Making Transport Systems Accessible for All – The Role of Autonomous Pods

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A transport system that is accessible for everyone – how do we make this happen?

1. Introduction

In the age of tackling climate change our cities and urban settings are adopting people focused infrastructure with the aim to reduce private vehicle use. These strategies encourage citizens to walk and cycle where possible selecting public transport as their main travel mode. However, for some these transport modes are inaccessible as a viable mode of day-to-day travel and therefore private vehicle use is a necessity. Policies aiming to reduce and restrict car use could have a negative effect on those who rely on these vehicles and subsequently restrict their access to opportunities.

Autonomous vehicle technology is increasingly being hailed as the future of urban transport networks. Increased safety and the potential to reduce traffic congestion are among the key benefits (Nicolaides, et al., 2017). Trials of autonomous technology within public transport modes (in the form of pods, platoons and buses) have been undertaken with the aim of reducing travel costs and improving reliability although, little research has been carried out to investigate whether autonomous public transport could reduce the barriers that disadvantaged people currently face on current transport networks (Aurrigo, 2020).

This paper will investigate the barriers people face while navigating current public transport networks and explore the potential benefits of autonomous pods for disadvantaged groups (those who face increased barriers whilst using current public transport).

2. Literature review

2.1   Importance of reducing private vehicles

Transport is one of the world's largest emitters of greenhouse gases responsible for around 30% of the EU's total CO2 emission with private vehicles contributing 60% of this (European Environmental Agency, 2020). From production to destruction, cars have an immense impact on the planet, the most devasting coming from fuel consumption. 90% of all private vehicles environmental impacts derive from the emission of greenhouse gases (National Geographic, 2019).

In order to tackle increasing emissions and the devasting effect they are having on our environment, urban areas across the world aim to reduce private vehicle use by investing in active travel infrastructure through education, low traffic neighbourhoods, bus gates and removal of on-street car parking (Masiol, et al., 2014). In addition, the nature focused, and cleaner air transport policies and

infrastructure have proven to improve the health and living conditions (Velders, et al., 2020). Whilst these policies and changes to infrastructure are hugely beneficial, little has been done to look at the impact the reduction in accessibility of private vehicles have on those that rely on them.

2.2   Accessibility issues for disadvantaged groups

A reduced car dependent society needs a robust public transport network as well as accessible walking and cycling corridors to support the mobility needs for all people. However, in the UK a lack of well-connected and accessible public transport in many places means for many, travelling by private car is a necessity (Berg, et al., 2016). Modern-day transport networks are designed to prioritise economic growth, and those that do not conform to the norm are simply forgotten and uncatered.

Groups of people who are impeded by our public transport infrastructure face challenges these include the elderly, those physically or mentally disabled, part-time/shift workers and the unemployed.

Elderly

It is difficult to provide a structured public transport network for the elderly as their day-to-day travel is commonly inconsistent making it difficult to construct a service that meets all needs. Those aged 60+ make 33% more shopping and personal trips than the overall average however their average journey time is shorter than other age groups (Shrestha, et al., 2017) (Bezyak, et al., 2020). The elderly have varying physical abilities and a study in Germany found that the older the individual the increasingly less likely they are to drive and own a vehicle, therefore become dependent on the public services to make the reduced travel distances required (Bergfurt, et al., 2019) (Wong, et al., 2017).

When the elderly cease to drive, many fear the loss of freedom and disconnect from society. Accessible and well-connected public transport services is essential to support them ensuring they are able to continue their daily activities (WHO, 2007). The majority of research into inadequacies of public transport find that infrequency and unreliability are main issues for all age groups however, within the elderly population these themes are rarely highlighted as this group are more likely to have more disposable time travel spare therefore, the unreliability of services could be less impactful to them (Moridpour & Fattima, 2019). Additionally, the elderly population across the UK have access to subsidised transport services possibly lowering their levels of expectations compared to those who pay full price (Mykura & Rye, 2009). The main barriers restricting the elderly from using public transport is the perceived lack of understanding of their needs, along with perceived extensive walking distance to the public transport stops and experiencing difficulties boarding and disembarking buses and trains (Mykura & Rye, 2009).

Those in the elderly population who commonly travel on public transport have been found to be less likely to develop other mental health conditions than those who do not (GREEN, et al., 2014) (Bergfurt, et al., 2019). This is due to the increased opportunistic social interactions encountered on public transport positively impacting wellbeing (GREEN, et al., 2014). Investment in accessible public transport has a positive effect on both socio and economic factors amongst the elderly population (WHO, 2007).

Physically and Mentally disabled

Public transport services are primarily designed for able-bodied citizens however many services are becoming adaptable to support those within the disabled community. For example, the UK rail industry must comply with the Accessible Transport Policy (ATP) and bus industry must comply with the Public Service Vehicles Accessibility Regulations (PSVAR) and the Public Service Vehicles (Uk Government, 2019). These regulations ensure that all public transport services deliver a minimum accessibility infrastructure including; wheelchair accessible, aural and visual information, passenger assist services during timetabled hours and where services are inaccessible for users, providers must deliver appropriate alternative transport to the next most accessible route/stop/station (Uk Government, 2019).

Despite these regulations and policies, the disabled communities still face many barriers whilst using public transport limiting their access to essential amenities and opportunities which often lead to an isolated life (Bezyak, et al., 2020) (Carreno, et al., 2007). This is reflected in a wide range of research across the UK, finding that across all age groups those with a disability take fewer trips and travel shorter distances than those without (Department for Transport, 2016) (Park & Chowdhury, 2018).

A qualitative study in Scotland, revealed that 46% of the disabled community refrain from using public transport due to health restrictions including finding boarding/departing buses difficult due to mobility constraints; impaired eyesight; living far from bus stops and poor footways and crossings resulting in a lack of confidence navigating their local areas (Carreno, et al., 2007) (Montarzino, et al., 2007). Some areas have "dial-a-bus" or demand responsive services that provide door-to-door transport (Enoch, et al., 2006). However, many users, including the disabled find these services require excessive pre-planning and as the services are not route based, the journey times are unpredictable (Mageen & Nelson, 2003).

Low Income Neighbourhoods

Urban transport networks typically provide the most accessible and frequent services during peak periods and favour one trip purpose journeys (generally work or

education). Although these services will serve the majority, those who do not conform to the normal transport patterns face increased barriers to accessing employment and other opportunities.

The low-paid, low-skilled or unemployed are the most likely to commute during non-peak hours. They are also the least likely to own a car therefore largely reliant on public transport to access employment. Job centres report that a lack of access to transport is one of the main barriers for those seeking employment, one study finds 19% of job offers were turned down due to poor transport accessibility (Department for Transport, 2016). As those in low skilled jobs are more likely to be female and young, they are disproportionately affected by inaccessible public transport. Many unemployed, especially single parents lack access to transport that would allow them for multipurpose trips, taking children to school and continuing to employment (Campaign for better public transport, 2013). Some have reported that working late shifts results in needing a taxi to commute home which consumes a significant proportion of their wages (Crisp, et al., 2018).

In some areas, subsidised public transport for unemployed result's in increased user willingness to travel further and take multiple interchanges to access employment due to the reduction in cost however, barriers of unreliability and poor route choice still restrict opportunities (Carlusson, 2004) (Crisp, et al., 2017).

2.3 Future Technology and Autonomous Vehicles

Through expanding technologies, the need and reasons to leave the home are diminishing (Barrister, 1997). In the 1970s, one in four Scots had to leave their homes to access a shared outdoor toilet, 50 years later shopping can be delivered from every service – food, clothes, and medicine. Increasingly many have discovered the ease (or perhaps pains) of home working, attending education virtually and socialising (Ailes, 2013). With this increased indoor lifestyle, the lack of fresh air and face to face social interaction is proving to have negative effects on mental and physical health especially for the elderly who are often the most disconnected from the online world (Berg, et al., 2016).

Those with more daily out of home trips have a higher life satisfaction and experience reduced loneliness (Stig Berg, et al., 1981). Those using a range of travel modes, including walking, public transport and car, have significantly less likelihood of feeling lonely and developing depressive symptoms (McCarthy & HABIB, 2018). Closer proximity to public transport and owning a car can not only increase the accessibility to essential amenities but also increase a person's social network and interactions. Public transport acts as place for social interaction for many due to the close proximity of passengers (Banister & Bowling, 2004). Studies have proven that although technology is decreasing our physical need to travel for amenities, it still

has an important role in supporting our emotional wellbeing by providing the capacity for increased social interactions (Bergfurt, et al., 2019).

Over the past decade, technology in vehicles have increased drastically from adaptative cruise control, to parking assist, the human component of driving is beginning to decline (Woodman, et al., 2019). A vast number of companies are developing fully autonomous vehicles (AVs) that can drive with limited human input (European Commision, 2016).

Throughout the 21st century the capabilities of AVs have expanded, and significant benefits are expected as they are fundamentally different to conventional vehicles. They can be programmed to obey safety regulations reducing human error, traffic congestion, have quicker reaction times and can allow independent travel for unlicensed users (Kockelman & Fagnant, 2015).

With changes in urban policies to prioritise sustainability and reduce private vehicle use within an urban setting private car uses, autonomous or not, is to be restricted. However, the autonomous technology is not only being piloted and developed on cars and private vehicles but also as a public transport solution (Webb, 2019).

Low-speed autonomous vehicles (L-SATS) or pods is a form of urban transport being developed to adapt autonomous vehicles to the urban environment (Webb, 2019). They are intended to cater for small to medium distance journeys, typically the "last-mile" on both urban roads and pedestrianised areas (Westfield AVs, 2020). Pods have potential to amalgamate into platoons to limit the impact on pedestrians and other vehicles. This structure would take place within high demand locations/routes such as train stations, key towns and large employment or retail locations (Aurrigo, 2020).

Acceptance studies have been carried out to understand people's attitudes and concerns about the adoption of autonomous pods within urban environments (Woodman, et al., 2019). Overall, it has been found that people are willing to use the service however many are concerned about how the pods communicate with the user and those surrounding the pods, particularly in shared spaces and pedestrianised areas (Woodman, et al., 2019). A study at Warwick University found that users identified a beneficial feature to aid a reduction collisions, would be to ensure the pod can communicate where it is going with surrounding pedestrians (Woodman, et al., 2019).

Another aspect of smart technologies being integrated into autonomous pods is the potential for an adaptive demand responsive service (McLeod, et al., 2017). Autonomous pods have the potential to adopt demand responsive shared or private rides allowing for more flexibility, dependent on the user needs, not restricted by a route (Földes, et al., 2018). However, studies have found that although shared rides are a cheaper option most users are willing to pay a premium to ensure privacy and faster journey times (Ambrosino, et al., 2003). A study in Germany has found that the

introduction of demand responsive autonomous pods would not attract many users who currently use public transport as their main mode but has a high potential to attract current car users especially in urban environments with a door-to-door service (Bishcoff, et al., 2019). Although some studies have found that door to door services would work most efficiently alongside other modes at off-peak periods and during peak periods the service would be most effective on a stop-to-stop basis or shared rides only to manage demand and network capacity constraints (Bishcoff, et al., 2019).

Using pods and SMART transport technologies as a means to improve accessibility for impeded users has not been widely researched. This study will investigate the impact, both positive and negative, autonomous pods could have on those who are currently impeded by our current transport network.

3. Methodology

This report aims to assess the potential benefits and limitations of autonomous pods being developed to increase the accessibility of transport networks. The objectives are:

1) What are the capabilities of Autonomous Pods and how are they currently envisioned?
2) What are the key barriers disadvantaged groups face on public transport?
3) Could autonomous pods reduce the barriers faced by disadvantaged groups?

Primary and secondary research was conducted to 1) collate the potential features of autonomous pods and future transport technology 2) assess and identify the range of barriers that disadvantages face whilst using their current public transport network. This research was carried out in 5 stages outlined in *figure 1*.
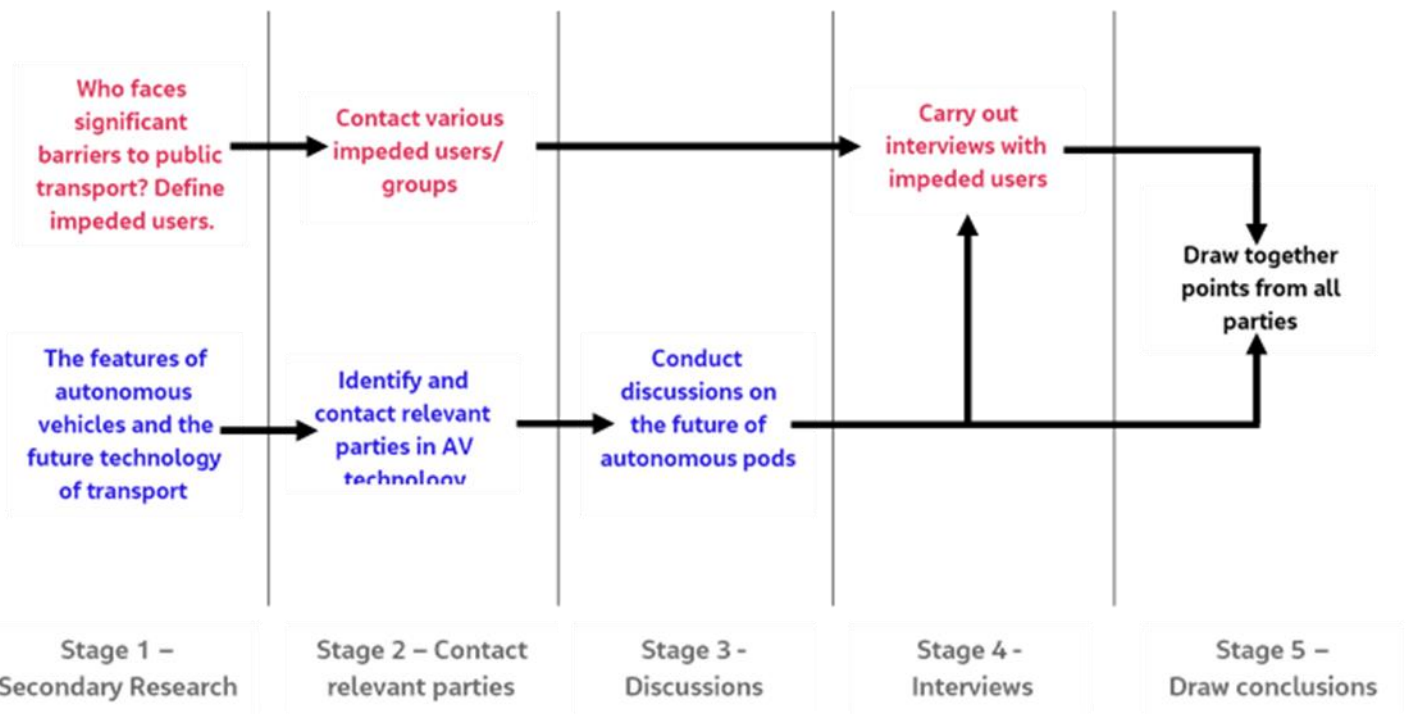
Methodology

Figure 1 Methodology used

- **Stage 1** to gather knowledge from current literature and studies from secondary research
- **Stage 2** identifying and contacting relevant parties to facilitate interviews and discussions.
- **Stage 3** facilitating discussions with transport and future transport technology experts. *Table 1* lists interviewees to discuss and explore the capabilities/or lack of autonomous vehicles. The findings aided the construction of the interviews and research questions for the disadvantaged groups in stage 4.
- **Stage 4** interviewing identified disadvantaged groups listed in *Table 2*.

Interviewees	Description
Glasgow City Council	Employees of Glasgow City Council Transport Planning Department
Oxfordshire Council	Employees of Oxfordshire Council Transport Planning Department
Autonomous vehicle companies	Representatives of companies developing autonomous vehicles
Focus group invested in future cities/technology	Focus group of academics researching and developing autonomous transport and innovative transport technology solutions

Table 1 List of Transport & Transport Technology Experts

Interviewees	Description
Deaf Blind Scotland	Employees from Deaf Blind Scotland, a charity who work to support and campaign for the deaf blind community.
Carr-Gomm Society	Group of employees from the Carr-Gomm society, a charity who provide social care supporting people with a range of needs, including but not limited to: • Physically disabled • Mentally disabled • Unemployed • Homeless • Mental health issues
Focus group of shift workers	Employees working within both public and private sector, typically working shift patterns frequently at off-peak periods.
Focus group of students	Studying at institutions within Glasgow City Council
Focus group from communities across Scotland	Range of residents living across Scotland (not all impeded users). Living in a range of environments from urban to rural.

Table 2 List of Impeded User Interviewees

Interview Questions

1) What is your main mode of transport?
2) Do you face barriers within the services you use or to any other public transport services?
   Interviewee presented with informative fact sheet on autonomous pods
3) What are your initial thoughts on autonomous pods?

4) Do you think there are any benefits or limitations of autonomous pods as a mobility service?

N.B. Additional explorative questions were asked when needed to further understand the specific users' experiences and views on how autonomous pods could impact their daily travel needs.

Further to the interviews, the findings were collated and assessed to establish the overarching themes identified by all the disadvantage groups.

4. Interview Findings

4.1 Objective 1 – What are the capabilities of Autonomous Pods and how are they currently envisioned?

Across the UK, multiple autonomous pod trials are being conducted to assess the safety and capabilities of this mode of transport within a shared environment. The pods developed by; Westfield, UK Autodrive and Aurrigo were chosen to compare. Discussions were also carried out with transport council employees in Glasgow and Oxfordshire and with academics of future transport technology.

Through the secondary research analysis, the three autonomous pods observed appeared to have consistent features allowing them to be used in similar environments. *Table 3* lists the capability and features included in those assessed.

Features of autonomous pods in development
Designed for first/last mile journeys
Ability to like together in platoon
Accessible features; wheelchair accessible, visual and audio communication
On-demand service
Flexible routes
24 hr service
Collison avoidance technology
Adaptable to roads and pedestrianised areas

Table 3 Identified features of autonomous pods (Aurrigo, 2020), (Westfield AVs, 2020), (UK AutoDrive, 2019)

Largely the current trials have been successfully held in controlled environments including airports, national parks, retail complexes and university campuses. Within these protected environments the pods have been able to provide transport to and from bus and train stations, individual shops and businesses (UK AutoDrive, 2019). Also care communities are able to transport residents efficiently to enable increased social activities including recreation and to visit friends.

Trials in Milton Keynes demonstrated the potential of car-free environments allowing residents to use pods for last mile journeys (Aurrigo, 2020). Largely used in pedestrianised areas to reduce walking time between other modes of transport. The majority of trials are to assess the pods for both the users and those in close proximity to the pod's safety. Little has been done to look at the benefits of aiding disadvantaged groups however, the blind community have taken part in some of the trials reporting that pods have the potential to increase independence and alleviate reliance on others (Westfield AVs, 2020). In periods of low demand, they are also adaptable to transport last mile deliveries (Aurrigo, 2020).

Council members who participated in this study recognised the potential for pods to transport people and goods around controlled environments. However, there was a clear concern, that UK cities and urban areas lack preparedness to adopt the emerging technology and infrastructure. Council members additionally raised concerns that the pods may divert able people away from active modes of transport reducing their physical activity for the means of arriving at their destination quickly.

4.2 Objective 2- What are the key barriers disadvantaged groups face on public transport?

A wide range of groups with disadvantages were interviewed during this study, and despite their differing needs multiple overarching themes were observed between the groups when questioned, outlined in *Table 4.*

Group Characteristics	Barriers faced in accessing/using public transport
Elderly	• Mobility Limitations • Lack of route choice
Physical disabled	• Mobility Limitations • Lack of support an information • Unclear if stations are accessible before arriving i.e. Step free
Mental health issues	• Lack of confidence to use new services
Shift workers	• Lack of route choice resulting in long journey times • Infrequency of services particularly at off-peak times • Affordability • Long walking distance to public transport
Care givers	• Lack of route choice • Infrequency of services • Affordability
Students	• Home students most affected • Infrequency of service • Lack of route choice • Affordability

Table 4 List if Barriers faced by disadvantaged users interviewed

Mobility limitations were identified as key barrier for both the elderly and those with physical disabilities. Mobility issues affect these groups at all stages of the journey; getting to public transport, onboarding, traveling and disembarking public transport, and getting to final destination. For some, getting to and from public transport has caused issues due to the poorly maintained and designed pathways.

> *"In some areas I find walking around both my local area and other areas difficult especially in shared spaces where I rely on others around me to understand my*

limitations. My guide dog struggles in situations where kerbsides are not clearly defined like the new public realm being installed" (Deafblind)

"Our support living centre is around a 10min walk to the nearest bus stop down a steep hill… making it out of reach for 90% of those that live here meaning most rely on taxi services which is unaffordable on a regular basis" (Carr-Gomm Society, Castlemilk)

Whilst onboarding, traveling and disembarking public transport, many interviewees often experience a lack of assistance from staff. One interviewee, from the deaf blind community identified that bus journeys are often unstable leading to an uncomfortable journey putting them off the services.

"When boarding buses, often the driver starts driving before I've reached my seat which causes me to be unstable and struggle. I often struggle to see the handrails, and this makes the experience unpleasant" (Deaf blind)

A lack of support and information was a barrier identified by those with varying mental health conditions and people recovering from hardship. Those most concerned have never independently used public transport, requiring assistance to access the service and find the lack of accessible information a major barrier. Elderly groups identified there is a lack of information at train stations about journey routes, finding the information displayed hard to understand, and struggle to use the computerised ticket machines at unmanned stations.

"I find the idea of using public transport a little intimidating as I have never independently used it and I am unsure of how to use it" (Mental Health Conditions, Argyll and Bute)

"My local station is unmanned and the information on the signs are difficult to read … When traveling to a place not on my line I mainly travel into the city centre where I can go to the travel centre and they can help me buy my ticket and find the right train." (Elderly, Glasgow)

Lack of route choice and infrequency of service was identified as prominent barrier for all groups interviewed however this impacts their lives differently. Most interviewees found infrequency of service negatively impacted on their employment and education. For some the lack of local transport network makes accessing local employment and amenities harder than accessing places further away.

"I have to arrive at work 45mins early for my shift because of lack of trains (frequency) *otherwise I would be 15 min late."* (Bishopbriggs, Retail Employee)

"It is easier for me travel into Glasgow than to get to my local centre, that's why I have always worked in jobs at Glasgow rather than the local area" (East Kilbride, Supermarket employee)

"With physical disabilities there is limited transport within the local area... restricting amenities choice often resulting in having to shop at the most expensive places" (Carr-Gomm society representative)

Shift workers and students acknowledged the expense of public transport limiting their use. The low paid workers found transport expenses consumed a significant amount of their wages and sometimes struggled to afford the overall cheaper lump sum monthly passes and those who are on zero-hour contracts were reluctant to buy monthly passes due to uncertainty of work.

"I've quit jobs before because of the cost of transport but there isn't much work in my local area, so I need to travel no matter what" (Unemployed, Drumchapel)

"I mainly work at off-peak times, so I am able to use my railcard which helps with the cost but sometimes I get shifts during peak hours which cost me two hours pay. I have turned down these shifts before especially if it's a late shift and have to pay for a taxi home which is equivalent to four hours pay, but this can result in less shifts in the future" (Zero-hour contract employee, East Kilbride)

4.3 Objective 3 – Could autonomous pods reduce the barriers faced by disadvantaged groups?

The final stage of the study was to allow the disadvantaged groups to express their views on how they think the autonomous pods could potentially increase or limit their transport accessibility outlined in *Table 5*. The interviewees were presented with an autonomous pods information sheet that details the key features of pods (*Appendix 1).*

Group Characteristics	Views on Autonomous Pods
Elderly	Benefits • Unrestricted by routes • Eliminating mobility challenges in local area • Increased independence Concerns: • Reduced social contact/interaction • Technological challenges
Physical disabled	Benefits: • Eliminating mobility challenges in local area Concerns: • Safety concerns • Reduced social contact/interaction
Mental health issues	Benefits: • Increased independence Concerns: • Reduced social contact/interaction
Shift workers	Benefits: • Unrestricted by routes • Off-peak travel is more accessible Concerns: • Long and inconsistency waiting times would • Cost
Care givers	Benefits • Ease multi-trip purposes • Unrestricted by routes Concerns: • Cost
Students	Benefits: • Off-peak travel is more accessible

Table 5 List of identified benefit and concerns raised by disadvantaged groups on the concept of autonomous pods

4.3.1 Benefits identified

Being unrestricted by scheduled routes and timetables was the key benefit identified by all groups during the interview. They found that the flexibility of the autonomous pod route choice and the on-demand nature of the service could allow those in need to travel with limited pre-planning at any time of day.

"Linking people to the existing public transport service would be a big bonus… and greatly improve choice" (Carr-Gomm Society employee, Glasgow)

"Being unrestricted by designated routes would really help in accessing more areas of employment especially outwith the radial routes to Glasgow" (Unemployed, Drumchapel)

"It takes me 45mins to get to my closest train station, the bus is not direct, and the cost isn't worth it, so a demand pod would really help me getting there." (Shift worker, East Kilbride)

By offering flexible route choice, unrestricted by timetables, autonomous pods could increase the network and services people have access to. This could increase employment opportunities, access to education and remove barriers for travel to all forms of health care (Rafferty & Lyons, 2003).

Eliminating local mobility challenges was identified as a key benefit for the elderly and those with physical disabilities. For many, the poor walking/wheeling infrastructure on local streets act to restrict the travel for those with mobility issues but the autonomous pods could have the ability to overcome these issues.

"This (Autonomous pods) *would help address many of the physical issues people face in moving around the city"* (Carr-Gomm Society, Glasgow)

"Being able to navigate shared spaces in a pod would alleviate issues interacting with other users and getting around safely"

For many disadvantaged groups, poorly maintained footways restrict their ease of traveling around local areas and accessing transport. Even shared user spaces, where walking and wheeling is intertwined, blind and deaf communities face increased safety risk as they rely on others to observe their disability (Montarzino, et al., 2007). Pods could alleviate these issues through an independent door-to-door service

Increased independence was a benefit identified by many groups, especially the elderly and those with physical and mental health conditions. Pods could allow them to access local centres with no additional support or reliance on others.

"I often have to wait for support staff to help me access transport, but a private mode of travel could allow me to take more responsibility of my daily needs" (Resident of sheltered accommodation, Glasgow)

"My closest bus stop is up a very steep hill which I struggle to reach especially with shopping, the door-to-door service would increase my independence as I wouldn't have to rely on friends and family to get my essentials" (Elderly resident, Glasgow)

4.3.2 Concerns Identified

The largest concern raised was the reduction in social contact and interaction which was particularly highlighted by the elderly and those with a physical and mental disability. For those with a physical disability concerns were raised if pods experienced an error the lack "staff" would delay the rectification. The elderly and those with mental health issues have concerns about the effect of reduced social interaction on the pods in comparison to alternative modes of transport.

"A pod type system like this would give people an opportunity to further isolate themselves from others"

"Having to engage with others is often the only path to recovery" (Carr-Gomm Society, mental health support worker)

Public transport, such as buses, can act as an environment for social interaction, enable those with limited social connections to interact with society. Studies have found that for those most isolated these environments could be the only social contact they experience on a day-to-day basis (Berg, et al., 2016). Pods could prevent people from using public transport increasing their isolation and loneliness.

Unpredictable waiting times was a key concern highlighted by the shift workers, students and those with caring responsibilities. Differing waiting times for the pods could result in these users missing the scheduled trains or being late for work.

"If the wait time is longer than 10mins, I would probably just walk dependent on where I was going as I would most likely forget to book early enough making me late for my train or work" (Shift Worker, East Kilbride)

"If the waiting times were unpredictable it would be difficult to know when you had to book the service when going for an appointment or job interview" (Unemployed, Drumchapel)

Other concerns highlighted were the technological limitations and the potential cost of the service which would impact the usability and affordability. Elderly groups were

particularly concerned they would struggle to book the service correctly. Students and shift workers were anxious that the cost of such a private and flexible service would be unaffordable to use on a regular basis.

"Many of our elderly residents are not technologically savvy, so they may struggle to book the service"

"I would be concerned at the price of the service, as a low paid worker, transport costs consume a lot of my income so I wouldn't use the service if it was unaffordable."

Although there is much uncertainty on the user cost of autonomous vehicles despite the initial extensive costs that autonomous pods and vehicles would have, those within the industry state that overall, the long-term investment could be economically viable to run and maintain compared to current taxi and bus services (Woodman, et al., 2019). It has been found that with AVs and pods, fuel costs would be cheaper than current transport as they are powered by electricity and are cheaper to maintain and only require monitoring rather than deliver the service whilst potentially providing a more expansive and adaptable service (European Commision, 2016).

5. Conclusion

The above research illustrates there is reasonable opportunity in the future for autonomous pods to contribute towards making transport accessible for all. The research exemplifies that a flexible on demand door to door service would be welcomed by disadvantage groups to alleviate many of the current barriers to transport and accessing amenities and opportunities. It is recognised however, there are several current challenges to develop prior to introducing autonomous infrastructure within our communities to alleviate technological and cost uncertainties alongside implementation research to understand the full requirements of providing and maintaining autonomous pods whilst developing workforce skills.

It should be noted that the main concern raised in this study from disadvantaged groups was the anticipated reduced social contact and opportunistic interactions experienced by the transport user. The potential impact of this shortcoming will need to be explored further but is likely to challenge the developers as the ethos of autonomous pods is to provide an independent, private mode of travel.

Appendix 1

Autonomous pods

POTENTIAL FEATURES

- ❏ Driverless

- ❏ Small to medium distance trips

- ❏ Demand responsive service

- ❏ Ability to travel on roads and pedestrianised areas

- ❏ Accessibility features – wheelchair accessible, assisted for visually impaired and deaf.

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