes every step a user takes when engaging with a service. It helps an organization, to look outward from the viewpoint of the end users (customers), in the process of designing inclusive services. The journey map allows to have a holistic viewpoint on the user experience and to improve the design process.

The importance of understanding the experience of a journey of a customer/user has always been a key area of research in the scientific literature on urban mobility (Tovey et al., 2015). Research has been carried out on motivations of users towards using different transport modes, on charting opportunities and barriers to move from one form to the other. With the rise of mobile digital applications, user-centered methods have been growing in importance in the field of mobility and transportation (Tovey et al., 2017; Woodcock & Tovey, 2020).

Customer journey maps come in different formats and styles. In this task we will follow the commonly used template (see Figure 5) of Nielsen Norman Group (Gibbons, 2018). Therefore, according to the template the INDIMO journey maps will have the following elements:

- A persona, allowing to have a clear point of view.
- A scenario, detailing the concrete experience to map, highlighting the goals and the objectives the user wants to reach (expectations).
- An overview of stages and phases of the journey, allowing to detail what the user is doing, thinking or saying from pre-purchase/use (awareness, consideration) to purchase/use (purchase/usage - retention) and post-purchase (confirmation/rejection/competitor) phase. By incorporating the pre-purchase stage, we focus already on processes before the experience actually starts.
- A list of touchpoints and channels in order to identify the different ways how the customer gets in touch with the service. Attention will be paid if these channels are pilot owned or not.
- An identification of emotions, allowing to chart the customer emotion for each stage.
- A box to note key opportunities in order to identify unknown gaps in the user experience so that appropriate measures to address them can be taken.
- Ownership, detailing who is responsible at a pilot to pay attention to the customer experience and hence in charge of the measures/actions to address unknown gaps.
- Other elements might be added during the course of the task and will be reported in deliverable D1.2 if this has been the case.

[19] Also known as customer journey map (Flahtery, 2020)

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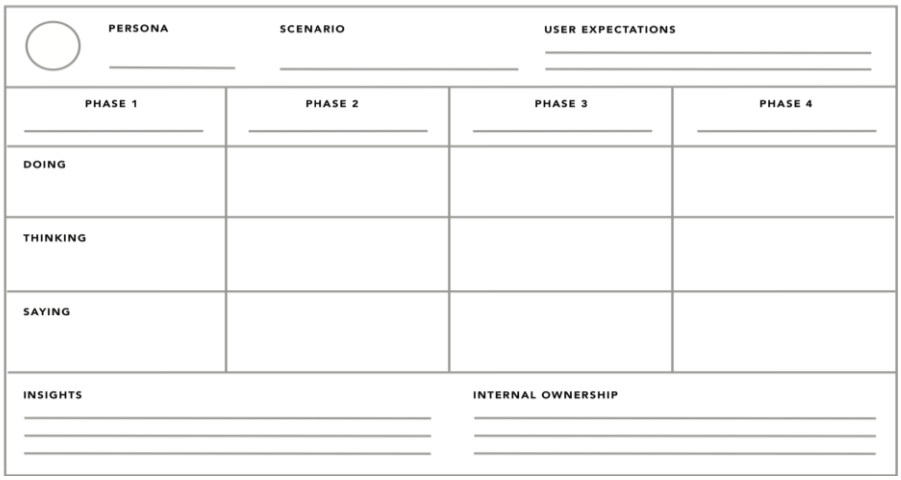

Figure 5: Customer journey map template (source: Gibbons- NNgroup, 2018)

Following the definition and description of the personas by each of the pilot projects, journey maps will be created with the persona as an inspiration point. The Journey map will allow to identify points in the current services that needs to be addressed in order to be more inclusive towards end-users. The journey maps will also be co-created by Imec and the pilot project.

The Journey map template will be presented in two webinars with a team from pilot projects and representatives from the communities of practice. The first webinar will end in a first version of the journey map, and in the second meeting the final journey map will be made with special attention to highlighting the issues that are relevant to address in WP2 and WP3. The period in between the two webinars will be used to verify uncertainties from the journey map if needed.

6.2.2 Activities and cooperation with INDIMO partners

As described in section 2, the task will be completed in collaboration with the pilot projects and with project partners having access to stakeholders and users in 5 other user case studies.

Imec, with support from VUB, MBE and ZLC, will lead the task. Cambiamo and EPF will support the contact to users through the case studies while Technion, Door2Door, VIC, CoopCycle, ITL, PI, IMEC will provide access to users in the pilot projects.

Imec and Cambiamo (see below task 1.3) will guide and support the pilot projects and case studies with the information collection and analysis by providing the framework, templates, online tools, webinars on co-creation of personas and drafting user journey maps, etc.

6.2.3 Detailed work plan: timing of activities and INDIMO partners roles

Table 16 presents task 1.2 detailed work plan including timing and activities.

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#	Timing	Activity	Contributions
1	31/5/2020	Final definition case studies and stakeholder identification (in addition to 5 pilot projects)	Imec (T1.2) VUB, ZLC, MBE, cambiaMO: support identification
2	31/5/2020	A quantitative survey	Imec: lead VUB, ZLC, MBE, cambiaMO: support/feedback
3	01/06/2020 - 01/07/2020	Interview/survey with stakeholders Case studies application analysis	Imec guidance and support (templates, online tools) Pilots: data collection (interview/application analysis)
4	01/06/2020 - 01/07/2020	Literature review on accessibility and inclusion of the services of the pilots projects and case studies	Imec guidance and support Pilots: data collection/translation of main results if needed VUB, ZLC, MBE: support in analysis literature
5	01/07/2020- 01/08/2020	Analysis of interviews/surveys and literature review completed	Imec, VUB, ZLC, MBE: Analysis Pilots: Analysis support (translation if necessary)
6	30/6/2020	Webinar to introduce pilot projects on persona and journey maps creation	Imec: organizer VUB, ZLC, MBE: support Pilots: participants
7	01/08/2020- 31/08/2020	Prioritization of use requirements	Imec : guidance of process and template VUB, ZLC, MBE: feedback and support cambiaMO and Pilots: mobilize CoP to gather feedback
8	01/08/2020 - 30/09/2020	Co-creation personas for each pilot project (2 webinars per pilot, 10 in total)	Imec: guidance of process and template Pilots: participation VUB, ZLC, MBE: support and

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#	Timing	Activity	Contributions
			integration of results
9	01/10/2020 - 31/10/2020	Co-creation of user journey maps for each pilot project (2 webinars per pilot, 10 in total)	Imec: guidance of process and template Pilot: participation VUB, ZLC, MBE: support and integration of results
10	01/11/2020- 31/12/2020	Drafting and finalizing deliverable D1.2 "User needs and requirements on a digital transport system" - a report on the findings of the analysis of the requirements of the users on the digital transport system.	Imec lead/support all Task partners

Table 16: Task 1.2 detailed work plan

6.3 Identification of user capabilities and use requirements of a digital mobility service on users (Task 1.3)

6.3.1 Description of the work plan

Task 1.3 will collect and analyse information on **users'** and **profile fit non-users'** (1) goals, needs and preferences, (2) skills, capabilities and (3) difficulties, challenges, limitations and constraints to support the development of the Universal Design Manual and the guidelines of cybersecurity and personal data protection.

This task includes several steps. In the first step each pilot project will be asked to identify **5 end users** who meet the dominant user profile of the pilot project, and **10** (same) **profile fit non-users** who will be the subject of information collection. If needed, additional recruitment channels (i.e. local networks, NGO, public stakeholders in charge of health caring services) will be included to identify participants who meet the defined profile (for further information see D3.1 Pilot handbook).

In the second step, information will be collected from **users** and from **profile fit non-users** concerning the goals, needs, capabilities, limitations, etc. The data collection will be performed via in-depth semi structured interviews (SSI) that will be developed upon the information collection dimensions identified in section 5.1, with adaptation to each of the pilots' user profile and digital mobility service. In total, 75 in depth semi structured interviews will be

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conducted by 5 pilot projects: 25 interviews of profile fit **users** and 50 interviews of profile fit **non-users**.

In the third step, each interviewee will fill out a quantitative survey (on the use of digital mobility services) at the end of the interview. This survey already described in task 1.2 will include up to 25 items in Likert scale.

The fourth step will include thematic analysis of the data collected in the SSIs. This analysis is aimed to reveal the common needs and difficulties of vulnerable-to-exclusion users beyond user profiles and beyond services. In addition, it may identify the unique needs and difficulties related to a specific user profile or a specific service.

Each of the pilot projects partners will perform the thematic analysis according to predefined criteria. "**Thematic analysis** is a systematic method of breaking down and organizing rich data from qualitative research by tagging individual observations and quotations with appropriate codes, to facilitate the discovery of significant themes."(Rosala, September 29, 2019). This analysis is useful for summarizing key features of a large and diversified data sets (in our case 75 diverse Semi-Structured Interviews), as it forces the researcher to take a well-structured approach for handling data, that produces clear results (King, 2004). In T1.3 we will prepare designated tools for carrying out the thematic analysis how to elicit the most important themes from the interviews data.

The analysis will be accomplished in the language of the interview, and only after consolidating the thematic analysis results of all the interviewees of each pilot project, a translation to English will be carried out. The reason for analysing content in the interview language is not losing information in the transition between languages.

The fifth and last step will synthesize and consolidate the data collected from SSIs and surveys of all pilot projects.

Task 1.3 results will be summarized in deliverable D1.3 "Users capabilities and requirements Identification of user capabilities and requirements of a digital transport system on users" - a report of identified user needs and barriers to use digital mobility services.

6.3.1.1 Semi structured interviews

A semi-structured interview (SSI) is a method of research conducted with a semi-open framework, which allows for focused, conversational, and two-way communication. SSIs are widely used in qualitative research because of the multiple advantages provided to the data collection process. While a structured interview has a strict set of questions that does not allow one to divert, an SSI is more open, allowing new ideas to be brought up during the interview as a result of what the interviewee says since it gives more opportunities to fully express themselves.

Conducted conversationally with one respondent at a time, the SSI employs a blend of closed- and open-ended questions, often accompanied by follow-up why or how questions. About one hour is considered a reasonable maximum length for SSIs in order to minimize fatigue for both interviewer and respondent.

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The interviewer in a semi-structured interview has a framework of themes to be explored, with questions and topics that must be covered. The unstructured part gives the interviewer more space to ask for clarification on answers and to express free flow of thoughts and he/she can build a personal bond with respondents under a relatively warm and friendly atmosphere.

Several examples of SSI use can be found in the transportation literature. Rosenkvist et al. (2009), employed SSIs in combination with a qualitative content analysis to get insight into reasons people with cognitive functional limitations cease to use public transport mainly identifying a usability problem (both real and imagined). Chowdhury et al. (2018), employed SSI to understand public transport users' perceptions and how this aligns with policy makers' perceptions of an integrated system, identifying similarities and differences between the two groups.

6.3.2 Activities and cooperation with INDIMO partners

As described in section 2, the task will be completed in collaboration with the pilot projects.

CambiaMo will lead this task with contributions from TECHNION, IMEC, EPF, DBL, and MBE while Technion, Door2Door, VIC, CoopCycle, ITL, PI, IMEC will provide access to users and profile fit non-users in the pilots.

CambiaMo and Imec (see above task 1.2) will guide and support the pilot projects and case studies with the information collection and analysis by providing the framework, templates, online tools and webinars on SSI, thematic analysis, etc.

6.3.3 Detailed work plan: timing of activities and INDIMO partners roles

Table 17 presents the detailed work plan for task 1.3 including timing and activities.

#	Timing	Activity	Contributions
1	6/05/2020	Planning SSI work plan with pilots	cambiaMO, ZLC and all pilots and case studies
2	6/05/2020	Identifying procedures of SSI	cambiaMO, ZLC, EPF and all pilots and case studies
3	13/05/2020	#1 Webinar for presentation of SSI work plan	cambiaMO, ZLC, IMEC, MBE and all pilots
4	04/06/2020	Presentation of example draft SSI questionnaire	cambiaMO, Technion, IMEC Inputs from EPF, DBL, MBE
5	24/06/2020	Presentation of Final SSI example questionnaire and submission to the VUB ethical	cambiaMO, Technion, and all pilots. Inputs from EPF, DBL, IMEC

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#	Timing	Activity	Contributions
		committee	
6	29/06/2020	#2 Webinar: SSI deployment guidelines	cambiaMO- Technion, ZLC, DBL, EPF, MBE)
7	07/07/2020	Launching fieldwork (SSI users (3-5) and profile fit non users (10-12)	cambiaMO-Technion- Pilots and all methodological partners: provide inputs
8	18/07/2020	#3 Webinar: Thematic analysis guidelines for first 5 interviews	cambiaMO-Technion- IMEC – DBL - EPF and all pilots.
9	31/07/2020	#4 Webinar: Thematic analysis (7-15 SSI).	cambiaMO-Technion- DBL –EPF – MBE and all pilots leaders
10	31/07/2020-10/08/2020	Partial end of SSI data collection	CambiaMO- Technion and all pilots leaders with ZLC
11	17/08/2020-31/08/2020	Initial comparative thematic analysis	cambiaMO -Technion
12	06/09/2020-14/09/2020	#5 Webinar: thematic analysis	cambiaMO -Technion- IMEC- and all pilots
13	15/09/2020-31/10/2020	End of comparative thematic analysis for defining users' needs, capability and challenges.	cambiaMO -Technion- DBL, EPF
14	03/11/2020-15/11/2020	Translation of end-users goals and needs to use requirements	cambiaMO-Technion Contributors: MBE, DBL
15	16/11/2020	#6 final webinar on use requirements. Diagram presentation.	cambiaMO -Technion-ZLC- IMEC- .MBE- DBL - EPF and all pilots participations
16	17/11/2020-30/11/2020	Drafting of D1.3 "Users capabilities and requirements Identification of user capabilities and requirements of a digital transport system on users" - a report of identified user needs and	cambiaMO Contributors: Technion, DBL, MBE.

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#	Timing	Activity	Contributions
		barriers to use digital mobility services.	
17	2/12/2020	Sharing draft D1.3 with internal INDIMO reviewers	Reviewers: ZLC, EPF
18	12/12/2020	Feedbacks for reviewers	Reviewers: ZLC, EPF
19	19/12/2020	Finalization of D1.3	cambiaMO Contributors: Technion, DBL, MBE.
20	21/12/2020	Submission of deliverable D.1.3 "Users capabilities and requirements Identification of user capabilities and requirements of a digital transport system on users" submitted to project officer	VUB

Table 17: Task 1.3 detailed work plan

6.4 Understanding the process of the deployment of digital mobility services (Task 1.4)

6.4.1 Description of the work plan

Task 1.4 aims to identify and analyse the goals, needs and challenges and opportunities of developers, operators and policy makers when introducing new, accessible, inclusive digital mobility services. This work will support the development of a recommendation array for the policy evaluation tool, as well as the universal design manual.

In this task, 10 deployment case studies[7] will be used for the analysis. These deployment case studies will analyse the development of the digital services and how aspects as inclusion, co-creation and regulatory framework were taken into account. Five of them are linked to the pilot projects; while the 5 additional deployment case studies are still to be selected.

This task consists of several phases. In the first phase, a **media analysis** will be conducted. A media analysis is a method to collect information from different kinds of media services. These services can be written (a newspaper, magazines, reports), online (online newspapers) and produced by broadcasted media such as television- and radio programs. Starting with an online search based on several keywords related to (inclusive) digital mobility services can provide a useful start. Based on the online sources other written sources can be identified. Finding

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information from television- or radio broadcasts might prove more difficult since these sources are not as easily found using the internet and there may be language barriers.

The second phase is an analysis of **documents and communication**. These documents can consist of numerous different sources for case study analysis: project plans, strategic mobility plans, meetings, presentations, interviews etc. It is favourable to analyse multiple sources, databases for each case study.

In the third phase, **semi-structured interviews with experts from each of the stakeholder groups** will be conducted. The specific kind of interviews that will be conducted still needs to be decided and will depend on the selected cases, identified stakeholders, expected information and the way the respondents will be contacted.

In the fourth phase, the results of the early phases will be consolidated and discussed with stakeholders in a **co-creation workshop.** All stakeholders will be represented in this workshop and collaborate with the INDIMO-partners for consolidating and discussing the deployment case studies. The workshop will include all partners, pilot leaders and organizations from the co-creation community.

Task 1.4 results will be presented in deliverable D1.4 – "Barriers to the design, planning, deployment and operation of accessible and inclusive digital personalized mobility and logistics services" – a report addressing the deployment of digital mobility and logistics services from the viewpoint of developers and policy makers.

6.4.2 Activities and cooperation with INDIMO partners

VUB will lead this task with contribution from ZLC (to cover the logistics services); POLIS (policy makers, transport authorities' perspective) and VDI/VDE-IT (developers and policy makers' perspective) will support the stakeholder involvement and also the analysis for different stakeholder groups.

6.4.3 Detailed work plan: timing of activities and INDIMO partners roles

A detailed work plan including timing and activities is presented in Table 18.

#	Timing	Activity	Contributions
1	01/3/2020-21/5/2020	• Development of draft methodology for task 1.4 for D1.1	VUB, Technion, cambiaMO
2	01/4/2020-30/4/2020	• Further development of methodology • Analysis: Is a deployment case study possible in each of the internal INDNIMO pilot cases • Selection of potential external	VUB

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#	Timing	Activity	Contributions
		cases for deployment case study	
3	01/5/2020-31/5/2020	• Analysis of selected cases for deployment case study • Stakeholder analysis: methodology • Snowball method • Stakeholder-led categorization	VUB
4	01/6/2020-30/6/2020	• Influence/importance analysis of the stakeholders • Development of the interviews	VUB, ZLC
5	01/7/2020-31/7/2020	• Interviews	VUB, ZLC
6	01/8/2020-31/8/2020	• Interviews • Work on the draft version of guidelines to use at co-creation workshop	VUB
7	01/9/2020-30/9/2020	• Co-creation workshop	VDI/VDE-IT, POLIS, VUB
8	01/10/2020-31/10/2020	• Analysis of results • Development of guidelines for INDIMO Policy Evaluation Tool	VUB, ZLC
9	01/11/2020-30/11/2020	• Drafting of deliverable D1.4 “Barriers to the design, planning, deployment and operation of accessible and inclusive digital personalized mobility and logistics services”, followed by review of D1.4 by internal reviewers • Revision of D1.4 for final submission	VUB, internal reviewers (IMEC, DBL)
10	01/12/2020-31/12/2020	• Finalisation D1.4 “Barriers to the design, planning, deployment and operation of accessible and inclusive digital personalized mobility and logistics services”	VUB

Table 18: Task 1.4 detailed work plan

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6.5 Opportunities, Limitations and Constraints for The Use of an Inclusive Digital Mobility Service - Synthesis of Analysis (Task 1.5)

6.5.1 Description of the work plan

Task 1.5 will be responsible for the synthesis of all the gathered information in tasks 1.2-1.4 and elicit from this synthesis practical conclusions and implications regarding the digital mobility services' use and deployment.

This task will be engaged in three tasks:

(1) **Definition of use requirements of the universal design manual for digital mobility services** with relation to the users' information on the following dimensions:

- Goals /purposes/ value of using the service
- Accessibility and inclusion: reasons for not using the service (for profile fit non-users only)
- Needs
- Description of the workflow when using the digital mobility service
- Usability of the service's digital interface
- Usability of the service's physical interface
- Skills / capabilities
- Difficulties, limitations, challenges and constraints
- User's perception of the service use demands and their ability to meet the demands
- Self-use, assist other or group use
- Perception of personal data privacy and security
- Safety perception
- Perception of the service's resilience to crisis like Covid-19
- Attitudes, feelings/ emotions, preferences and opportunities

(2) **Recommendations for the policy evaluation tool** will refer to the dimensions of data collection from developers, operators and policy makers:

- Perception of the value of the service to the users
- Reasons for not using the service
- Needs addressed by the services
- Service characteristics
- Demands from users
- Business Demands: demands for developing, operating and maintaining the service

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- Accessibility and inclusion
- Difficulties, limitations, challenges and constraints
- Growth potential and strategy of the digital mobility service
- Service's resilience to crisis like Covid-19

(3) **Recommendations for cybersecurity and personal data protection** will refer to the following dimensions of data collection:

- Security of personal data
- Payment details security
- Control of the visibility of information
- Infrastructure demands
- Technical demands

6.5.2 Activities and cooperation with INDIMO partners

The task will be led by TECHNION as WP leader. All Task leaders from WP 1 (VUB, IMEC, Cambiamo) will contribute to synthesize results.

Outcome of task 1.5 will be deliverable D1.5 "Opportunities, limitations and constraints of an inclusive digital transport system" - a summary report of the findings of WP1 and recommendations for the tools to be developed in WP2.

6.5.3 Detailed work plan: timing of activities and INDIMO partners roles

A detailed work plan including timing and activities is presented in Table 19.

#	Timing	Activity	Contributions
1	01/11/2020-30/12/2020	• Collection of information analyses from tasks 1.2- 1.4 • Integration and synthesis of information	Technion, VUB, Imec, cambiaMO
2	01/01/2021-21/01/2021	• Deliverable D1.5 "Opportunities, limitations and constraints of an inclusive digital transport system" review by reviewers • Revision of D1.5 for final submission	Technion, VUB, Imec, cambiaMO
3	31/01/2021	• D1.5 submission "Opportunities, limitations and constraints of an inclusive digital transport system"	Technion, VUB, Imec, cambiaMO

Table 19: Task 1.5 detailed work plan

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7.Conclusions

This report describes the framework for data collection and analysis of Work Package 1. It includes:

- A definition of user characteristics and user profiles of which information will be gathered.
- A review of current and emerging digital mobility services that will be included in the data collection.
- A definition of the scope of data to be collected from end users, developers, operators and policy makers.
- A detailed work plan for the data collection of Work Package 1.

The data collected and analysed according to the described framework of analysis will enable the creation of the main outcome of INDIMO project - the digital mobility deployment toolkit.

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Annex 1: Vulnerable-to-Exclusion Users Characteristics Data Collection Form

Vulnerable-to-Exclusion Users Characteristics Data Collection Form

Dear partners,

Benefiting from digital technology requires specific skills, willingness and abilities. The main challenge is therefore to ensure that all members of society can benefit from digitalization. The purpose of this form is to identify the characteristics of segments of the population that may be excluded from the use of digital transport solutions (vulnerable-to-exclusion users).

Please prepare a list of characteristics of vulnerable-to-exclusion users and send it back to Efrat@usense-ux.com by 3 Feb 2020. Thanks.

Partner name	
Contact person name & email	
Location	
Vulnerable-to-Exclusion User Characteristics	Example: • Residence in peripheral locations, • Language barriers, • Etc. If you have a set of characteristics that define a profile, please mark it as follows: • XXXX • XXXX • XXXX Profile name: YYYY

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Annex 2: User Characteristics Importance Evaluation by Groups

1- It is **not important** to gather data from users with this characteristic or from this target group

2 -It is **ok** to gather data from users with this characteristic or from this target group

3- It is **important** to gather data from users with this characteristic or from this target group

4- It is **highly important** to gather data from users with this characteristic or from this target group

	Evaluated Level of Importance by group						
User Characteristics or Target Group	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**	**G7**
Socially isolated	1	3	1	2	4	3	4
Child	1	2	4	1	2	2	1
Temporarily or situationally excluded (e.g. cell phone lost).	1	1	1	2	2	2	1
Short-term injured people	1	2	1	2	2	2	2
Travel in a group	1	1	1	4	1	1	1
Business Visitors (no invoice to claim travel expense, no access to service on work phone)	1	1	1	2	1	1	1
Under 20	1	1	3	1	1	1	2
A short time visitor (e.g. tourist/ business visitor)	1	1	2	4	2	2	1
Commute for long haul	2	2	1	2	2	1	2
Strict or sustainable lifestyle and transport choices	2	2	2	2	2	1	1
Travel with large family	2	3	2	3	2	2	2
Limited use of digital technologies (not using or barely using digital applications)	2	2	2	3	3	2	3
Technological barriers (devices that are too old or too slow)	2	2	3	4	4	3	1
Don't have a driving licence or that do not drive	3	2	2	4	2	4	-
Socio-cultural and/or religious beliefs influencing social interactions	3	2	3	4	3	2	2
Travel with a baby carriage	3	3	2	4	3	4	3
Travel with a large luggage	3	1	1	4	1	2	1
Complete rejection of digital technologies	3	3	4	3	2	2	3
Lack trust in digital services (mobile payment and booking systems, data-privacy)	3	3	4	3	4	4	3
Permanently impaired or with disability -physical barriers to use transportation services	3	4	4	3	4	4	2

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1- It is **not important** to gather data from users with this characteristic or from this target group

2 -It is **ok** to gather data from users with this characteristic or from this target group

3- It is **important** to gather data from users with this characteristic or from this target group

4- It is **highly important** to gather data from users with this characteristic or from this target group

	Evaluated Level of Importance by group						
User Characteristics or Target Group	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**	**G7**
A mental or cognitive disability	3	3	4	2	4	4	4
Lack of knowledge of transport terminology	4	4	4	4	2	2	2
Lacking digital skills (although owning a mobile phone)	4	3	4	3	3	3	4
Residing in peripheral locations	4	4	3	4	4	3	4
Travel with an assistance animal	4	4	1	3	4	4	2
Caregiver of children/ people with disabilities/ older people	4	4	3	3	3	4	4
Permanently impaired / disabled - physical barriers to access digital applications	4	4	4	3	4	4	4
Lack of access to digital devices	4	3	4	4	4	4	4
Lack of high-speed internet connection	4	2	3	4	2	3	1
Low income	4	4	4	4	4	4	3
Low level of education	4	3	4	2	3	4	4
Personal security concerns (e.g. about ridesharing)	4	3	3	4	4	3	3
Migrant	4	4	4	4	4	4	4
Gender: Women	4	4	4	3	4	3	4
Lack of services (e.g. car sharing is mostly deployed in dense urban areas)	4	4	3	4	4	4	3
Older age	4	4	4	4	4	4	4
lack of knowledge of the existing digital mobility services /transport network	4	2	4	3	3	3	1
Language barriers - low proficiency in local language and/or English	4	4	4	4	3	3	2
Lack of access to methods of payment (don't have a credit card, mobile payment or bank account)	4	4	4	4	4	4	3

Table 20: User Characteristics Importance Evaluation Raw Data

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