Mobility for ALL – Who Is "ALL", and How Are "ALL" Addressed by Mobility Solutions and Services Using Automated Shuttles?

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Abstract

Visions for future mobility solutions often contain expressions such as "mobility must be available and affordable for all" and "accessible to all". This paper discusses who "all" is, what "all" should be able to reach and how future mobility concepts, represented by automated shuttles, address "all". First, aspects to consider when discussing "mobility for all" are identified. Based on a benchmarking of sites with automated shuttles services, and a stakeholder workshop involving cities - the paper analyses coverage of "for all" aspects in shuttle initiative ambitions, objectives, target groups, and underlying driving forces among the involved cities and regions. Results indicate that explorative objectives, focusing vehicles and technology, dominate among existing shuttle initiatives. Less is done on services to simplify usage. Diving forces coupled to "for all" are not in majority. The paper concludes with recommendations for factors to consider when addressing mobility "for all" by automated shuttle services.

Keywords: *mobility for all, user aspects, automated shuttles*

Αφηρημένη

Τα οράματα για μελλοντικές λύσεις κινητικότητας περιέχουν συχνά εκφράσεις όπως «η κινητικότητα πρέπει να είναι διαθέσιμη και προσιτή για όλους» και «προσβάσιμη σε όλους».

Αυτό το άρθρο ασχολείται με το ποιος είναι «όλα», τι «όλα» πρέπει να φτάσει και πώς οι μελλοντικές έννοιες κινητικότητας, που αντιπροσωπεύονται από αυτοματοποιημένα λεωφορεία, αντιμετωπίζουν «όλα». Πρώτον, προσδιορίζονται πτυχές που πρέπει να ληφθούν υπόψη κατά τη συζήτηση «κινητικότητα για όλους». Με βάση τη συγκριτική αξιολόγηση ιστότοπων με αυτοματοποιημένες υπηρεσίες μεταφοράς με λεωφορείο, και ένα εργαστήριο ενδιαφερομένων μερών που περιλαμβάνει πόλεις - το έγγραφο αναλύει την κάλυψη των πτυχών «για όλους» σε φιλοδοξίες, στόχους, ομάδες στόχους, και υποκείμενες κινητήριες δυνάμεις μεταξύ των εμπλεκόμενων πόλεων και περιοχών.

Τα αποτελέσματα δείχνουν ότι οι διερευνητικοί στόχοι, εστιάζοντας τα οχήματα και την τεχνολογία, κυριαρχούν μεταξύ των υφιστάμενων πρωτοβουλιών μεταφοράς. Λιγότερα γίνονται στις υπηρεσίες για την απλοποίηση της χρήσης. Οι δυνάμεις κατάδυσης σε συνδυασμό με το «για όλους» δεν είναι στην πλειοψηφία.
Η εργασία ολοκληρώνεται με συστάσεις για παράγοντες που πρέπει να ληφθούν υπόψη κατά την αντιμετώπιση της κινητικότητας «για όλους» από αυτοματοποιημένες υπηρεσίες μεταφοράς.

***Λέξεις-κλειδιά**: κινητικότητα για όλους, πτυχές του χρήστη, αυτοματοποιημένα λεωφορεία*

1. Introduction

The future transportation system is in a transition phase. The research on mobility has for a long time argued for the need to include societal dimensions of mobility transitions (Sheller, 2014), and that long-term society perspective needs to be included (Milakis & Müller, 2021). Also a clearer policy and planning agenda which clarifies the long term public vision for automation in infrastructure and transport planning has been asked for (Oldbury & Isaksson, 2021).

In general, there is a strong need to find transportation solutions that are sustainable. This includes aspects such as fossil free vehicles, shared solutions, more active travelling, and behaviour changes – all dependent on the citizens' acceptance and willingness to change, which calls for development starting points not only from a technical perspective but also from a user centric perspective (Kyriakidis, et al., 2017).

Advancements in technology and digitalisation provide opportunities to develop a wide spectrum of "smart", automated and connected mobility solutions. "AV" (Automated Vehicles) and "CCAM" (Cooperative, Connected and Automated Mobility) are accompanied by a range of growing expectations such as "…provide more safety, better social inclusion and higher efficiency…" (European Commission, 2019).

One of the main arguments in the emerging literature on societal aspects of AVs is that there is reason to believe that the sociotechnical nature of the transport system may be ignored (Milakis, 2019). According to Gandia et al. (2019) less than 5% of research papers between 1969-2018 within the AV area are of non-technical nature, even though the numbers are increasing from 2015 onward. Milakis & Müller (2021) claim that there is a need for an open, socially constructed process for AV's development, and that research needs address not only the technical, but also the societal dimension of AV's transition.

Even if several societal aspects in relation to users, e.g. system level ethical issues, have been raised for transitions involving AVs (Borenstein et al., 2019), it is often argued that initiatives with AVs are driven from technical innovation. In contrast to a "technology push" a white paper on smart cities and integrated mobility initiatives states that "An informed vision and a structured measurement strategy are needed well before the implementation of the project to unlock benefits." (Polytechnique Montréal, 2018). The authors note that the two most popular triggers for a city to launch a smart city initiative were enhancing social cohesion and quality of life and supporting economic development in a sustainable way.

There are several visions and goals related to future mobility and automated transport solutions. In this paper ambitions to provide access "for all" are of particular interest. An example on the international level is UN Sustainable Development Goal 11.2: "By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (UN, 2021).

The European Commission in its Sustainable and Smart Mobility Strategy points out that "…it is crucial that mobility is available and affordable for all, that rural and remote regions are better connected, accessible for persons with reduced mobility and persons with disabilities…" (European Commission, 2020).

Inclusiveness is also addressed in national transport policies. One example among the EU member states is Sweden, where STA, the Swedish Transport Administration (Trafikverket, 2019a), has an overarching objective for 2030 (with a view of 2050) stating that the transport system shall be inclusive, offering good access for both citizens and industry – regardless where in Sweden you live or act (Trafikverket, 2019b). This means that all citizens irrespective of age, gender, background or economy should be able to use the transport system for their basic access, and persons with specific needs should have equal opportunities to travel, no matter where they live and where they have their destination. While recognizing that the degree of access depends on e.g. socioeconomic aspects, geographical location, disability, degree of digitalisation etc., STA states that:

- citizens living in rural areas can access work, schools, services (public and private), culture and experiences;
- business and industry have access to markets and an educated workforce;
- access in cities primarily is provided by sustainable, shared and coordinated, highly reliable transport solutions.

Driving forces for automation can be illustrated by an example from Japan. In 2017 the Prime Minister at the time, Shinzo Abe, stated that "we will aim to address labour shortages in rural areas and help people with mobility difficulties by introducing automated driving that does not need human drivers by 2020." (Roland Berger, 2018). An increasingly automated mobility system is seen to assist the aging population and people with mobility impairments, and to tackle driver shortages in rural areas. Additional objectives are increasing road safety and reducing traffic volumes. Similar expectations are numerous and can also include expectations on reduced environmental impact (Ministère de la transition ècologique, 2020; Trafikverket, 2019b).

There are however also concerns. Questions are raised about whether AVs are sufficiently safe, if traffic may increase and cause more congestion, if use of PT may decrease, or the risk of increased inequalities (Blumenthal et al., 2020; Litman, T. 2021; Horizon 2020 Commission Expert Group to advise on specific ethical issues raised, 2020; Trafikverket, 2019).

The span of expectations on CCAM regarding equality and inclusion is illustrated by Lucas (2019), who notes that “Optimists see e.g. that people who are currently not able to own or drive their own vehicles will be given new access to the benefits they derive. Pessimists predict an increased concentration of transport wealth amongst the already privileged and partial or a total lock-out of the people and places who cannot access these services for reasons of their unaffordability or non-operability within certain spatial contexts, e.g. sparsely populated and remote areas.” (Lucas, K. 2019).

One solution to provide accessibility to citizens is to use automated shuttles, most often as a complement to existing public transportation (PT). Citizens is a wide definition of a user group and it might be relevant to ask what constitutes a mobility solution that provide accessibility “for all”?

According to Hewitt et al. (2019) the user should be able to reach her destination cost-efficiently and safely, trust the service and feel safe while using it. Ideally, the mobility service should allow the user to have adequate control over the complete journey and, if needed, get assistance to reach the destination. This could be both in “physical terms” e.g. getting to, on and off the

vehicle, as well as how to pay, access information about operations, use apps etc. Infrastructure and vehicles involved in the use of a service should be practically feasible.

In 2016 Columbus, Ohio, USA won a "Smart City Award" (City of Columbus, 2021). The city notes that the very nature of many "smart city" systems means that a part of the population, usually those with limited access to information and communication technologies, might be excluded from certain aspects of the smart city (City of Columbus, 2020). Mott Macdonald (2019) recommends that people can engage with the information services that provide the gateway to access connected and automated vehicles (CAV), and that those unable to do so are not excluded. Elimination of technological barriers for users who may not have the means to access a device to use the service is furthermore recommended. In addition, it is pointed out that urban and rural contexts for CAV access and use differ in terms of the characteristics of users and their mobility needs.

Several projects and studies have investigated inclusiveness for mobility and transport solutions. INCLUSION is an EU Horizon 2020-project that aims at identifying gaps and needs for providing accessible and inclusive public transport for all, especially vulnerable categories. This is considered being key to ensure equity of transport and social inclusion (INCLUSION-Project, 2019). Additional studies which focus accessible transportation are e.g. (City of Columbus, 2018; Lucas, K. 2012; Roland Berger, 2018). "Transport poverty" is a concept that broadly refers to difficulty or inability to make necessary journeys. It depends on e.g. the households' disposable income, rate of employment, level of completed education, type of housing in the area (Lucas, 2012). The age structure also plays a role, since the ability to use PT and to drive a vehicle varies with age. Ideally a mobility solution "for all" helps mitigating transport poverty. Gates et al. (2019) claim that transport can be integral to improving equality, by increasing access to jobs, education and services, and conclude that the accessibility of a transport and mobility system is defined by its level of cost, the geography it covers, and the time and reliability of different transport options.

AV users are also discussed in the AVENUE project (AVENUE, 2020). It deploys automated minibuses in 4 European cities, and has studied acceptance. An interview-based study found that expected advantages include bus connections where there are none today and cheaper tickets. The same study also notes user requirements of importance are absence of rigid timetables and being able to call the bus to any position whenever needed (AVENUE, 2018). User aspects can also be found in Hewitt et al. (2019), and include the ability to get assistance needed to reach destination – this can be both in "physical terms" e.g. getting to, on and off the vehicle, as well as how to pay, access information about operations etc, use apps. Additionally, infrastructure and vehicles required to use service should be practically feasible.

Even though a lot of demonstrations and research have been done it is still not, to the best of our knowledge, clear how future mobility concepts, represented by automated shuttles, address "all". The aim with this paper is to identify aspects to consider when discussing "mobility for all", including who "all" is, essential destinations that "all" should be able to reach, and basic requirements for a mobility solution "for all" with AV.

2. Method

Automated shuttle services were selected as a use case to discuss how future mobility concepts address inclusion in terms of mobility for all. As a starting point "4all" (for all) is defined by identifying who "all" is and the destinations that all should have the right to reach. Two activities were undertaken:

- **Benchmarking** of sites in Europe where automated shuttles are or have been used in pilots and demonstrations, obtained through web-searches of projects described in the UITP (2020) SPACE progress map, and two complementing web-searches for additional pilots and demonstrators. In total over 90 initiatives have been reviewed. For included sites, see Annex 1. The amount of information available for the sites varied largely, leading to a selection of 40 sites for the analysis with respect to ambitions, objectives, target groups, and underlying driving forces for involved cities and regions. This material was used to identify if and how 4all aspects were considered.
- **Workshop with stakeholders.** Benchmarking findings were shared and further elaborated in a workshop with stakeholders from five Swedish cities which have shown an interest in automated shuttles. There were also some additional participants representing owners of land, public transport operator, the organization in charge of the region's public transport, and research organizations. The ongoing operation with two shuttles in Linköping, Ridethefuture (2021), was used as a concrete example to inspire the workshop participants. Due to covid-19 pandemic a physical experience with the shuttles was not possible instead a video describing a ride was used. At the workshop findings from the benchmark/mapping were presented to participants, who were asked to react and grade these from different point of interest via the interactive polling tool menti (Mentimeter, 2021).

The presentation of the results and the analysis is done based on four different research questions:

- Who and what should be included in a 4all mobility concept?
- Are 4all aspects included in the objectives of the benchmarked initiatives?
- Do the target groups of existing initiatives include 4all perspectives?
- Are there any 4all-related underlying driving forces for the shuttle initiatives and at higher policy levels?

3. Results

3.1 Who and What Should be Included in a 4all Mobility Concept?

There are several suggestions of groups that could be considered users of future mobility solutions. A consolidation based on the reviewed sources and policy documents shows that a mobility service is prepared 4all if it works for any person regardless age, encompassing those that are too young and too old to drive a car, as well age groups in between and those with accompanying persons. Children, youth, elderly and parents with children needs to be included. Furthermore, all genders and ethnicities are to be included. 4all also encompasses persons irrespective of level of income or education (no-low-high), ability to use and access digital tools, and physical and cognitive health capabilities. Those that have, as well as those that do

not have, special needs should be included. Urban, peri-urban and rural citizens are all part of "all" disregarding if the area they live in is well or under-serviced by PT and the areas socio-economic standing. Furthermore, the mobility solutions should allow all to persons getting to education, work, culture and experiences, health care, child- and elderly care, as well as providing access to goods and markets.

The different aspects of who "all" are and the destinations "all" should be able to reach through mobility are summarized in two, so called, 4all-checklists, to be used further in the study:

Checklist for "who to be included"
- ✓ Age
- ✓ Gender
- ✓ Ethnic aspects
- ✓ Educational levels and digital experience
- ✓ Income levels
- ✓ Persons with special needs / persons with disabilities
- ✓ Citizens in rural areas

Checklist for "what all should be able to reach"
- ✓ Education
- ✓ Work
- ✓ Culture, experience
- ✓ Health care
- ✓ Childcare, elderly care
- ✓ Market, goods

3.2 Are 4all Aspects Included in the Objectives of the Benchmarked Initiatives?

The objectives defined for each demonstration site are often unique. At some sites they are part of a larger scope or linked to an overarching driving force. In Figure 1 objectives retrieved from the benchmarking of shuttle projects have been clustered into groups, when applicable. Some projects have more than one objective. A bar reflects a certain objective's occurrence among all objectives identified for the reviewed shuttles – in some cases projects may have more than one. 4all-related objectives are marked in dark grey.

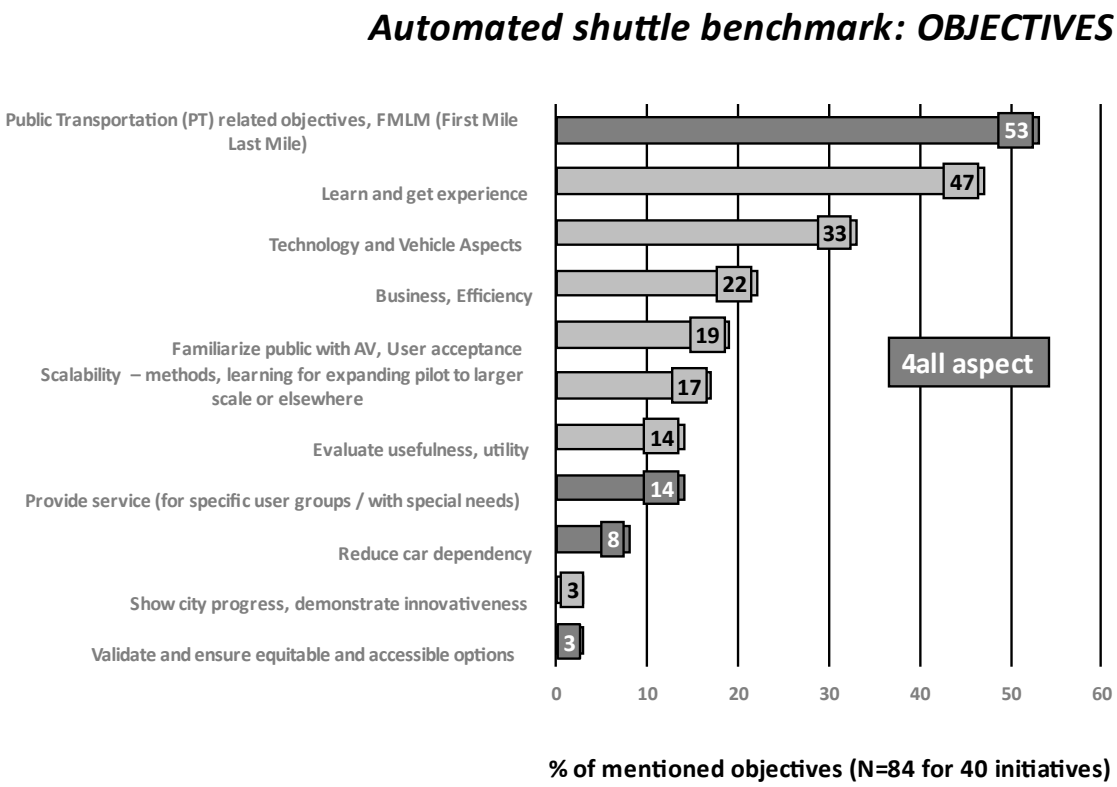

Figure 1: Benchmark study: Objectives of automated shuttle initiatives.

The most frequently occurring objectives are related to PT, in particularly to provide first mile, last mile services (FMLM), which can have a coupling to 4all when equity and accessibility is part of the objective. There are also projects aiming to provide service for specific user groups or users with special needs.

Many objectives can be labelled as "exploratory". This includes projects undertaken to learn and get experience with technology, vehicles, or permit procedures; to familiarize the public with AVs; to study user acceptance; evaluate methods or to investigate potential usefulness of a shuttle.

3.3 Do the Target Groups of the Benchmarked Initiatives Include 4all?

The shuttle initiatives intend to address various types of users, and some aim to target several groups. In Figure 2 a target group has been given "a point" when a project includes at least the specific user group. As can be seen persons living in cities and in communities constitute target groups among the largest number of benchmarked initiatives. Numerous projects are directed towards persons who can be assumed to have a choice and financial means, i.e visitors, tourists, commuters, employees.

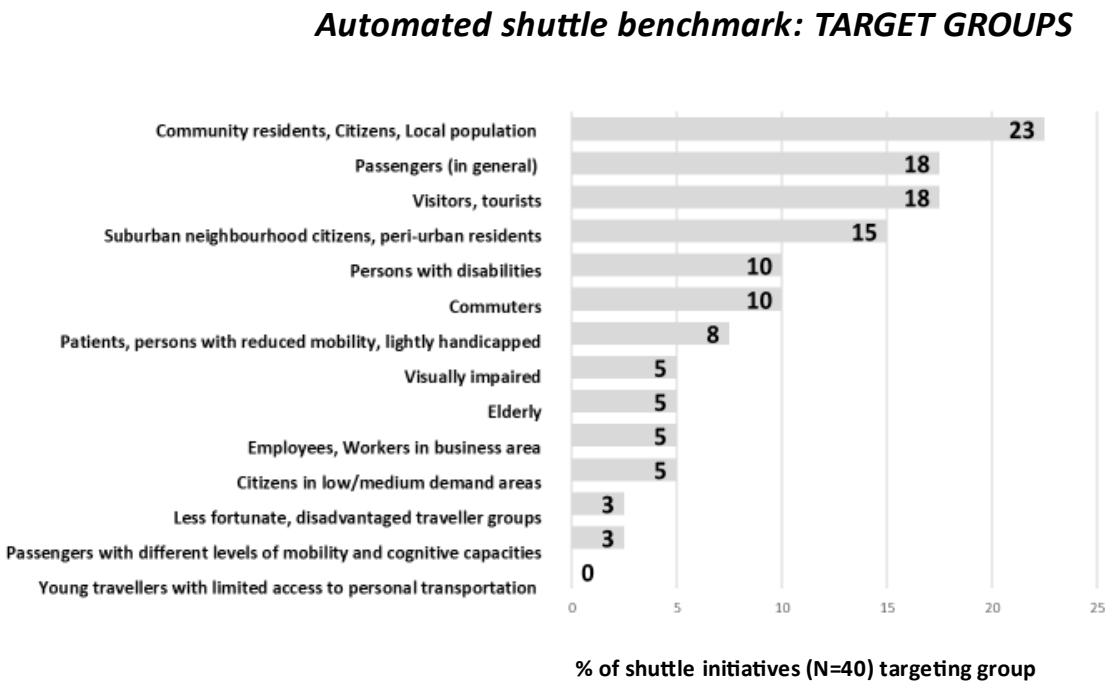

Figure 2: Benchmark study: Intended target groups.

Among the groups in the checklist, it can be noted that some projects target elderly or persons with various (reduced) cognitive or motor capacity. However, only one single project identifies "less fortunate, disadvantaged traveller groups" as a target group, and no initiative explicitly addresses younger persons.

3.4 Are there any 4all-Related Underlying Driving Forces for the Shuttle Initiatives and on Higher Policy Level?

As noted from the introduction there are multiple expectations and visions for automated mobility solutions. The higher-level ambitions that are reflected in driving forces for shuttle initiatives is presented in Figure 3. It should be noted that there were sites where no coupling to societal ambitions could be found. For a certain driving-force the lighter portion of the bar indicates the number of projects where it is found to occur, while the darker portion refers to the occurrence in studied policy documents and where 4all-related driving forces are marked with an arrow.

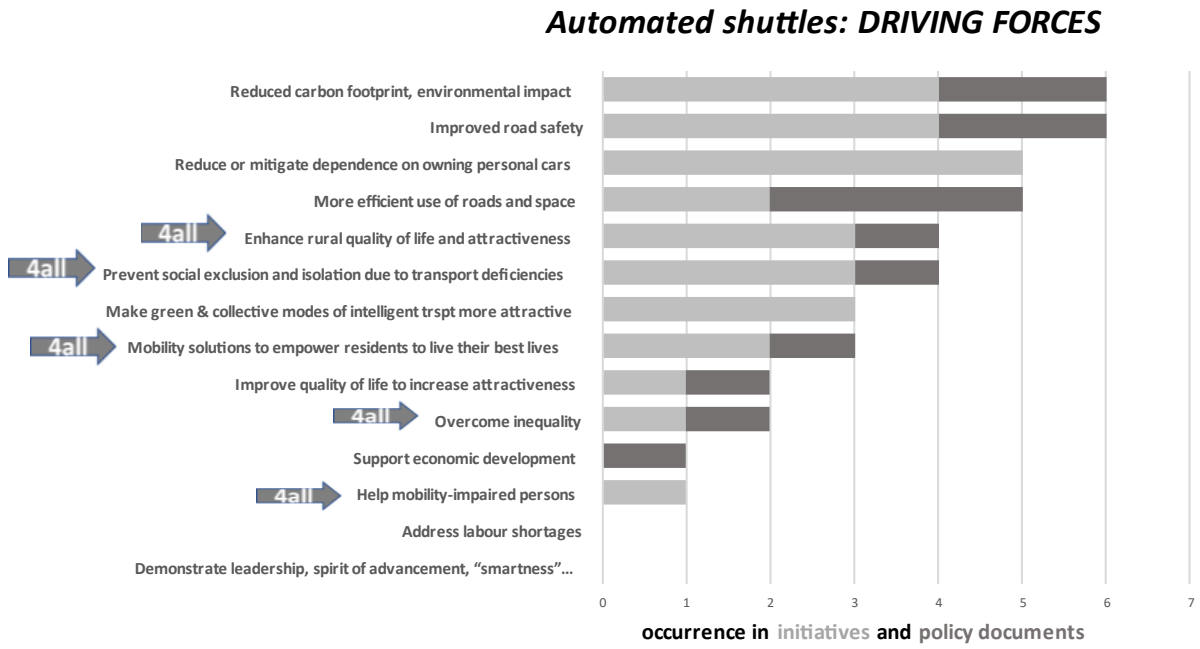

Figure 3: Shuttle mapping: Driving-forces identified among initiatives (N=40), policy documents (N=7)

3.5 Workshop

As a complement to the benchmarking the workshop was performed. The participants were asked to grade to what degree they thought an automated shuttle can play certain roles – from no role at all to large role. Taking for granted that shuttles' technical limitations, such as the limited velocity, have been solved, there are high expectations on the contribution to PT, as can be seen in Figure 4.

***Error! Reference source not found.**: Workshop with Swedish stakeholders; N=12*

Another highly graded role is to provide fairer, more equal access which according to the stakeholders means inclusion of various age groups, citizens in rural environments and persons with special needs. These three categories are also those that the workshop ranked highest when asked about which of the groups in the checklist they consider make up "all". Rated as most important was to include different age groups (36% of votes), closely followed by inclusion of citizens in rural areas (30%). In declining order "all" irrespective of disability (20%), income and digital experience/savvy-ness (both 7%) have also been marked.

The workshop furthermore pointed out that "persons with disabilities", "disability" or "persons with special needs" are a very broad descriptions and cover a wide range of needs of various nature. It was also noted that car ownership in cities or vulnerable areas is often lower. Citizens may have working schedules outside PT's typical peak hours, while PT may be the most

common way to reach the "rest of the city". The stakeholders raised concerns about the costs to provide 4all-services, and the importance to explore any savings opportunity through coordination of shuttles and PT.

The checklist about "who is included" was presented to workshop participants. They marked which group they considered needs to be included in 4all. Inclusion of all ages and of citizens in rural areas were considered most important (36% and 30%, respectively, of awarded points). Persons with reduced cognitive or physical capabilities are also graded comparatively high (20%) and followed by coverage of different income levels (13%).

4. Discussion

Results indicate that existing shuttle initiatives to a large extent aim to get technology experience and explore potential usefulness. Target groups of existing shuttles cover primarily persons living in or close to cities. The coverage of 4all factors is in principle limited to age (adult and elderly) and persons with disabilities. Not much is done on services to simplify usage. Even if there are examples of target groups and driving forces that couple to 4all, these are not in majority. Future projects will have to widen the current typical scope dominated by vehicle and technical aspects to respond to 4all-related driving forces and ambitions.

Based on a consolidation of the results from this study, with support from the literature, it might be claimed that to address the 4all perspective a mobility service using AVs like shuttles needs to include several user aspects in its design. It needs to operate in areas of different socio-economic standing and the price for travelling must be manageable, also for those with low income or unemployed. It is important that the service is developed to fit all age groups, including not only specific groups as children or elderly but also those of ages between. A person's level of education, or experience of digital solutions should not be barriers for usage. Here the concept "design for all" is of great importance. As always what is good for those with specific needs most often also benefit the majority without specific needs.

Furthermore, 4all perspectives must be included in the service offer, such as operating during hours when travellers need to go which may be beyond conventional rush hours. The duration of a trip must be acceptable, an issue that is highly related to the speed of the shuttle. On-board and supporting staff must be fair, trustworthy, and supportive to travellers if assistance is needed. The operation itself needs to be perceive as safe, secure, and dependable. In addition, the vehicles should be experienced as safe and trustworthy. It is also important that the infrastructure where the shuttle is running is optimized for shuttle users, e.g. at stops and their access routes. Considering the workshop discussions, reviewed projects, and literature, it is suggested that an automated shuttle must include several components such as vehicles, stops and the infrastructure allowing access to the stops, routing, schedules/timetables, information, payment methods/ticketing, business models, drivers/personnel. Considering user-oriented

questions that have been discussed in the establishment of the Ridethefuture (2020) shuttle service a set of components for a successful operation have been identified, see Table 1.

Table 1: *Coupling between user questions and mobility solution components.*

User oriented aspects	**Mobility solution component to handle the aspect**
Where does the shuttle go, and when?	Choice of route, relevant hours of operation
How can this information be obtained?	Information, ”app”
What is the cost? How do you pay? Is it secure?	Business model, payment methods, ticketing, Business case
How can this information and the payment/ticketing be achieved?	Information, ”app”
How can you get to the shuttle service?	Shuttle stop design including how it can be accessed (infrastructure)
How to get on and off the vehicle?	Vehicle design
	Information, bus personnel
Is the ride perceived as comfortable, safe and secure?	Vehicle design, way of driving
	Safety driver, bus personnel
If help is needed to get information, to travel, when on the bus – how and where can it be accessed?	Information,” helpdesk”, ”app”
	Service design

This study and Table 1 point to that a systems approach is needed when designing 4all automated shuttle services. The components to be considered might be grouped into three “building blocks” for a 4all service:

A. The choice of area for the operation, the route, schedule, hours of operation, frequency of trips, integration with other transportation
B. The design of “apps” and information essential for a user’s use of the service
C. The design of the vehicle, the stops and how to get to the stop; support onboard vehicles and at stops

The most common purpose of existing shuttles is to supplement existing public transport and to provide FMLM service in urban areas or their close vicinity. It is also common that shuttle projects are exploratory, designed to gain experience of the technology and its use, while trying

to see what needs the shuttle can solve. In contrast, there is no or only sparingly, mentioning of payment methods/ticketing, “apps”, and information design and/or content among shuttles’ purposes. Sites seldom address how to get in touch with the service or acquire information. Cost of services when using the shuttle were not found to be subject of any of the mapped studies (Iclodean et al., 2020). Instead, most of the demonstrations ongoing were free of charge. Another area not addressed was how those without digital experience/skill or not having access to digital devices or mobile phones can benefit of using the shuttles.

The groups most targeted by the benchmarked projects are people in or close to urban areas. In the workshop the stakeholders from the cities stressed the importance of making PT available to more people: outside commuting times, providing connections to areas not served by conventional PT for economic reasons or due to e.g. spatial or environmental constraints. The threshold for using existing PT could be lowered by combining it with self-driving solutions.

The workshop participants rated age as the most important 4all factor to consider closely followed by inclusion of citizens in rural areas. The cities present in the workshop expressed that they expect that automated solutions should make traffic cheaper and provide more frequent trips to the countryside. The literature about rural citizens is however rare. It appears that the longer distance from a city centre, the fewer projects there are.

Additionally, stakeholders consider it a high priority to cover persons with special needs, which is pointed out to be a highly heterogenous group. This is to some extent addressed in the benchmarked projects, most often by including elderly and people with reduced physical or cognitive ability in target groups. No project among those studied explicitly mentions the age group "young". While the workshop also indicated that persons with different income levels and digital capabilities should be encompassed by 4all services, it can be noted that only one of the mapped projects addresses less fortunate and disadvantaged traveller groups, and there is no mention of digitally inexperienced.

Driving forces can be considered as a basis for a stakeholder’s desire to make a certain implementation, e.g. of automated shuttles in a city. Among the driving forces found in the studied initiatives, five can be considered to be related to 4all aspects in the check-list; see Figure 3.

In the benchmarked AV shuttle sites safety and environmentally related driving forces, e.g. “reduce dependence on owning and using a private car”, dominate. Cities in the workshop expressed that the main driving force for their interest in automated shuttles is to increase PT use and attractiveness. They argue that if this is successful several other driving forces will be handled (need to own personal car, congestion, emissions). Workshop participants also identified a potential for AV shuttles providing mobility for various age groups, citizens in rural environments and persons with special needs, which aligns with 4all-related driving forces. This is in line with earlier research (Milakis & Müller, 2021).

The analysis of the 4all user groups from the checklist provide an input to 4all aspects for consideration in the respective building blocks – A (Area of operation, route, schedules, timing), B (Payment methods, apps, information) and C (Vehicle, stops, access points, service).

Purposes related to building block C dominate among the reviewed shuttles' objectives, however with limited attention paid to 4all aspects. The default user of a service appears to be an adult, and when ages are mentioned, it is usually by including elderly as intended shuttle travellers. The design of the vehicle and bus stops in some cases consider persons with disabilities.

To adequately address building block B 4all factors and target groups identified need to be considered in shuttle service design, especially regarding the information and apps involved. Increased attention to building block A, which has limited coverage in the studied shuttles, involves designing operations' routes to cover areas where the various 4all groups live and work, and services needs to be designed so they are accessible for intended users, thus enabling their getting to essential destinations during relevant hours. If all, or "everyone", is to be included, it is also necessary to develop business models that do not limit opportunities to travel to privileged income groups.
The benchmarking study and the stakeholder workshop both show that the most frequent purposes for automated shuttle initiatives are to increase the use of PT and to improve its attractiveness, in particular by playing a role as FMLM service.

5. Recommendations

Automated shuttle services are expected to make PT more attractive, primarily by providing FMLM-services. Taking into account all building blocks and aspects above shuttle services can provide opportunities to give fairer and more equal access to mobility.

To realize ambitions the following actions are recommended:

- To complement PT and/or provide opportunities for new routes that are not possible today due to e.g. spatial constraints, the capacity of the shuttles, regarding e.g. possible number of passengers, tour frequency, speed, should be shaped to enable integration into the PT system.
- Solutions with AVs are also expected to make it easy and smooth to move between two points, preferably on demand and to provide a realistic alternative to privately owned cars, which calls for solutions that not only attract pedestrians and cyclists.
- Despite the vehicle and technology focus of numerous initiatives there is also a need for vehicle developments of the shuttles. Workshop participants stress that a shuttle ride must feel safe, secure and comfortable, preferably be climate friendly, and offer stable operations at decent speeds, allowing acceptable duration of travel. The business dimension and alternatives for providing persisting, and economically sustainable, 4all services also need to be developed.

6. Conclusions

There is a gap between the desire to achieve "mobility for all" through automated solutions represented by shuttles and how this is supported by the studied initiatives. "4all" is not

dominating neither among purposes of nor driving forces for existing shuttles, except for occasional ambitions to include citizens in rural areas.

Services must include 4all-aspects in their target groups, and be designed for persons irrespective of age, gender, ethnic aspects, level of education, digital experience, income levels, special needs, or disabilities, or if persons live in cities or rural areas.

Younger persons and people with limited experience of and access to digitalization need to be taken into account, especially when designing service/apps, routes/timetables and information.

In addition to the current focus on vehicles and technology it is essential to apply a systems approach. Projects must devote dedicated attention and activities to all three building blocks:

- Area of operations, route, schedule, time, integration into public transport
- Information, apps, payment methods
- Vehicles, stops, access points, on-board personnel

Targeting wide enough groups and taking a systems approach, by applying the checklists and considering all the building block aspects, might increase the chances for future solutions that indeed provide “mobility for all”.

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Appendix: Analysed Shuttle Projects

SHUTTLE LOCATION	**Source**
Norway	
• Gjövik	
• Kongsberg	
• Arctic Memory Svalbard – airport – City,	
• Route 35 Oslo (Ruter) Akershusstranda – Vippetangen	
Sweden	
• S3 Lindholmen, Gothenburg	
• Stockholm linje 549	
• Ridethefuture, Linköping	
Robobus, Helsinki, Finland	
URBAN-CAD Tampere, Finland	
Movia Copenhagen, Denmark	
Germany	
• HEAT (Hochbahn) Hamburg	(UITP, 2020) July 2020
• Bad Birnbach	
Greece	
• ACINT Trikala	
• CityMobil2 project, Trikala	
Belgium	
• First STIB pilot campaign, Brussels	
• Autonomous shuttle service Brussels Health Campus	
France	
• Charles de Gaulle Bridge Shuttle, Paris	
• Lyon Confluence – NAVLY	
• Paris la Défense Autonomous Vehicle	
Switzerland	
• Swiss Transit Lab Route 12, Mars 2018 -Navya; Schaffhausen	
• SmartShuttle; juni 2016; Navya, Sion	
AutoMOS; large bus; Málaga, Spain	
Germany	
• Karlsruhe – city center	
• Living lab mobility Aachen, Germany	
Kehlheim, Germany	(Donaukurier, 2020)
Route 35 Central Oslo – Kongens Gate	(Ruter, 2020)
Bus Route 85B: Nedre Bekkelaget – Malmøya	
Digibus Willischwandt, Austria	(Digibus Austria, 2020)

SHOW Horizon 2020 project Trikala, Greece Austrian megasite: • Graz • Salzburg • Vienna Brno satellite, Czech Republic Swedish megasite	(SHOW, 2020)
Project Synergy, Greater Manchester, UK	(Project Synergy, 2020)
Queen Elizabeth Olympic Park Shuttle, London, UK	(London Legacy Development Corporation, 2018)
Mannheim /Mannheim, Germany	(Verkehrsverbund Rhein Neckar, 2017)
Autobus.com; Seestadt, Austria	(Wiener Linien, 2020)
Copenhagen Satellite, Denmark	(Lincproject, 2020)
SUMP 10 goals (Sustainable Urban Mobility Plan)	(European Commission, 2013)
AVENUE Project Lyon, France Pfaffentahl, Luxembourg Copenhagen, Denmark	(AVENUE, 2020)
Drive2theFuture project	(Drive2theFuture, 2020)
34 German projects listed in	(VDV, 2020)
Additional shuttle intiatives mentioned in (Iclodean, Cordos, & Varga, 2020)	
Turin, Italy	https://www.torinocitylab.it/en/news/391-the-deployment-of-the-olli-self-driving-shuttle-starts-in-turin
France:	
• Lyon	https://www.lyon-entreprises.com/actualites/article/de-meyzieu-a-la-zac-des-gaulnes-premiere-experimentation-de-la-navette-autonome-navya-en-site-ouvert
• Fontevraud	http://saumur-kiosque.com/article.php?id_actu=43455
• Lille	https://www.univ-lille.fr/nc/actualites/detail-actualite/?tx_news_pi1%5Bnews%5D=1423
• Rennes	https://www.univ-rennes1.fr/actualites/une-navette-autonome-pour-desservir-le-campus-de-beaulieu
• Sorigny	https://www.tld-group.com/news/the-autonomous-shuttle-bus-of-easymile-the-ez10-is-at-the-tld-facility-of-sorigny/
• Satory	http://www.vedecom.fr/les-navettes-autonomes-de-vedecom-1-an/?lang=en