



## **D1.5 – Opportunities, Limitations & Constraints of Digital Mobility Services**

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## Executive Summary

This report - ‘**Opportunities, limitations & constraints of a digital mobility service**’ - is the last deliverable (D1.5) from Work Package 1 (WP1) - “*Analysis of barriers and opportunities for tapping the full potential of the digital interconnected transportation system*” of the INDIMO project.

In the passing year, by means of **multi-stakeholder** subjective **qualitative** research and a **co-creation approach**, WP1 tasks (T1.2, T1.3 and T1.4) investigated, analyzed and discussed the **drivers** and **barriers** for the development and deployment of **inclusive** and **accessible** digital mobility services from the perspective of users and non-users, developers, operators, and policymakers. The tasks’ applied methodology and detailed findings and results could be found in the tasks’ deliverables (D1.2, D1.3 and D1.4 respectively).

In this report, we address the resonating key significant **opportunities** and **limitations** for accessibility and inclusivity of digital mobility services, cybersecurity implications, as well as data protection and data privacy.

Interestingly, among the tasks’ findings and synthesized analysis henceforward described, all fieldwork outcomes suggest that human contact is not only still relevant, but rather fundamentally essential to enhance users’ trust in digital services, promote users’ engagement, and facilitate both digital mobility services (DMS) and digital delivery services (DDS) in today’s raising digital era.

Also, the findings stressed the importance of consulting end-users and their representatives in order to gather insights on accessibility and inclusivity features for all potential users to benefit from. A bottom-up agile approach in co-creation of digital mobility solutions with attention to sustainable use of (urban) space and social equity holds the key to the success of future digital mobility services that are equally accessible and includes all sections of the society.

**The synthesized findings and results of WP1 tasks in this report, D1.5, will enable to target the major issues when developing tools in WP2: Co-creating the INDIMO Inclusive Digital Mobility Toolbox.**

The work presented in this report has three important outcomes:

1. A comprehensive formulation of opportunities and limitations of digital transport systems for delivering inclusive transport and the barriers that prevent tapping the full potential of digital mobility systems in supporting inclusive transport.
2. Recommendations for the use requirements of a Universal Design Manual (UDM) for creation of digital transportation services to support the sampled vulnerable-to-exclude user’s, with implications to diverse users with special needs, and all users in general.
3. Recommendations for Policy evaluation tools, cybersecurity and personal data protection for developers, operators, and policymakers.

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## 1. Introduction

The INDIMO project aims at filling the knowledge gap about accessible-by-design digital mobility services and improving the inclusiveness and equity of the interconnected transport systems. Pursuing this mission, INDIMO explores needs, capabilities, barriers, and requirements of vulnerable-to-exclusion users on the one hand, and the challenges that developers, operators, and policymakers face, on the other hand. To this aim, the main outcome of the project will be the Inclusive Digital Mobility Toolbox, which includes a universal design manual for digital mobility services, guidelines for improving the design of interfaces, guidelines for cyber security and personal data protection and a policy evaluation tool for policymakers.

Deliverable D1.5 is the last deliverable of Work Package 1 (WP1), which has the aim to analyse barriers and identify opportunities to tap the full potential of digital interconnected mobility systems from an inclusion perspective. It unites the outcomes and analysis conducted in tasks T1.2, T1.3 and T1.4 and elicit from this synthesizes practical conclusions and implications regarding the digital mobility services' use and deployment.

This deliverable report for the WP task is structured as follows. Chapter 2 first presents the INDIMO's multi-stakeholder approach and methodology. Secondly, it outlines WP 1 work plan framework as specified in D1.1 - "*Analysis Framework of user needs, capabilities, limitations and constraints of digital mobility services*". Chapter 3 to 5 each dedicated to one task each, to present the conclusions and highlight the key findings from WP1 tasks described in greater details in their respective deliverables D1.2 - "*User needs and requirements on a digital transport system*", D1.3 - "*User capabilities and requirements of a digital transport system on users*", and D1.4 - "*Barriers to the design, planning, deployment and operation of accessible and inclusive digital personalised mobility and logistics services*". Chapter 6 is the last chapter and consists of synthesized opportunities, limitations and constrains of digital mobility services. The deliverable report ends with practical conclusions and implications regarding the digital mobility services' use and deployment.

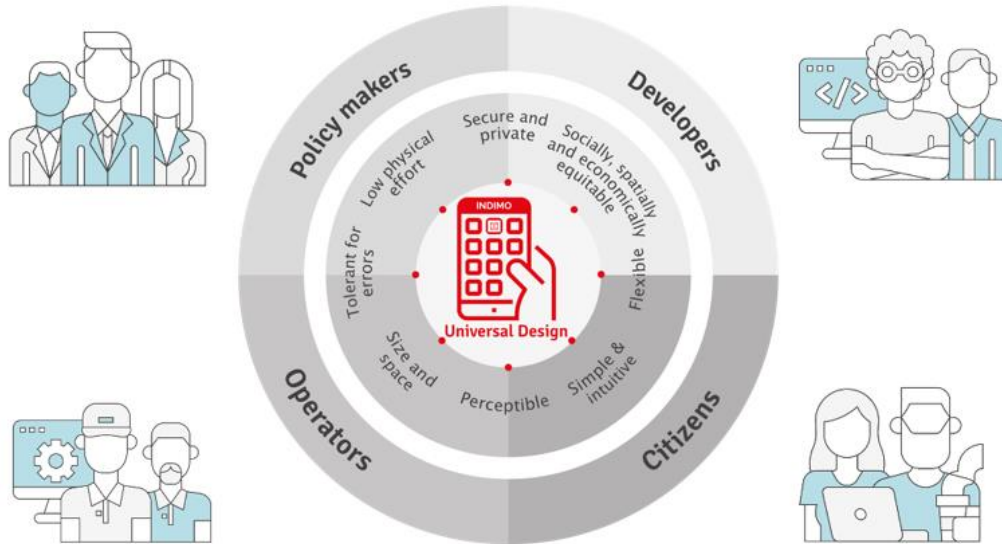
## 2. Methodology

Whilst digital mobility solutions are mainly developed for general use according to the assessment of the needs and capabilities of a-priori typical users, 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. Aware of the subjective variance of potentially excluded groups, fulfilling this goal requires a holistic standpoint and research that are beyond the scope of the INDIMO project. Nonetheless, INDIMO's multi-stakeholders' qualitative investigation of selected various vulnerable-to-exclusion characteristics provides wide-ranging implications for potentially excluded populations in general.

Thus, INDIMO takes into consideration a variety of digital services through an extensive data collection from citizens including end-users and non-users of digital mobility services, software

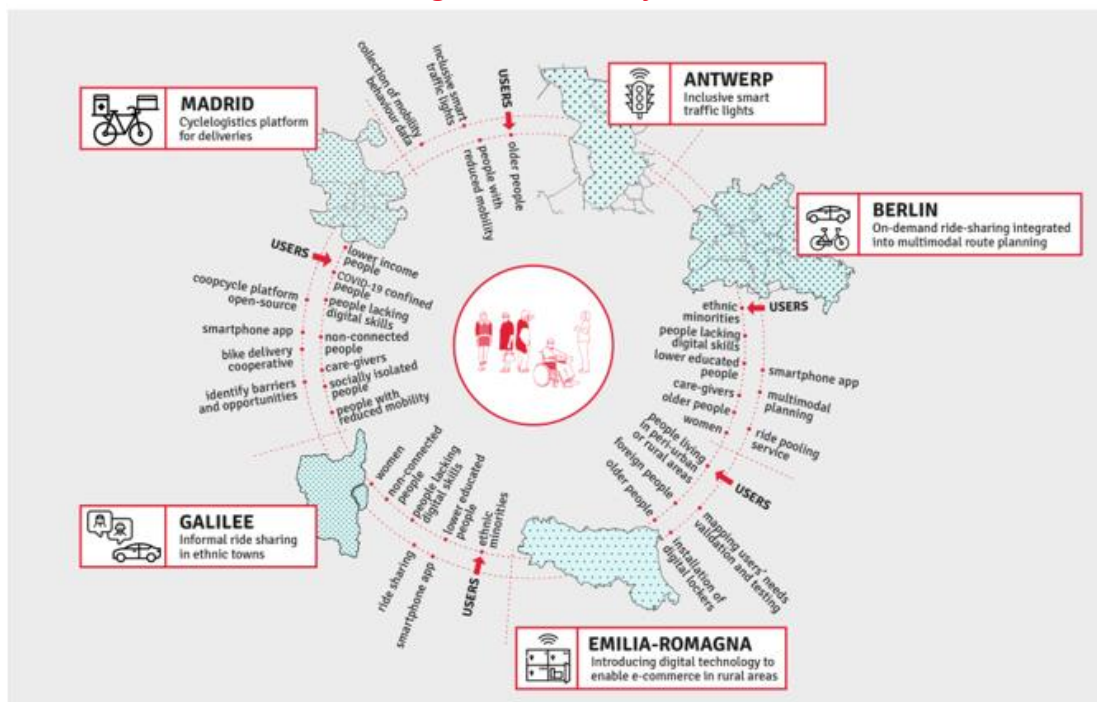
and hardware developers, digital mobility and logistics operators, and transport authorities, municipality and governmental policymakers (Figure 1).

Figure 1: Target Groups



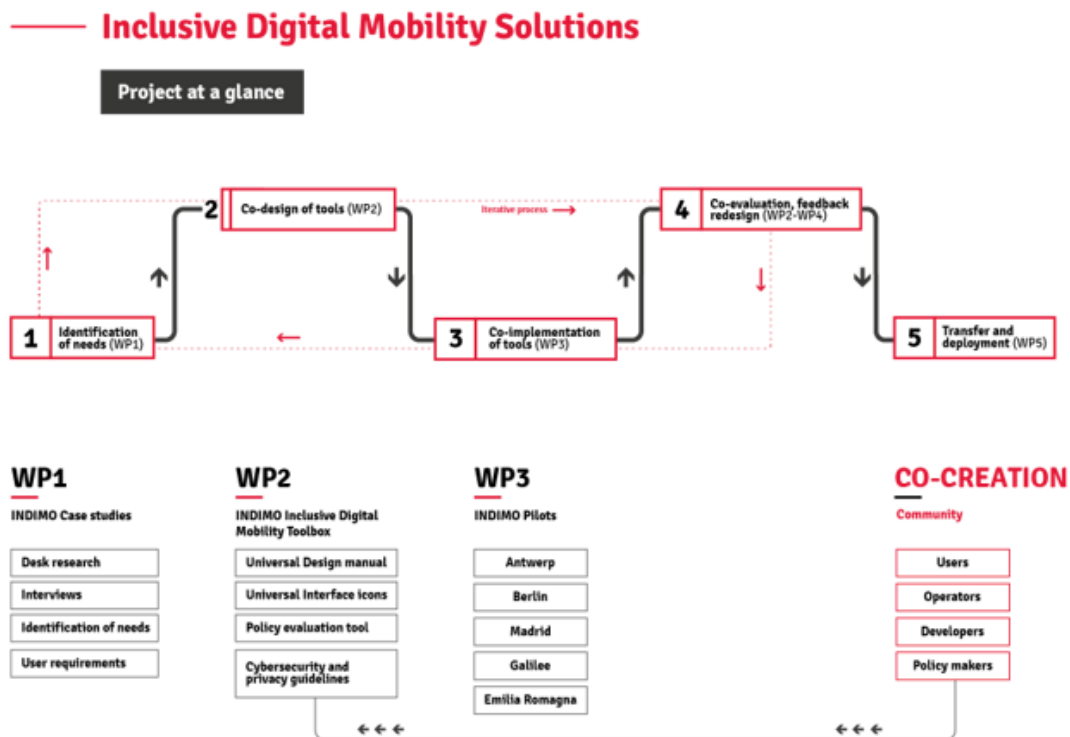
Overall, the INDIMO methodology consists of a multi-stakeholders' user-centric approach. The INDIMO Inclusive Digital Mobility Toolbox will be co-designed with local communities of practices in five pilot sites in five countries: Italy, Belgium, Israel, Spain, Germany (Figure 2) and with an international co-creation community including policymakers, user representatives, industry, academia, and developers, during the three years of the project.

Figure 2: Pilot Projects



The INDIMO co-creation process is designed as a five-stage process (Figure 3). Stage 1 is devoted to the identification of user and non-user needs and capabilities, and to the investigation of requirements and concerns of developers, policymakers and operators when introducing digital mobility/delivery services (DMS/DDS). Stage 2 concerns the co-designs of the INDIMO Inclusive Digital Mobility Toolbox to bridge the digital mobility gap, on the basis of needs, capabilities, requirements and barriers identified in stage 1. Stage 3 looks at the co-implementation of tools from the INDIMO toolbox, their impact and usability tests in the five pilots. Stage 4 efforts are focused on co-evaluation, feedback and redesign. The co-evaluation will be, both, in terms of inclusion and accessibility assessment of the DMS/DDS, and of the INDIMO Toolbox. Pilots will provide feedback in order to improve the INDIMO toolbox. Finally, Stage 5 concerns the transferability assessment and the deployment of the INDIMO Toolbox as an online toolkit.

Figure 3: Methodology Concept



This practice aims to lead the establishment of guidelines and policies for developing digital information systems and applications for inclusive transportation. As such the outcome of this project will be a comprehensive online digital mobility deployment toolkit comprising 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 (UIL) icons)
- Guidelines for cyber security and personal data protection
- A policy evaluation tool and recommendations for policymakers

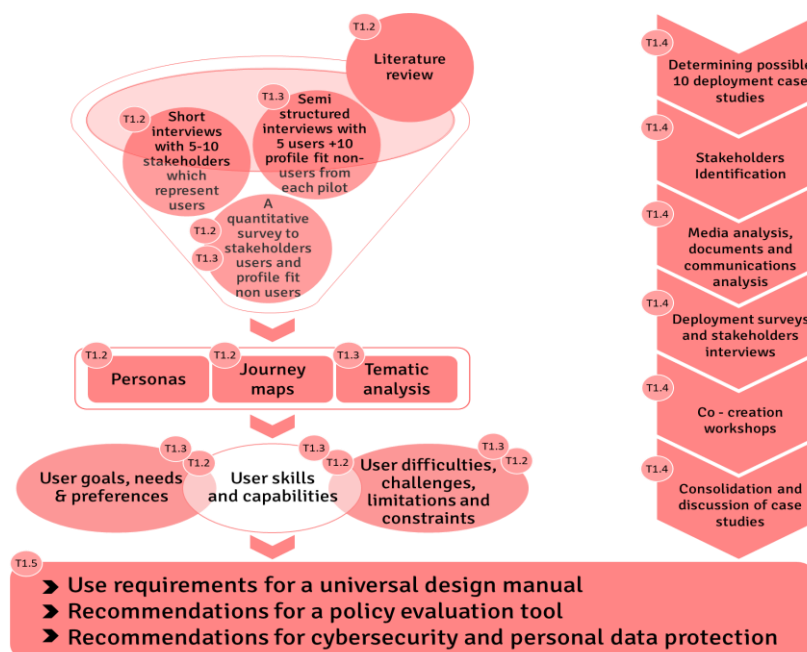
This report synthesizes and discusses the limitations and opportunities emerged from the research carried out in the first stage of the co-creation process, during the first year of the INDIMO project taking in consideration COVID-19.

## 2.1 WP1 Framework

During the first phase of Work Package 1 (WP1) “Analysis of barriers and opportunities for tapping the full potential of the digital interconnected transport system” a comprehensive framework (Figure 4) was established for the work plan of WP1 tasks (Table 1). The detailed results of T1.2, T1.3 and T1.4 are publicly available in deliverables D1.2, D1.3 and D1.4 respectively.

In general, the WP1 analysis framework of qualitative data collection included definitions of users’ characteristics in the five pilots (Table 2) and opportunities for information collection (table 4). Each pilot site addressed specific user profiles and characteristics and focused on certain digital mobility or delivery services that will be tested and re-designed during the project to be improved from the accessibility and inclusiveness perspectives.

**Figure 4: WP1 Framework**



**Table 1. WP1 Tasks**

<b>Task ID</b>	<b>Task Title</b>	<b>Leader &amp; Contributing Partners</b>
T1.1	Framework for analysis of user needs, capabilities, limitations & constraints of a digital transport system	Technion VUB, VDI/VDE-IT, IMEC, CambiaMO, MBE
T1.2	Analysis of the requirements of users towards the digital interconnected transport system	IMEC VUB, CambiaMO, DBL, MBE, Technion, ZLC, EPF, Door2Door, VIC, CoopCycle, ITL, PI
T1.3	Identification of user capabilities and requirements of a digital transport system on users	CambiaMO Technion, IMEC, EPF, DBL, MBE, Door2Door, VIC, CoopCycle, ITL, PI
T1.4	Understanding the process of the deployment of digital mobility services	MOBI – VUB VDI/VDE-IT, ZLC, polis
T1.5	Opportunities, limitations and constraints for the use of an inclusive digital transport system	Technion VUB, IMEC, CambiaMO

**Table 2: User profiles of the INDIMO pilot projects**

#	Pilot 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	<b>1<sup>st</sup> user profile: Older people who receive/send parcels</b>	<ul style="list-style-type: none"> <li>• Age: older</li> <li>• Lack of digital knowledge</li> <li>• Residing in peripheral locations</li> <li>• Lack of digital services</li> <li>• Lack of dedicated network infrastructure</li> <li>• Limited access to transport services and commercial delivery services</li> </ul>
			<b>2<sup>nd</sup> user profile: Migrants or foreign people who receive/send parcels</b>	<ul style="list-style-type: none"> <li>• Low economic conditions (assuming migrant from out of Europe)</li> <li>• Low level of education (assuming migrant from out of Europe)</li> <li>• Language barrier</li> <li>• Lack of digital knowledge</li> <li>• Residing in peripheral locations</li> <li>• Lack of digital services</li> <li>• Lack of dedicated network infrastructure</li> <li>• Limited access to transport services and commercial delivery services</li> </ul>
P2	Antwerp	Inclusive traffic lights	<b>Vulnerable pedestrians</b>	<ul style="list-style-type: none"> <li>• Age: older (over 60)</li> <li>• Permanently impaired or with disabilities: visual disability, wheelchair mobility</li> </ul>
P3	Galilee	Informal ride sharing in ethnic towns	<b>Informal ride sharing users</b>	<ul style="list-style-type: none"> <li>• Ethnic minority man/women</li> <li>• Residing in the periphery</li> <li>• Insufficient public transport services</li> <li>• Language barrier</li> <li>• Lack of digital skills</li> </ul>
P4	Madrid	Cycle logistics platform for delivery	<b>Healthy food delivery users</b>	<ul style="list-style-type: none"> <li>• People with reduced mobility</li> <li>• People with reduced vision</li> <li>• Socially isolated (unwanted loneliness)</li> <li>• Not-connected people (e.g., Low digital skills, lower technology availability)</li> <li>• Low income</li> <li>• COVID-19 isolated with none or reduced number of daily trips allowed</li> </ul>
P5	Berlin	On-demand ride-sharing integrated into multimodal route planning	<b>On demand ride sharing users</b>	<ul style="list-style-type: none"> <li>• Caregivers of children/ impaired/ elders</li> <li>• Gender: women</li> <li>• Lack of services (reduced mobility)</li> <li>• Lack of digital skills</li> <li>• Residing in peripheral locations</li> </ul>

**Table 3: The scope of information collection**

<b>Scope of information collection from Citizens</b>	<b>Scope of information collection from developers, operators and policymakers</b>
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	
Usability of the service’s digital interface	Service characteristics
Usability of the service’s physical interface	Demands from users
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 & security	
Safety perception	
Perception of the service’s resilience to crisis like Covid-19	Business demands: demands for developing, operating and maintaining the service
Attitudes, feelings/ emotions, preferences and opportunities	

In total, 70 semi structured interviews (SSIs) with digital mobility services’ users and non-users and 95 interviews with stakeholders representing users have been carried out. SSI structure was setup in accordance with several dimensions identified in the general analysis framework. SSIs and interviews were firstly debriefed, and secondly analyzed through a coding process performed by using the Quirkos CAQDAS (Computer Assisted Qualitative Data Analysis) software. Finally, the thematic analysis allowed to organize the identified codes in meaningful crosscutting themes in terms of similarities, differences, and relationships.

## **3. Synthesis results of D1.2**

### ***User Needs and Requirements on a Digital Transport System***

The present exercise aimed to gather an understanding of users' goals, needs, challenges and limitations of the INDIMO pilots via the perspective of stakeholders. We understood the notion of "stakeholder" as an actor that is active in pilot site and that, due to its activity, has experience with interacting with the user characteristics selected by INDIMO in the pilot. As such they can inform INDIMO about the end-user and his/her requirements towards the INDIMO pilot service although the end-user still remains someone who 'is spoken about'. The research results reported here should thus be read in combination with the output of D1.3 as the latter interviewed users and non-users and allowed to further refine requirements.

#### **3.1 User goal and needs**

The different INDIMO pilots were all acknowledged to have the potential to have a positive impact for the various user profiles. According to the interviewed stakeholders, vulnerable users might use the digital mobility services because a) they can increase autonomy by reducing the dependency on other persons and by reducing insecurity, b) they end isolation by connecting with relatives, c) they increase quality of life with their offering and d) they support emancipation and education.

In order to achieve these goals, there is a need for an easy and convenient system. This can on the one hand be achieved, not necessarily by using the newest technologies, but by rather looking in an intelligent way to familiar used technologies (for example use WhatsApp for connecting with elderly persons with a service such as food delivery) or solutions that allow hands-free operations (for example for blind persons crossing the street). On the other hand, it can be achieved by easy accessing and by supporting flexibility - allowing for sudden changes in needs and adapting the requests (for example cancelling a ride on the last moment and book a new one for caregivers in Berlin).

Some needs are more connected to particular vulnerable characteristics and go beyond technology. Confidentiality is a particular need for refugees and migrants. Persons with impairments (mobility, visual, auditory, cognitively) are highly in need of a system that is deployed within a broader strategy or structure in order to avoid a mere symbolic implementation of the solution. For example, in case of a smart light also the surroundings and safety of the pavements matters. In the case of food delivery, not only the availability of healthy food options matters, but also that it is presented in a structure approach of menus. Caregivers demand a solution that pays as much importance to the person they take care of as to themselves, requesting particular demands to the service agent or the physical tool involved

(car, tram, ...). For women from ethnic minorities in rural settings, the need is to reconcile two worlds: the one of tradition and the one of modernity.

## 3.2 User requirements

In order to achieve the above-mentioned goals and needs, the following user requirements were deduced from the stakeholder interviews:

**Usability:** Interfaces (digital or physical) should be intuitive and easy to use with an interface in the local language and using easy to understand terminology. The latter becomes more important with the age of the users. Gender sensitive terminology was mentioned as a requirement for the women belonging to ethnic minorities in rural areas. Attention should also be given to features that increases accessibility (adapting fonts, using colours, incorporating voice-over text technologies, ...).

The digital and physical tools should have a special approach to errors. On the one hand, the information they provide should be trustworthy and reliable (as people in particular difficult circumstances count on them to support them), while on the other hand, the functions that allow the user to provide information to the system, should be flexible and designed as much as possible to tolerate mistakes made by the user and allow easy ways out (a restart button and procedure, going back, confirmations, ...).

The digital tool should be customizable to personal preferences and needs. ). This requirement is not inspired by a wish to increase the options to choose from, but to focus and streamline the action better.

Finally, the physical tool should be recognisable by means of a clear branding and placed in a location that is easily accessible. In case of ridesharing and ride-pooling service, the car should meet certain requirements of safety and of size and storage space.

**Workflow:** The kind of workflow requested will depend on the kind of service. Two broad categories of workflow can be discerned. For delivery systems – digital lockers, healthy food delivery – as well as smart traffic lights, the vulnerable profiles demand a structured approach (e.g., step-by-step like in Instagram). In the case of the first two services, this is to reduce the information overload and allow for a learning curve through usage. In the latter case this is to be sure that too much information won't distract the user from the traffic circumstances.

In the case of transport systems, the user profiles on the other hand ask for a logical order – search, select, order, confirm – but in order to act fast, it is requested to set preferences or save history in order to skip parts of this order. For example, a caregiver of child might need to adapt a ride while looking after a kid: she or he does not have time to move through the whole interface but rather would like to order a ride based on past searches or preferences.

**Support and assistance:** Besides support tools such as videos or a FAQ, the need for a human assistance is felt among most of the user characteristics. In the case of younger profiles (women from ethnic minorities in rural villages or caregivers of children) the fact that a helpdesk is not operated by a bot or another technology but by a person is sufficient. In the case of older persons or persons with impairments or isolated persons or persons with low

income, training is felt as essential. This starts already in the early stage of detecting the system and follow-up should be organised throughout the usage stage. Working together with specific organisations that are working on the ground with vulnerable users is seen as a key element for success.

A particular aspect is the service agent. According to stakeholders, service agents play an important role, either as a support to explain/demonstrate a service (older persons, digital locker) or as crucial element in the experience of the service. This latter aspect is important for ride-pooling and ridesharing systems where the driver should be trained to understand caregivers and their specific needs. In the case of food delivery services, the service agent should talk on a certain soft tone in order not to scare customers and stay in a certain know auditory experience.

**Privacy and security:** For stakeholders, privacy relates on the one hand to a need to follow data privacy legislation, although they stress that some user characteristics won't be interested as such in the issue apart from bank details (older persons in particular). Besides data privacy, privacy also relates to preventing eavesdropping with impaired persons or protecting the safety of refugees (preventing giving away locations to authorities or human traffickers). Women from ethnic minorities in rural areas also request a certain respect of their privacy by for example not having a publicly visible profile on the service.

**Trust and reliability:** Trust for vulnerable persons will depend partly on the operator that is running the service. On the other hand, opinion leaders around them are important to introduce them to a service. In the service itself, ratings of service agents from other users is considered as a means to increase trust. Finally, a reliable service is very important, especially for impaired persons. They count really on these services to organise their mobility and a non-functioning system might have an important impact. Reliability is also important for users of ride-pooling and ridesharing and is in this context understood as offering a punctual service.

**Covid-19.** An important part of the covered profiles by INDIMO are considered as belonging to a group at high risk – older persons and impaired persons. A general requirement of vulnerable end-users will be that each service will develop a particular protocol to interact with them, apart from the general sanitary measures (wash hands, distance, gels). For home delivery services this means looking for safe ways to drop the food at home, with a different approach for each vulnerable segment. For transport services – be it ride-pooling or ridesharing – certain grouping of passengers will be needed in order to reduce risks of contamination. This is more urgent if caregivers are the target audience of the latter services. For digital lockers the system will have to be redesigned in order to avoid queues – for example by spreading opening hours of the place where the locker is placed or by organising a ticketing system with a certain hour when one can use the locker.

Covid-19 also had an impact on vulnerable pedestrians. Vulnerable pedestrians such as PRM's (people with reduced mobility) and visual impaired testified that other persons initially were more hesitant to provide assistance on the road. The Belgian public rail service provider for example interrupted the service for impaired persons. Only after a few weeks they noticed a change in attitude. Apart from a change in attitude of other pedestrians, the fact that during

lockdowns less people were on the street also impacted the mobility of visual impaired people as they had less auditory cues (cars, boots) around them to orient themselves or cross streets.

### **3.3 Persona and user journey**

For each pilot a persona was created to turn the gathered users' goals, needs, challenges, limitations in the stakeholder interviews and the interviews with users and non-users (See D1.3) into a human portrayal of a user that can inspire developers to redesign the INDIMO services into a more inclusive and accessible tool. The persona represented the user characteristics for which the most information was collected in a pilot. All 5 personas turned out to be women, but apart from that touched upon different user characteristics.

For each of the personas, also a user journey map was also designed in order to portray the current user experience for developers and the pilot teams. Key areas of attention to improve the user experience with the INDIMO services are the following:

- Awareness stage:
  - Communication at crucial contact points with vulnerable end-user
  - Build a network of local organisations/opinion leaders
- Consideration:
  - (Structured) information on the application/digital tool
  - Set-up a support strategy
  - Highlight particular functionalities present on the tool that are relevant for the target audience
  - Make the service customizable to personal preferences
- Service usage:
  - Check presence / train service agent
  - Enable key-functionalities that support the vulnerable target audience
  - allow easy ways out and be flexible
  - Real-time structured information
  - Provide support to users via familiar app such as WhatsApp
- Post – usage:
  - Work on feedback channels in order to learn lessons about end-user experience
  - Assure post-usage follow-up (monitoring of usage, adapt learning strategies)

### 3.4 Recommendations for the UDM

1. Guidelines of the UDM with respect to the digital tool should focus on accessibility (fonts, colours, voice-over text) and inclusion (terminology, language) as well as workflow (logic order, learning process); these should also be translated to the physical tool (car, locker).
2. Guidelines of the UDM should take into account the familiarity of technology to vulnerable users and avoid learning new skills. Focus on what they already use, not on complex new technologies for end-users.
3. Guidelines of the UDM should not be limited to only the digital interface or the digital tool, but as well to the service agents and the physical tools.
4. Guidelines of the UDM should take into consideration aspect of reliability and how to verify this for the end-user (a “working” technology).
5. Guidelines of the UDM should focus on support and assistance mechanisms besides the digital tool. How to connect to opinion leaders and associations that provide support to vulnerable users.
6. Guidelines of the UDM should take into account, besides protecting data privacy and theft, other aspects of privacy such as protecting human safety, avoiding eavesdropping or keeping confidential profiles online.
7. The UDM should be used from the initial stages of ideation/prototyping in co-creation processes so that requirements of end-users are taken from the start into the development process.
8. Participation of end-users in co-creation should go beyond mere consultation. End-users should not only inform but also have “decisional” power.
9. The UDM should stress the importance to create flexible and customizable systems, able to adjust to specific needs and requirements
10. The UDM should enable feedback so problems can be detected sooner and DMS / DDS can be improved along the way.

## **4. Synthesis results of D1.3**

### ***User Capabilities and Requirements of a Digital Transport System on Users***

#### **4.1 Identification of users and non-users' needs**

The research was framed in the users' experiences and preferences about digital service or applications. It moved forward towards the identification of requirements of current and future users with regards to digital interconnected transport system. The methodology comprised user and non-user in depth-interviews, stakeholder interviews; literature analysis; Communities of Practices (CoP) discussion, user case studies on topics that highlighted certain aspects that are not covered or slightly covered by pilots (e.g., Budapest use case).

The insight from the pilots, with different user profiles, locations, and mobility solutions, allowed us to identify needs of the users and potential users. Also, stakeholders on behalf of specific groups of population, provided their inputs to build a narrative that moves across geographies and profiles. Needs vary across populations groups and pilots, but there are threads as "space", "time" and "trust & Human Contact" that are points of contact and common areas for all pilots and their specific profile of users and non-users.

Space-related needs are associated to the lack of infrastructure, transport poverty and difficulties for personal mobility. Some settings, such as the disperse villages of rural geography or the scattered and less densely connected peri-urban landscape contributed to a feeling of inadequacy of current transport setting and the potential of Digital Mobility Services (DMS) and Digital Delivery Services (DDS). Time-related needs are associated with the good use of the variable time; time needs to be flexible, adapting to the user demands. And at the same time punctuality of different services is highly valuable, especially in the context of mobility of care (D1.3, specific dedicated session). Finally, with regards to trust and human contact, there is a demand for the human presence and assistance behind the services that cannot be completely replaced by automation of features. The contact with human people, even by technological channels, is a valuable source of inclusion and a cornerstone of trust building.

#### **4.2 Users' requirements**

Users' requirements were collected from Stakeholders, Users and Non-Users of DMS/DDS applications and services. We followed the CLR path (Capabilities, Limitations and Requirements), as the path that allows us to provide the inputs for the ulterior construction of the Universal Design Manual. We organized the fieldwork and their instruments with the dimensions in accordance with the guidelines from D1.1. Those dimensions were the starting point. But the output, the Main requirements, were organized through the following relevant categories that resulted from our analysis:

**Accessibility:** search of autonomy, reducing the dependency on relatives, friends or unknown passers-by in the street. Anticipation and control on the graphic interface are key elements to reduce the anxiety associated with orientation or excess of information in a digital environment. Real time input for users contributes to the feeling of continuous feedback and reassurance .

**Inclusiveness:** human contact and assistance are a strong and constant element of this category of requirements. Human contact contributes to the warmth of relations as well as the feeling of flexibility and adaptation. The inclusion of different levels of digital competence, experience, language skills and socioeconomic status imply a strong need for adjustments and flexibility in the treatment. The availability of language options, but also a simple and familiar wording (using icons and images as part of this language) is also part of the requirement.

**Additional options:** the DDS/DMS are seen not only in their current status, but also in their potentiality. Users pointed out the benefits that an extension of the delivered products, functionalities and services, including the covered geographical area, could bring.

**Workflow:** most of these requirements address the simplicity with which the information is exposed, highlighted and treated. Requirements in this category deal with the ease of the navigation of the interface and the aids that this navigation may have for people who are not familiar with apps or who have specific difficulties. Be it the completing bar, the calculator and the error detection, these requirements target the feedback that the user has during the navigation process in order to ease the anxiety and reinforce the orientation.

**Physical interface:** the interaction with the riders/drivers generates a new layer of interface that is populated with its own reinforcements and barriers. The manners, help, offer and general friendliness of the service agents are highlighted. The way they express themselves, the introduction, the knowledge of the user's name and their identification contribute to the feeling of safety and trust building are key elements of these requirements. Also, new concerns about risk exposure in times of COVID-19 pandemics. In this context, an oriented training or the human contact availability can be useful.

**Privacy and data security:** this group of requirements is triggered by the sensitivity that some information (mainly bank and credit card info, address, phone number and personal identity) hold for the users. Transparency about the date that is stored and clearly conveying conditions of how the data can or will be used lay out the direction of these requirements.

**Security and safety:** especially sensitive for women, there are physical integrity concerns related to the interaction with rider/drivers, with the spatial setting and with the other users that may be part of the service. The requirements in this group tackle the effective response of the service to unforeseen situations of harassment, violence or assault specially related with gender.

**Communications:** requirements in this category are related to the service exposing clearly their benefits and the target audience, expressing their social and environmental values in any, and facilitating the adoption and use through pieces of communication such as manuals, tutorials and lessons or the contact with facilitators.

**COVID-19 related:** this category addresses the relevance in current times of working with clear protocols regarding the operation, which is especially relevant for people who feel more at risk in the face of pandemics, such as older people. These protocols should not only be in place but also actively communicated.

## 4.3 Summary of main findings

**Digital gender divide.** A good part of the research on women and mobility focuses on the threats and the violence they face moving around in the public space. An important finding of our research shows that when women were parenting, their identities of mother stood above other identities, and their main concern was related to their children's safety, and about the interaction of others with their children. A main insight of our study shows that regular mobility services address a "male individual" user and do not contemplate the specific needs of caregivers in charge of dependents. This is an aspect of mobility that sometimes is obscured: transporting with others, either children or older people imply special requirements (type of vehicles, equipment, on-boarding and off-boarding spots etc.). Finally, women, especially when they are socially isolated, feel less comfortable with unproven technology.

**Mobility and physical disabilities.** A new insight of our study is that many people with reduced mobility are eager to show that they can have things done by themselves and may visualize the services of an app (for example, a service of food delivery) as an assistance that undermines their autonomy and their ability to solve issues on their own. Assistance appears as a two-fold aspect: as favoring autonomy or intruding in it; both as empowering and as a non-considered assistance. This has been long developed in our theme for Madrid, "Search for autonomy" and brings the focus on what levels of assistance are desired by different segments of the target-groups population.

**Smart traffic lights and disable people.** The studies reviewed focused on smart traffic lights for the fluidity of vehicle circulation and there are not many articles that view smart traffic lights from the point of view of the pedestrians. This way of thinking the traffic is so rooted that, like it was found in the present research, vulnerable users incorporate this view when recognizing feelings of guilt for "stopping or delaying the traffic". This is a new insight that the present study casts light on. It was also found that there is no accessibility solution that is only a technological solution. In the case of Antwerp, if smart traffic lights were not accompanied by repairing and maintenance works in the surroundings of the crossing, the innovation would be perceived as "just another gadget". This is a reminder to avoid the excessive techno-optimism and to bear in mind that digital approaches to problems always have a physical interface which has an important weight on the nature of the problem.

**Foreign people as central public users of DDS.** The new insight of the present research is to identify the potentiality of foreign people as central users of the locker system of parcel delivery. It was seen in the elaboration of Emilia Romagna pilot that there is an unmet need of the foreign people regarding the simplification of their exchanges with their families in their hometown. DDS offer a possibility of simplifying and enhancing this operation that is part of the life of someone settling down in a foreign country. Foreign people are presented in this way as potential users and participants of a new experience.

**Non-connected people.** One of the ways the present research goes beyond the bulk of the literature is that it does not consider all older people as a homogenous group. We found that

many of the characteristics of low connectivity ascribed to older people were in fact idiosyncratic elements of specific contexts. This is the case of the examined rural areas where old mobile equipment (which blocks the possibility of a successful download of a new app) was associated with a more traditional mindset and the attachment to the “old way” of doing things. An idiosyncratic resistance typical of an environment goes far beyond the age cohort.

Most of the literature on user-centred approaches to include these groups mainly covers the feedback given by the app (through sounds, tones, pop-ups) but does not emphasize sufficiently the importance of the humans behind all the digital interfaces, the need of direct contact with other humans, to give confidence and empower the user.

## 4.4 Recommendations

1. To enhance the concept of human-centred design, it is advisable to start-off from the identified requirements in order to build up the design, technical and visual solutions that address the aforementioned items. The CLR path (capabilities, limitations and requirements) as well as the *persona* experience, developed in D1.2, allows design for concrete profiles and with real users in mind.
2. Allow potential users to take part in the design and decision process before the deployment of a new service. A participative approach, such as co-creation workshops, facilitates the user’s engagement and provides the tools for developers to know more of their target population.
3. Integrate vulnerable-to-exclusion people, from different profiles, in the decision-making process of the items of accessibility and inclusiveness of the services and apps. Only the direct involvement of those who are really concerned with accessibility may make differences on this aspect.
4. Future research on this topic will need to be aware of the specific difficulties in the sampling of recruiting of certain profiles. Also, regarding difficulties that arose during the fieldwork completion. During the interviews, many non-users, who have not yet adopted digital delivery services or digital mobility services, were led by the researcher into hypothesis, conjectures, and possible scenarios to talk about their beliefs and feelings about the technology they are not familiar with.

## 5. Synthesis results of D1.4

### *Barriers to the Design, Planning, Deployment and Operation of Accessible and Inclusive Digital Personalised Mobility and Logistics Services*

#### 5.1 Main findings

The results of this task will be used to define the contents of the Universal Design Manual for Digital Mobility and Logistics Services (D2.1) as well as to start the development of the Policy evaluation tool in Task 2.5. The barriers and drivers identified through the case studies will be used to identify what issues the Universal Design Manual and the Policy Evaluation Tool need to address in order to provide a comprehensive and relevant blueprint for inclusive and accessible digital mobility services in the future.

Based on the results presented in deliverable 1.4, we have identified a number of common requirements, needs and challenges of policy makers, operators and developers that are relevant for all types of services investigated. These barriers and drivers are related to the **market position of the services, the regulatory framework in place, the integration of the service into the public transport service network, the diversity of the vulnerable to exclusion groups, knowledge about the vulnerable groups, the level of user involvement (co-creation), the fast evolution of digital mobility services and the availability of local support for ensuring accessibility and inclusiveness, communication and collaboration between stakeholders.**

From the significant drivers and barriers described above, four topics were discussed more frequently and more elaborately during the interviews and thus, were considered to have a bigger impact on the development and implementation of an inclusive digital transport system. First, the need for **a regulatory framework on multiple levels** is clear, for both developers and operators, but also for cities and regions, so that there is a clear vision of what is needed and expected when services want to operate in a designated area. The framework should also address specific aspects such as accessibility, availability, inclusivity, sharing of data, collaboration between the private and public sector. Such a regulatory framework would push for more initiative towards the development of inclusive transport services and would therefore also have a positive impact on the number people making use of a more inclusive digital transport system.

Secondly, there is a need for **collaboration and open communication** during and after the development phase on several levels. Firstly, operators and developers should have open communication so change happens faster and more efficiently, secondly, they should be in close contact with the policy makers in the regions they are active in. In combination with a regulatory framework stating the needs and expectations from the service this would create a more stable market situation. A more stable market situation positively influences user

involvement. A clear example is car-sharing, compared to other services, it's the oldest type of shared mobility we studied, with a decent regulatory framework in most places and the providers have more stable operations and a secure market share. We concluded that fluctuation in the market results in operators and developers focus on the general population without keeping in mind the vulnerable to exclusion groups and any measures to include these groups such as co-creation events. Market stability results in a steadier revenue stream, resulting in services taking time for co-creation with and input from vulnerable to exclusion groups. A third important aspect of communication is the need for **user involvement** and co-creation between all stakeholders and the (potential) users of their service, keeping in mind the need for heterogeneous groups when organising co-creation events. User involvement needs to be focused on the people vulnerable to exclusion and not on those already making use of the service. A major issue is the lack of knowledge among the stakeholders about vulnerable to exclusion groups, which makes reaching them very hard. This often results in events with very homogenised groups: highly educated, majority, middle-class people who already have the means, skills and knowledge to make use of these services.

A last pivotal topic for further development of the digital transport system is the **collection, management and sharing of mobility related data**. Shared knowledge and experience would be a massive boost for the development of services, which are now happening horizontally by developers and cities, with multiple developments experiencing the same issues and barriers. Apart from sharing knowledge and experience, sharing data, by the introduction of KPIs, would have a major impact on the efficiency for users. It is no surprise that the MaaS-like services already collect a lot of information, several of these services are in favour of sharing information, operators and developers are a bit more concerned. Sharing of relevant information could result in a disadvantage compared to the competition. Another aspect the operators and developers were concerned about is the management of data, they do not trust governments have the skills to collect, manage and share the data so that it creates advantages for all parties.

A regulatory framework related to inclusive development, data collection, data-management and sharing and collaboration, in combination with the growth towards a more stable market could have a positive effect on the inclusivity and accessibility of a mobility or logistics service. These topics will be key during the development of the INDIMO Policy Evaluation Tool.

## **5.2 The Policy Evaluation Tool - recommendations for further work in INDIMO**

The development of the policy evaluation tool is based on the results from three tasks and the input from two workshops related to the INDIMO Co-Creation Community (CCC). The tasks providing input are Task 1.4 Understanding the process of the deployment of digital mobility services, Task 2.3: Enhancing appropriation of digital mobility solutions and Task 2.4: Cybersecurity and privacy assessment guidelines. The Policy Evaluation Tool is an online tool for policy makers and user organisations (NGOs) created to evaluate digital transport solutions and services based on the principles outlined in the Universal Design Manual. The goal is to

help policy makers to create a framework that will provide accessible, inclusive digital mobility to all groups in society.

Currently, only the results from Task 1.4 are available, results from both other tasks will gradually become available during the project as both task 2.3 and task 2.4 start in project-month 20 (April 2021) and end respectively in month 34 (October 2022) and month 20 (August 2021). Furthermore, two co-creation workshops will be organised to involve stakeholder in the development of the tool.

As described above, Task 1.4 focused on multiple topics of which the regulatory framework in effect, the user involvement, inclusivity measures and data collection, management and sharing were the most prominent ones and considered relevant as input for the Policy Evaluation Tool. This section contains the first recommendations for the development of the tool, based on input from interviews and the workshop as part of T1.4 and thus can only be considered as a first set of guidelines that were produced.

The Policy Evaluation Tool will be used, primarily by policy makers to ensure the introduction of inclusive digital mobility services. Therefore, a clear description of an inclusive service is pivotal, for which the Grant Agreement cites the Universal Design Guidelines with two guidelines related to the digitalization of transport systems<sup>1</sup>. The seven principles of Universal design are:

- Equitable use
- Simple and intuitive use
- Low physical effort
- Size and space for approach and use
- Flexibility in use
- Tolerance for error
- Perceptible information

The two principles that were added for the INDIMO project are related to the digital transformation of the modern, interconnected transport system:

- Social, spatial and economic inclusiveness
- Security and protection of data

The first guideline that was added, the social, spatial and economic inclusiveness, relates to a multitude of different aspects related to digital inclusion: having the economic power to pay for multiple subscriptions, living in a neighbourhood where digital transport is active, having access to mobility at the moments you need it, having the tools to access the information etc. Secondly, the security and protection of data is becoming more and more important and has a significant effect on the general workings of a service.

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<sup>1</sup> Story, M. F., Mueller, J. L., Mace, R. L. (1998). The universal design file: Designing for people of all ages and abilities.

Based on the general findings above, the Universal Design Manual and the Policy Evaluation Tool should address the following topics:

- **Recommendations for the consideration of the market position of the services.**
- **Recommendations for the regulatory framework that supports accessibility and inclusion.**
- **Accessibility and inclusivity requirements when integrating a digital service into the public transport service network.**
- **Methods to address the diversity of the vulnerable-to-exclusion groups and the identification of key groups.**
- **Ways to gain knowledge about the vulnerable groups.**
- **Support for user involvement (co-creation) in the development of services.**
- **Flexibility to deal with the fast evolution of digital mobility services.**
- **Recommendations for subsidies and incentives to ensure accessibility and inclusiveness.**
- **Recommendations to foster communication and collaboration between stakeholders.**

All interviewees and experts asked for guidelines and frameworks for the development of services, for the collection and sharing of data and help in general for the creation of an inclusive digital transport system.

A bottom-up agile approach in co-creation of digital mobility solutions with attention to sustainable use of (urban) space and social equity holds the key to the success of future digital mobility services that are equally accessible and includes all sections of the society. Therefore, both the Universal Design Manual and the Policy Evaluation Tool should pay special attention to what benefits co-creation can bring in making services more inclusive and accessible and how this can be facilitated during the development phase of the services. Several questions can be raised such as: What are the technical, financial and knowledge requirements to integrate co-creation into the development process? How can we involve vulnerable-to-exclusion persons in this process? Who should implement such a process and how?

Notwithstanding the barriers and drivers outlined in the previous section that are relevant for most digital mobility and logistics services, **there are differences** in the way of developing and operating the different types of digital transport systems leading to a difference in the collection of data, the target groups, possibilities for inclusion and accessibility. While general guidelines are helpful, digital mobility and logistics services are very diverse in terms of target users, technological solutions, business models, duration of being on the market, competition, volatility on the market. This requires that the Universal Design Guidelines and the Policy Evaluation Tool **provide tailor made advice** to specific types of services.

Due to the fast evolution of digital technologies and business models, **the guidelines also need to be flexible** and will need to be regularly updated to reflect these changes.

## 6. Opportunities, Limitations & Constrains

Conducting the field work in accordance with WP1 Framework (Figure 4) provided both insights and implications to the opportunities, limitations, and constrains of digital mobility/delivery services (DMS/DDS). In general, INDIMO consortium and pilot partners have managed to produce helpful feedback through the extensive fieldwork. Meeting WP1 objectives, the remarkably detailed information collected allows for the establishment of clear guidelines for the INDIMO Digital Mobility toolbox.

**Opportunities:** The face of digital mobility services is continuously changing as new technologies, applications, and devices offer more and new mobility options. The repeated appearances of use requirements, beliefs, motivations and feelings, shared by the target groups of the five pilots and case studies, make us think that addressing the opportunities for more inclusive and accessible digital mobility/delivery services (DMS/DDS) is of great importance at present. Covid-19-related repercussions stressed this importance even more. Clearly there are social representations and images about digital services that should be considered at the time of designing technology taking into consideration, rather, **all** end-users.

At the same time as citizens are looking to enhance their mobility, regulators, operators and developers drive the movement of private-public-partnerships (PPP) forward toward more inclusive and accessible transport network systems.

**Limitations:** The results of our multi-stakeholder investigation pointed out several key barriers to the deployment of inclusive and accessible digital mobility services. Nowadays, applications can be easily developed practically by anyone and uploaded to the Internet for the public to use at one's "own risk". The regulatory framework is often non-existing or outdated, and there is a lack of knowledge among developers about potential vulnerable-to-exclusion users. In general, users are predominantly not involved in the development of these services. Also, there may be a lack of cooperation and collaboration between private and public organizations. Application development outbreak typically overlook accessibility and inclusivity features, as well as the data privacy and protection sensitivities of various target groups. Further, the limited willingness to share mobility related data and information among developers, operators and public authorities may harm the service.

**Constrains:** Alleviating a number of constrains can help make existing and/or new digital mobility services more inclusive and accessible. First, there is a genuine to engage potential users and enhance public awareness of existing mobility services and increase users' engagement. For people to trust and make use of present digital mobility systems, personal data needs to be collected on "a must have" basis and handled in accordance with strict data privacy and data protection regulations (e.g., GDPR the General Data Protection Regulation). Having said that, unstable market conditions lack a comprehensive universal regulatory framework addressing cybersecurity, data privacy and data protection. Data privacy and data protection regulations are often unclear, too complicated and therefor overlooked by users, operators and other stakeholders, which are not aware how data is randomized, protected and shared. Our investigation outcomes show there is a need for clear determination on the use of personal and mobility data.

Secondly, gender and culture biases require the integration of digital services into the public transport service network following explicit guidelines to overcome the barrier of mobility services deployments targeted only for “male individuals” or “modern cultures”. Given we live in a “small global village” consultation with end-users and their representatives globally could provide insights on accessibility and inclusivity features and understandings for all potential users to benefit from. Finally, our findings stress that the assumption that in the digital era human contact is obsoleted is wrong. On the contrary, for digital services to flourish, the constrain is the digital transformation itself. It is crucial to build trust among users, to provide dedicated assistance and support mechanisms for the service to be reliable, while ensuring privacy and prevention of personal data misuse. Utmost users proclaim human contact prior, during and following the use of digital mobility and delivery services.

## 7. Discussion

WP1 synthesized results represent a shift of paradigm from the design-as-usual where experts “know what users need” to integrating the perspective of multi-stakeholders including vulnerable-to-exclusion groups from the beginning, and thus increasing the users’ acceptance of digital mobility and delivery services.

Outcomes derived from WP1 tasks and the work plan framework (Figure 4) highlight the significance of using comprehensive design guidelines as a cornerstone for accessible and inclusive digital mobility services developments. Co-creation events and communication with multi-stakeholders provide the required platform for sharing of information about best practices and local support schemes, which could further enhance the introduction of accessibility and inclusiveness features along with supreme data privacy and protection.

Evidently, the differences between the digital mobility/delivery services studied in the pilots and case studies show that there is no single “right” approach to design, develop, deploy and operate more inclusive and accessible services. Though, the different applications and digital services may vary by type of service (e.g., mobility, delivery), location, language and culture, the design and deployment resonating limitations and constrains most of the services are struggling with are alike. Thus, results highlighted in this report cover relevant aspects for fostering the Universal Design approach throughout the planning and design process of digital mobility applications and services. Further, the key findings and result analysis may provide the opportunity to help create the guidelines for developing inclusive and accessible digital mobility services that are more aligned with use requirement of vulnerable-to-exclusion groups.

Overall, WP1 results offer a qualitative take allowing for filling the knowledge gap about accessible-by-design digital mobility services and improving the inclusiveness of the interconnected digital transport systems by exploring needs, capabilities, barriers, and requirements of vulnerable-to-exclusion users on the one hand, and the challenges that developers, operators, and policymakers face, on the other hand.