Proceedings of 7th Transport Research Arena TRA 2018, April 16-19, 2018, Vienna, Austria

Transport and Mobility Services to Support Active Ageing

Tom Voege[a,*], Yanying Li[b], Dirck Beckmann[c]

[a]*International Transport Forum of OECD, rue André Pascal 75775 Paris Cedex 16, France*
[b]*ERTICO – ITS Europe, Aveneu Louise 326, 1050, Brussels, Belgium*
[c]*DLR, Rue du Trône 98, 1050, Brussels, Belgium*

Abstract

Active ageing is the process of optimising opportunities for health, participation, and security in order to enhance the quality of life as people age. Provision of adequate mobility services is essential to enable older people, including those with illness or disability, to participate in society. In the past, much effort has been made to make public transport more accessible for older people or to provide specific door-to-door transport services. Transport and mobility services to support ageing society should look into new technologies which can support the elderly in their driving tasks, either using privately owned cars, shared vehicles, or various mobility services to provide door-to-door transport solutions through Mobility as a Service (MaaS), shared mobility, etc. Various driver assistance and vehicle automation technologies which can reduce driver workload and enhance safety will offer viable solutions for the mobility needs of an ageing population. MaaS, which can provide a one-stop solution to access and payment for all types of transport modes, would be an excellent solution for older travellers. This paper aims to provide a forward thinking analysis of transport policy for an ageing population.

Keywords: Active Ageing; Transport Policy; Vehicle Automation; Mobility as a Service (MaaS).

* Corresponding author. Tel.: +33 145 24 82 00; fax: +33 145 24 85 00.
E-mail address: tom.voege@itf-oced.org

1. Introduction

1.1. The aging society and the concept of active aging

The World Population Ageing 2015 from the Department of Economic and Social Affairs, United Nations (UN, 2015) projected that between 2015 and 2030, the number of people in the world aged 60 years or over is to grow by 56%, from 901 million to 1.4 billion. And by 2050 the number of people aged 80 years or over globally, i.e. the "oldest-old", is growing even faster than the number of older people overall. The rapid ageing of the populations of many countries around the world is resulting in a number of social and societal challenges, including in the context of mobility, according to Bloom et al. (2010). In order to address the pressure from ageing populations, many government policies on ageing society have shifted towards encouraging and supporting 'active ageing'.

WHO (2002) defines active ageing as "the process of optimising opportunities for health, participation and security in order to enhance quality of life as people age". It applies to both individuals and population groups. Active ageing aims to make people realise their full potential for physical, social, and mental well-being throughout their lives and to actively participate in society while providing adequate services, care, and protection to ensure continuing participation in social, economic, cultural, and civic affairs. Active ageing has many benefits to both individuals and society as a whole, such as enabling independence throughout life. To enable active ageing, including for those with illness or disability to participate in society, provision of adequate mobility services is essential.

1.2. Current transport policy for aging society and social changes

As the aging population grows, so has the focus of transport policy for older people in government policy. In the past, much effort has been devoted to make public transport more accessible for older people, or to provide specific door-to-door transport services (also known as demand-responsive transport services or dial-a-ride). Whilst there is no doubt that such efforts have had impacts on enhancing the mobility of older people, in the past decades, transport policy and efforts to enhance the mobility of older people was often somewhat narrowly based on various assumptions, such as mobility declining with increasing age, and older people being on low incomes (Metz, 2003). Typically, many developed countries offer senior citizens free pass or discounted fares for local public transport and provide railway services which aim to benefit pensioners on low incomes, who could be hindered in their travel by the cost of fares. Such assumptions may not be valid in today's social and economic environment.

A current study has confirmed that personal mobility does not necessarily decline with increasing age; e.g. a study from the Independent Transport Commission UK (ICT 2016) on recent trends in road and rail travel shows that for women over 60, car driving mileage have more than doubled between 1994 and 2014, while over the same period, for young men (under 35) car driving mileage almost halved. Regarding the economic situation of the aging population, research carried out by the OECD shows that poverty has shifted from the old to the young across OECD countries (OECD, 2015a); in other words, the old are getting richer and young people are getting poorer. However, the current transport policies in many countries do not reflected this altered social trend.

While the increase of the ageing population has resulted in many challenges, it has also presented many opportunities, particularly regarding the applications of Information and Communication Technologies (ICT) according to a study by the OECD (OECD, 2015b). In recent years ICT has been successfully used for personal health services, known as 'e-Health', to improve access to health services. However, transport policy for an aging population has been slow in the uptake of ICT for the provision of personal mobility services to older people, although there are many innovative technologies and services which can meet demands of older people and enhance their travel experiences. In recent years, the transport and mobility sector has experienced a revolutionary transformation enabled by ICT, sharing economy, smart phones usage, and ubiquitous mobile internet access, etc. Applications of various innovations can fill the gap of current services and meet increasing travel demand from an active ageing society. Transport services for older people can thus be a fast-growing market for various innovations in the transport and mobility sector.

1.3. Trends of the personal mobility market

The personal mobility market is experiencing a revolution driven by new technologies, such as vehicle automation, smart phone uptake, and social media. Such revolutionary changes in personal mobility can bring significant benefits to older travellers to meet their demand and encourage them to continue participation in social and economic activities. However, such benefits have not yet been realised; neither by service providers nor by policy makers, resulting in a lack of adequate policy frameworks and business models to leverage benefits of new technologies to older travellers. Currently, many new service providers in the personal mobility sector often aim to provide services to young customers and rarely consider that their services may also be an excellent solution for older people who increasingly have the budget to pay such services and are willing to do so.

It is essential to study possible business models, needs in policies and future research, in order to develop suitable services to bring new technologies in the personal mobility sector to support the ageing society. Service providers, researchers, and policy makers should study the needs of older people in the current social and economic contexts, thus developing adequate innovative services and policies to support older people's local journeys and long haul travels.

This paper aims to raise awareness of new mobility services for older people. There are number of new technologies in personal mobility, which have great potentials to support active ageing. This paper uses two examples of new technologies, i.e. Mobility as a Service (MaaS) and vehicle automation, to analyse their potentials to serve an ageing population and to identify needs in research in the short and the long term, and for developing the supporting policy framework. The two technologies are selected since they have attracted a somewhat inflated interest among the mobility sector stakeholders, but applications for meeting demands of older people are currently not fully discovered.

2. Mobility as a Service (MaaS) for older people

2.1. General principle of MaaS

The concept of Mobility as a Service (MaaS) emerged in 2014 during the Intelligent Transport Systems (ITS) European Congress in Helsinki, where the MaaS Alliance was officially launched. Since then, many projects and organisations have embraced the concept, finally making it a reality. MaaS is the integration of various forms of transport services into a single mobility service accessible on demand by individual customers. To meet a customer request, a MaaS operator facilitates a diverse range of transport options, be they public transport, ride-, car- or bike-sharing, taxi or car rental/ lease, or a combination thereof. MaaS can offer to its users added value through use of a single application to provide access to mobility, with a single payment channel instead of multiple ticketing and payment operations. For MaaS users, it should be the best value proposition, by helping to meet their mobility needs and solve the inconvenience of planning and booking individual journeys as part of the entire system of mobility services, as indicated by the MaaS Alliance in its recently published white paper (MaaS Alliance, 2017).

MaaS is seen by the ITS community as a major game changer for mobility services, driven by widely used smart phone Apps for travel information, booking and payment, and the increasing importance of the sharing economy in the transport sector, i.e. car-sharing and ride-sharing (Li and Voge, 2017). The revolution MaaS has brought to the personal mobility market is a monthly subscription combining various transport services, which in the past was applicable to public transport only. Using real-time information from road traffic, availability and use of various transport modes, MaaS provides the most suitable transport plans to a customer, based on estimated travel time, cost and personal preferences. The principle of MaaS is that a traveller does not need to search for information on individual transport modes, in order to find a suitable combination and to purchase tickets of individual transport modes and operators. MaaS will carry out these tasks for a traveller and the traveller will be given the most suitable travel plan through a Smart Phone App and use the App to access all transport modes planned.

2.2. Users of MaaS: younger vs. older people

MaaS offers users high levels of flexibility and convenience of person mobility, resulting in less need for car ownership. In recent year, it has been noted that the Millennial Generation has a lower rate of car ownership than

previous generations at their age, due to demographic shifts, e.g. delay of starting a family, and lifestyles, e.g. preferring urban living (the Wharton School, 2017). Therefore, it is not surprising that MaaS currently targets young customers who live in cities and who use Smart Phones as a primary tool to communicate, to access information, and to pay for shopping and services. MaaS is a response to these social changes. However, young customers may have sufficient knowledge on their local transport options and prefer to use various Apps to access transport information and services.

Contrary to the primarily targeted customers, MaaS may therefore also be a good solution to meet the travel demands of the aging society. MaaS can integrate innovative transport modes (e.g. shared mobility) into journey planning. Current mainstream journey planner tools, e.g. Google Map, require users to select a preferred mode, e.g. driving, public transport, or walking. For planning a journey using public transport, such journey planner will only include conventional public transport modes, such as metro and bus. The current mainstream web-based or App-based journey planners have their limitations in integration of all possible modes (e.g. a journey can be carried out partly by car, partly by public transport). They certainly have not considered new mobility modes in their journey planning.

Such an approach does not match the roles shared mobility can play in the personal mobility sector. For example, Uber is targeting what is known in transport planning as the first or last mile gap. In Sydney, data provided by Uber indicated that 10 per cent of Uber trips start or end within 200 meters of a medium frequency public transport hub. The 'first and last mile gap' is often considered as a key factor to prevent modal shift from private car to public transport. This factor may play an even more important role for older travellers when they plan their journey. The 'first and last mile gap' issue is more critical for older people. Hess studied public transit usage data in two American cities specifically about those aged 60 and above, and concluded that it is apparent that they use public transportation only if the origins and the destination of the journeys are made along the inter-town express public transit network, but the usage is very low (Hess, 2009). The current public transport systems in most cities have long been perceived to be inconvenient with services adequate to older people's needs. Therefore, they rely on the automobile to satisfy their mobility needs to avoid social exclusion. MaaS can help to bridge the gap, to enable older people to enjoy public transport services with minimum inconvenience.

2.3. Discussion on feasibility of using MaaS for older people

Research shows that not having a car available results in a sharp decrease in accessibility to older people (Böcker et al., 2017). From the built environment attributes, address density has a significant positive effect on public transport usage over the car, for the non-elderly, but even more so for the elderly (Su et al., 2009). This could be related to better access to public transport in higher density areas, which could be of particular importance to the elderly, who may have a limited ability to reach stations and make transfer connections.

Current research has shown more than 60% of elderly people in the UK own Smart Phones. This is the first generation of older people who are used to the Internet and Smart Phones. Thus, they will continue to use Smart Phones for meeting their travel needs. A one-stop solution to access and pay for all types of transport modes would thus be an excellent solution for older people. However, older people as MaaS customers have not been given specific considerations. Although current design features of MaaS may be able to meet the majority of user requirements from older people, some specific design features may attract more users among older people and enable them to benefit from the new technologies more than younger people. Maas should incorporate features to ensure it can be used by everyone, including older people and people with disabilities, as MaaS can play an important role in improving mobility services for an ageing population according to NADTC (2017).

In addition to the distance to bus a stop, identified barriers to discourage older people's use public transport also include boarding/ alighting and insecurity if travelling alone, as researched by Wretstrand et al. (2009). Such barriers may be addressed by MaaS if providers consider providing additional functions to older customers. MaaS can provide a seamless door-to-door transport plan to integrate taxi, ride-sharing, and public transport, while minimising walking and ensuring easy access to all types of transports, e.g. only including vehicles with disabled access in the travel plan. In addition, MaaS may offer security and safety services for older people when they are travelling, if the MaaS user interface with a simple update can serve as 'travel companion". Since any MaaS App is able to track a customer through their entire journey, such a function can be integrated with eHealth and motion detectors, which can detect falls or abnormal activities, in order to generate related alarms and even liaise with an

emergency call centre. Such functions can improve independence of older people with physical or mental disabilities, which is an important factor for enhancing their quality of life.

2.4. Proposed MaaS for older people

To enable older people to enjoy the benefits brought by MaaS, research into user requirements for older people and integration of various functions is needed in order to realise benefits of MaaS to support active aging. Existing functions of MaaS can be further adapted or enhanced to address specific needs of older people to enable them to rely on MaaS for their daily travelling.

Table 1. MaaS Functionalities for older people

Functionality	**Basic Function of MaaS**	**Enhanced Function for older people with specific needs**
Tracking user location	Giving real-time information	To integrate with eHealth and motion detectors to report the location of the user and identify if help is needed.
Use of public transport	Including all possible public transport modes	Only those vehicles and stops/ stations with disabled access will be included in a journey plan.
Access to public transport	Walking and cycling to bus stop/ train or metro station may be considered	Adequate transport (e.g. taxi) to a bus stop/ train or metro station will always be provided.
Taxi service	Few taxi services are included in a MaaS package	Use of taxi may be increased for older people, taking into consideration the trip purpose. For example, for a shopping trip an older user may use public transport to go to shop but use taxi to come home.
Walking route guidance	No specific consideration.	For any walking route, special reminders, e.g. steps, gaps, will provided by audio.

When designing MaaS services for older users, specific considerations should be given to providing additional services and to address special needs of older users. As MaaS can be a key enabler of active ageing, it should allow users to use MaaS for travel despite any physical and mental constraints.

Key features of interfaces for older people may include:

- The interface should minimise time when a user looks at the smart phone; it should allow audio guidance and audio inputs;
- It may allow a third party to enter a journey from different devices; for example, a care home worker may be enabled to plan the journey for an older user and the journey plan will be available on the user's smart phone;
- Having the option of contacting care persons or emergency services automatically sending the location and basic information to the care persons or the emergency services.

MaaS providers may potentially even benefit from service to older people, more than to young people. For example, use of taxi in MaaS is a key business mode to generate profits for MaaS providers since obviously MaaS providers cannot make profits from subscription of local public transport (Li, 2017). Therefore, providing MaaS services to older people with more taxi rides would have potential to generate higher profits for MaaS providers. Monthly subscription to MaaS often includes a number of taxi rides. For example, The Whim Basic from MaaS Global in Helsinki includes unlimited travel on public transport and 2 taxi rides (Whimapp, 2017). The feature of including a number of taxi rides may not be attractive to young users as their usage of taxi service is very limited. Percentage of usage of taxi will increase with aging, for medical appointment, shopping, and other social activities. However, such features would be useful for older travellers, as their choices of transport modes are often related to trip purposes and weather condition. Increasing of taxi may result in higher profits for MaaS providers. MaaS providers therefore should also look into different business models of MaaS for older people.

2.5. Proposed research and policy framework

There are needs for research projects to demonstrate MaaS services with features to address older people's specific needs and to evaluate users' acceptance in order to prepare for mass uptake of such MaaS service. Public authorities should be aware of potential benefits of MaaS and consider provision of MaaS to older citizens as a part of transport policy. Recommendations for future research (short, medium, and long terms) are proposed below in order to exploit benefits of MaaS for active ageing. Corresponding policies from cities and national government are also needed to provide adequate support in policy development and public spending.

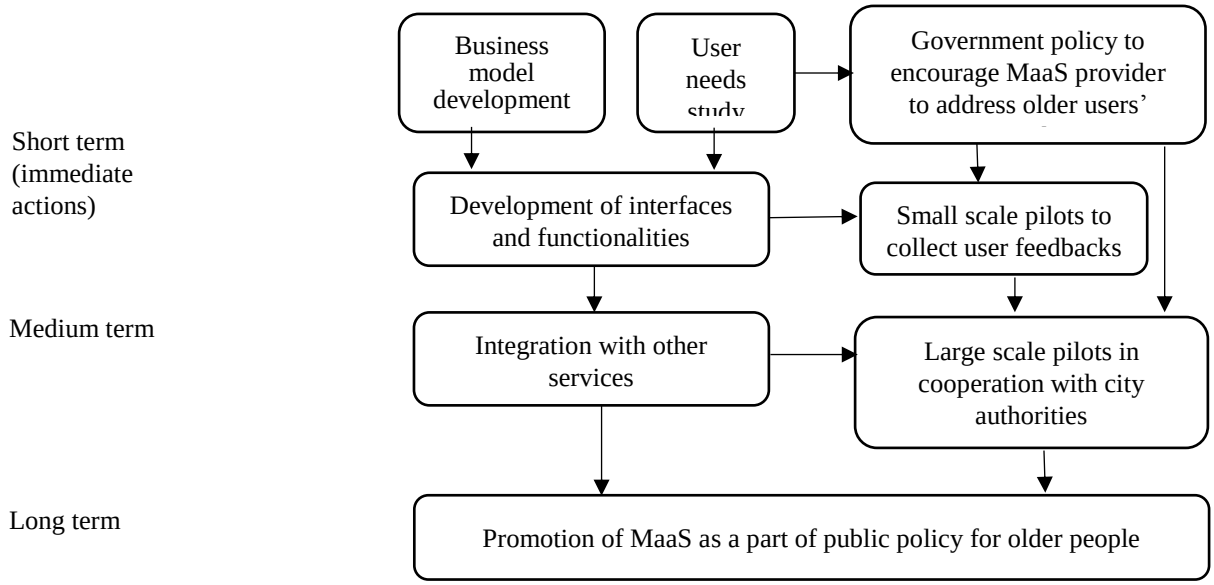

Fig. 1 proposed research for exploiting benefits of MaaS for older people

3. Vehicle Automation for the Ageing Society

3.1. Driving safety and age

Although MaaS may serve as an effective means to enable older people to travel with public transport, many older people may still prefer driving and continue to use their cars as the primary transport mode. Nevertheless, the private car is the most used mode of transport for older people as the private car accounts for 63% of all trips made by those over the age of 70 (ICT UK, 2016).

The statistics on mortality amongst older people involved in accidents has been of concern to road authorities and policy makers. A comprehensive literature review on cognitive and physical factors affecting older drivers (Garin etc al, 2014) concluded that while cognitive, sensory (e.g. attention, vision, reaction, and hearing) and physical variables (e.g. neck rotation and potential factors associated with falls risk, arthritis, and heart disease) determine an individual's driving capacity, self-monitoring beliefs (such as insight into individual's driving capacity) determines the choices of individuals about driving behaviour and hence driving safety. A study (Freedman, 2008) reported that death rates per vehicle-miles travelled starts to rise in the 65–69 age group, death rates then rise again after the age of 74, based on the analysis of 1993–1997 US Federal Government data. Consequences of road safety such as injuries and potential disability for older drivers involved in car accidents are significant to individual families as well as the community. Therefore, improving safety for older drivers is essential.

Statistics from DfT UK (2014) and Road Safety Observatory (2016) show that three types of declines have a measurable impact on driving ability and safety:

- Physical: Restricted joint movements, which can cause difficulty in scanning the road environment, or turning the steering wheel;
- Cognitive: Difficulties in processing information, which can lead to an older driver needing to take longer to gather the information required to make a decision;

- Visual: Age-related sight problems that may impact driving performance and safety.

Those types of decline can be compensated through education, physical training, awareness campaigns, etc. However, technologies, particularly the fast-developing technologies in vehicle automation, may hold the promises to enhance older drivers' safety and make driving more comfortable.

3.2. Vehicle Automation for Older Drivers

Since many older people choose to continue driving, various vehicle assistance and automation technologies which can reduce driver workload and enhance safety will be a good solution for the ageing population. While fully automation (SAE[1] Level 5) may not be realised in the short term, SAE levels 1-3 automation which are available already, can address specific needs of older drivers due to decline in physical, cognitive and visual abilities. Vehicles with automated driving supports can be privately-owned, or shared. Shared cars have many advantages for users who do not need to take care of the vehicles for maintenance or to purchase insurance, etc.

According to the current technological development and business models of mobility services, three business models of automated vehicles (AV) may be considered for older people's mobility, as shown the in the following table. Some research has identified that vehicle automation would be a perfect transport solution for an ageing society (Voege et al., 2017). Research showed that older people are generally supportive of automated vehicle technology, with about half of respondents being willing to use the technology either by driving themselves or being in an automated vehicle (Duncan et al., 2016).

Table 2. Potential business models of Automated Vehicles (AV) for older people

	Privately owned AV	**Shared AV through car-sharing schemed**	**AV for ridesharing**
Potential customers	Healthy driver; Driver with reduced physical functions	Healthy driver; Driver with reduced physical functions	Older people who may not be able to driver safely anymore
Potential benefits in additional to enhanced safety	Offering full independence and confidence	Reduced costs, saved parking spaces	Offering independence and convenience
Specific usage for older people	Enabling older drivers to driver longer distances	Offering door-to-door transport services	Enabling those who otherwise cannot travel without companion to be able to travel independently, thus improving quality of life.

3.3. Recommendations for future research and demonstration projects

Since automated vehicles are not yet widely available on the market, it is difficult to forecast the favourite model among older people. Moreover, the next generation of older people, who are used to new technologies, e.g. social media, smart phones, sharing economy, electric vehicles etc., may have different opinions from the current generation of older people. There is therefore a need for further research into these issues. Since cars with full automation, i.e. SAE Level 5, may not be available on the market soon, immediate research should cover how to use SAE Level 1-3 to enhance safety specifically to address key risky factors of older ages.

Currently many car makers and technology providers are testing and demonstrating their automated vehicles on public roads (both in cities and on motorways). Extensive research has been carried out into users' experiences for automated people movers. However, current testing and demonstrations have rarely been used to collected users' experiences on different types of automated cars. Recommendations for future research (short, medium, and long term) are proposed below in order to address the social and societal challenges of an ageing society and future mobility of the ageing population.

[1] SAE identifies six levels of driving automation from "no automation" to "full automation". Level 0 is no automation, Level 1 is Driver Assistance, Level 2 is Partial Automation, Level 3 is Conditional Automation, Level 4 is High Automation and Level 5 is Full Automation.

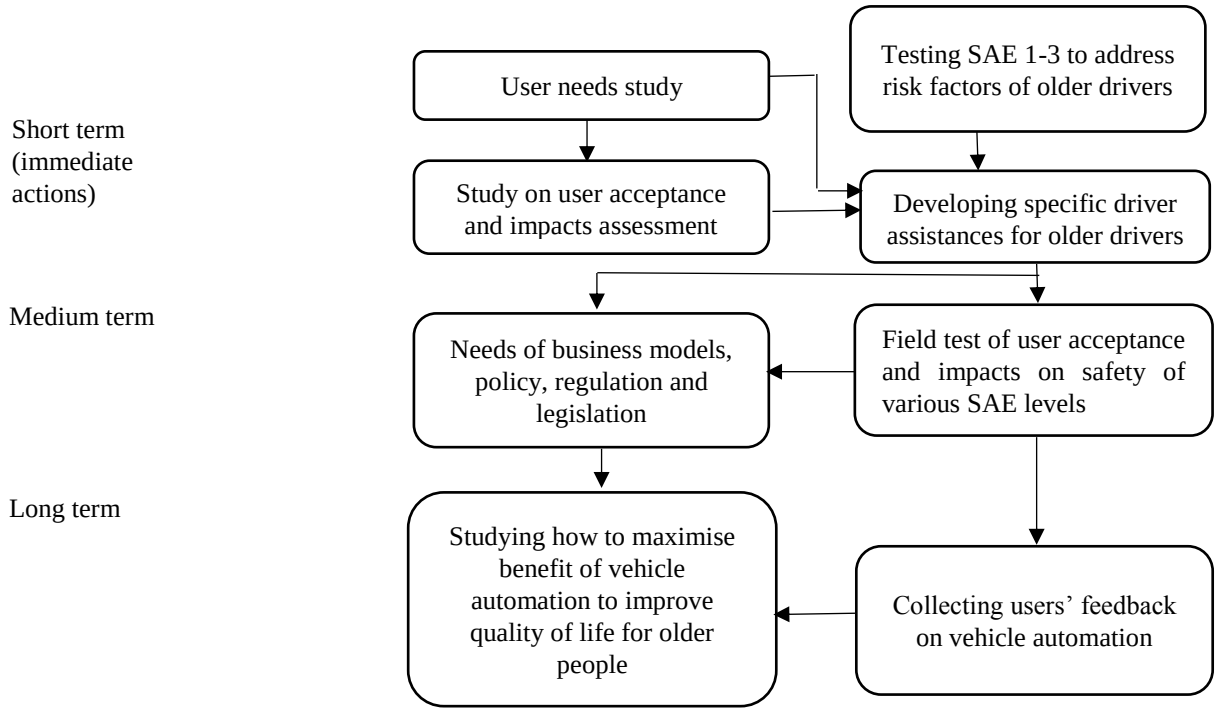

Fig. 2 proposed research for exploiting benefits of vehicle automation for older people

4. Conclusions

Ageing society brings huge social challenges including impacts on transport services. It however also brings opportunities. In many countries, active ageing has been seen as a way to address the social challenges from an ageing society. Active aging enables older people to actively engage with society. In order to do so, provision of adequate transport services is essential. To address challenges of an ageing society in transport and mobility services, the conventional transport policies such as providing free or discounted public transport pass or providing door-to-door transport services may not be sufficient. Many innovations in the field of ITS hold great promise to enable active ageing. These potential benefits have not yet been fully exploited.

This paper aimed to raise awareness of researchers and policy makers to seek innovative solutions in transport and mobility services to provide services to older people to meet their specific needs. Such transport and mobility services will enable them to be actively engaged with society, thus enhancing quality of life. Transport services for older people can be a fast-growing market for various innovations in the transport and mobility sector. The authors use two examples, Mobility as a Service (MaaS) and Vehicle Automation, to demonstrate their potential benefits to the ageing society. Both technologies are currently popular and seen as a game change for the future transport and mobility market. However, use of them for older people has not been discussed yet by providers and researchers. In other words, their potentials of benefiting older people have not been realised by the transport community.

MaaS, for example, can fill the gap of the 'first and last miles' to public transport services which often prevent older people to use public transport. MaaS can also be a perfect travel companion for an older people who may be concerned about safety and security when travelling alone. Since concerns over safety and security are a key factor preventing older people to leave their home, MaaS can give older people confidence to travel independently. MaaS may also be integrated with other services, e.g. eHealth and motion detectors, to monitor older travellers, and trigger alarms when necessary. As older people use taxi more than younger users of MaaS, MaaS for older people may generate higher profits and result in different business models for MaaS providers.

Vehicle automation, either as a private car, car-sharing, or ride sharing, can enhance older drivers' safety by addressing accident factors caused by old ages such as physical declines. Vehicle automation can significantly reduce driver workload, resulting in longer distance driving. Vehicle automation technologies can enable drivers with physical disabilities to drive independently.

In order to realise such potential benefits, various research and demonstration projects are needed. Recommendations for future research at short, medium and long terms have been developed. Such projects include user need study, business model development, field tests, as well as study on policy, regulation and legislation.

5. References

Bloom D. E., Boersch-Supan A., McGee P., Seike A., 2011. Population Aging: Facts, Challenges, and Responses, Working paper series of Program on the global demography of ageing, Harvard University, USA.

Böcker L., van Amen P., Helbich M., 2017, Elderly travel frequencies and transport mode choices in Greater Rotterdam, the Netherlands, Transportation 44(4), 831 – 852.

Carin N., Olaya B, Miret M. etc, 2014, Built Environment and Elderly Population Health: A Comprehensive Literature Review, US National Library of Medicine, National Institutes of Health,

Duncan M., Charness N., Chaping T., etc, 2016, Enhanced Mobility for Ageing Population Using Automated Vehicles, Florida State University, USA.

Department for Transport (DfT) UK, 2014, Reported road causalities in Great Britain: main results 2014 release, London, UK.

Hess D. B, 2009, Access to Public Transit and Its Influence on Ridership for Older Adults in Two U.S. Cities, Journal of Transport and Land Use 2 (1), 3- 27.

Independent Transport Commission (ICT), 2016, Recent trends in road and rail travel - What do they tell us, UK.

Li Y., 2017, Future Role of Public Authorities in Mobility as a Service (MaaS), SPICE project report, Brussels, Belgium.

Li Y., Voege T., 2017, Mobility as a Service (MaaS), challenges of implementation and policy requirement, Journey of Transportation Technologies 7 (2), 95 – 106.

OECD, 2015b, Trends in ageing societies and sustainable urban development, in Ageing in Cities, OECD Publishing, Paris.

MaaS Alliance, 2017, What is MaaS, available at https://maas-alliance.eu/homepage/what-is-maas/

Metz D., 2003, Transport Policy for an Ageing Population, Transport Reviews 23 (4), 375 – 386.

National Aging and Disability Transportation Centre (NADTC), 2017, Mobility as a Service White Paper.

Road Safety Observatory, 2016, Older Driver Review for the Road Safety Observatory, London, UK.

Su F., Schmöcker J-K., Bell M. G.H., 2009, Mode Choice of Older People Before and After Shopping: A Study with London Data, Journal of Transport and Land Use 2 (1), 29–46.

United Nations, Department of Economic and Social Affairs, 2015, World Population Ageing, UN Publishing, New York.

Voege T., Li, Y and Brizzolara D., 2017, Automated vehicle – a perfect transport solution for the ageing society, 12th European Congress on Intelligent Transportation Systems. Strasbourg, France, paper #TP0902.

The Wharton School of the University of Pennsylvania, 2017 http://knowledge.wharton.upenn.edu/article/demographic-shifts-shaping-future-car-ownership/

World Health Organization (WHO), 2002, Active Ageing, a Policy Framework, UN Publishing, Geneva.

Wretstrand A., Svensson H., Fristedt S., Falkmer T., 2009, Older people and local public transit: mobility effects of accessibility improvements in Sweden. J Transp Land Use 2(2), 49–65