Age and the city: The case of smart mobility

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Abstract. This article investigates social inclusion from the perspective of smart mobility and transport, which are core aspects of smart city policy. More specifically, it discusses older people's mobility practice in smart city environments as a phenomenon at the intersection of age, digital ICT and data. Drawing on mobility studies, communications and critical data studies the article uses the following questions to frame its analysis: How transport (and) mobility practices interact with mobile ICT use in smart cities? What do we know about the transport mobilities of older people? What do we know about the mobile media and ICT practices of older people? After introducing the concepts of smart city and smart mobility the article discusses these questions through literature review, secondary data, and examples from public transportation services in the city of London, one of Europe's principal 'smart' cities. The analysis highlights age-bias in inherited transport systems, gaps in available data about older people's mobility practices and their media and ICT use, and opportunities for more inclusive (and sustainable) smart transport.

Keywords: Age – Data - Older people - Smart city - Smart mobility - Social inclusion

1 Introduction: Smart cities and smart transport

Cities are both physical and conceptual realms. Key functions in city systems such as transportation, communication, education and policing comprise built, material and digital environments including green spaces, transport networks and Wi-Fi infrastructure [2, 33]. The 'smart city' concept first emerged under initiatives by global tech companies such as CISCO and IBM and has been proposed as digital upgrades to the built city and its institutions. According to IBM, a smart city 'makes optimal use of all the interconnected information available today to better understand and control its operations and optimise the use of limited resources' [14]. The concept of smart city entails 'the use of intelligent solutions' for infrastructure, energy, housing, mobility, services, and security, 'based on integrated sensor technology, connectivity, data analytics, and independently functional value-added processes.' [22] (p 25)**.** This kind

[1] Please cite as: Sourbati, M. (in press) Age and the City: The case of smart mobility. In Q. Gao and J. Zhou (Eds.), Human Aspects of IT for the Aged Population: Technology and Society. 6th International Conference, ITAP 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings (pp. 1-15). Cham: Springer International Publishing. DOI: 10.1007/978-3-030-50232-4_22

of ‘smart city’ ideas and practices can be seen to apply ‘technologies to cities’ [33] (p. 45)

Smart city solutions apply big data to urban governance [49] as a new way to understand and address urban problems in which ‘ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies’ [4] (p. 481) This is a techno-centric model, where an analysis of social, spatial, transport and environmental data, generated through communications systems and integrated into the structures of the city can provide a general understanding of the living conditions in these cities [2] (p. 32). Resonating this perspective, the European Commission sees the advantages of smart cities laying in making the traditional city systems and services more efficient with the use of digital ICT ‘for the benefit of [city’s] inhabitants and businesses’ [17]. Internationally, smart cities are widely considered as the new engine for economic and social growth supported by digital, networked ICTs [37].

Smart mobility is a core element of smart city initiatives. Enabled by networked communications smart mobility and transport can be understood as a convergence of movement in the physical space and in data flow. In an urban setting the application of networked ICT capability in existing mobility systems, including sensors in public roads and parks, IoT solutions built into public and private transportation modes such as buses and cars, and citizens’ use of networked ICT, generates millions of data points, which can be processed to create insights that help improve mobility. The potential of smart mobility to improve quality of life, sustainability and economic opportunities through digital support for connected mobility in cities is increasingly recognized in public policy, both in Europe and internationally [17] According to Gassmann, Böhm and Palmié [22] (p. 40) smart mobility pursues the following core objectives: sustainable, innovative, and secure transportation systems; access to diverse transportation modes; good availability in the entire city; inclusion of nonmotorized transportation; integration of ICT in transportation systems.

From an ‘end-user’ perspective – this of the citizens— the smartphone becomes an essential technology in the smart city. The smartphone becomes ‘the platform for reinventing smart cities from the bottom up’ [47] (p. xiv) . Described as ‘computers on wheels’ smartphones can transform moving vehicles, means of transport and movement in urban spaces [20] A familiar, to many, example of innovative applications of smartphone data is the sharing of rides in cars. ‘Carpooling’ was launched as a successful commercial service in 2016 by Uber’s ride sharing option *Uberpool* and became commercial success in cities across the world.

Policy and industry attention on smart mobility has been technology-centric and uneven. As demonstrated in Behrendt’s study [6] (pp. 1 & 16) despite the potentially ground-breaking social, environmental and sustainability impacts of smart mobility applications, only those modes of transport mobility that are smart/intelligent/networked and engage with data – especially the car and related IoT – gain visibility and become major policy focus areas with associated funding. Important considerations of environment and sustainability [6] of place more broadly, relating to the communities, neighbourhoods, spaces and networks in which we live, and of social inclusion [44] are left out.

Today, within a broader context of converging 'mega-trends' [35] in population ageing, urbanisation and digitalisation the needs of older city residents are beginning to receive some acknowledgement across Europe as an area of smart city outcomes [17]. In the UK, ageing and mobility are seen by government as 'Industrial Strategy Grand Challenges', representing an urgent case for change – yet to be addressed by stakeholders. In this socio-economic context the digital ICT capabilities of older groups and the growing diversity of ageing urban populations is an important conversation, which this article aims to introduce. The research questions are: How transport (and) mobility practices interact with mobile ICT use in smart cities? What do we know about the transport mobilities of older people? What do we know about the mobile media and ICT practices of older people? The remaining of this article is structured as follows: The following section introduces the concepts of (smart) mobility and transport. Then the article introduces a framework for the analysis of older people's mobility in the city that highlights the role of digital data and of mobile ICT use as a capability for smart transport mobility. The article goes on to discuss examples from smart transport applications in London, one of Europe's principal 'smart' cities, illustrating tensions between their potential to create a more socially inclusive transport system for all ages and prevailing age-discriminatory bias in inherited transport systems and in digital data datasets. The final section summarises main threads of this discussion and highlights areas requiring further engagement with in research and policy practice.

2 Mobility

The concept of mobility can be used to refer to peoples' movements outdoors, to access desired places, activities and people or simply to move around. It can be destination dependent and destination independent. Mobility is often considered 'as a prerequisite for citizens to have independence and participate in activities, access services, and form social relations' [28] (p. 2). Transport mobilities are resource-dependent and embedded into their material conditions, including policy and space [2] (p.33). Following Levin [28] (p. 3) mobility involves not merely moving bodies in the transport system but 'desires, abilities, and resources, which are only partly observable and may be investigated indirectly by observing their manifestations.' (see also [40])

Drawing on disability and capability models [41] mobility practices can be understood as an integration of personal and environmental components: A 'person-environment relationship' [25] of transport mobility [4] comprises the physical and the built environment, the social/cultural and the institutional/regulatory systems [48]. The affordability, e.g. of public transport, information devices, and understanding how to use them are important components of access to mobility and social inclusion [40] bringing in the dimension of social, technological infrastructures of digital data and networks. In light of this, an urban road environment can be considered as 'a system with human presence' [2](p.31) on which demographic trends, such as population ageing, and development in digital technology is having an effect.

Framing transport (and) mobility as person-environment, interactive and resource-dependent practices allows for a better appreciation of the role of public policy in shaping access to those systems. Complexes of social mobility practice such as working, shopping, visiting friends and family are connected to infrastructural arrangements across space and time [39] (e.g. routes, destinations, shelters, data infrastructures) in ways that cannot be controlled by individuals alone. The policy, the design, the spatial, the personal and the social elements of transport mobility therefore must be seen as interconnected.

2.1 Older people's transport mobility

In terms of their broadly similar general mobility patterns older people travel less than younger people, considering all modes of travel, and replace driving a private car, after retirement, by walking or the use of public transport [21]. Public transport and walking are the most recurring mode of transport among older people in cities in Europe [2, 27] A Reliance on public transport, especially busses, and walking, is a practice older people share in common with other socially disadvantaged groups, namely the poorer groups and younger people aged under 21, who are less likely to own cars [21] (p. 64). These options hardly ever appear to be able to fully satisfy their mobility needs. According to research in the UK one third of older adults report unmet travel needs in relation to pursuing leisure activities or visiting friends and family [32, 11].

Lack of voice in transport policy is another common characteristic between the older and the younger (and the poorer) groups alike whose transport practices remain 'at the margins of transport planning' [28] (p.2). A study prepared for the UK Department for transport found that pedestrians are rarely included in transport system appraisals. There appears to be no legal requirement for this effectively creating an appraisal process that does not encourage walking and values pedestrians less than other road users: The study report cites 'a built-in assumption that walking tends to be carried out by people at much lower incomes' [13] (p. 5). The transport mobility practices of older populations require further attention from a social and cultural inclusion perspective that would account for large differences due to gender, sex, ethnicity, cultural norms [43] as well as individual's health and skills, and the growing heterogeneity of hyper-diverse city populations – but this is a discussion outside the scope of this paper.

3 Smart mobility, transport, data networks

Smart mobility has been descriptively defined, as alluded to in the introduction of this article, as the converging of the digital ICT and traditional transportation (see also[1]). In a broader sense 'smart' transport refers to the use of digital technologies to improve transport by improving access to information about any aspect of the journey, including destination and pickup points, booking and payment systems, timetable etc. [7]. Smart transport solutions include a range of services, from transport journey updates accessed on the web or through an app, to smart buses and autonomous vehicles. Journey planning information such as real time public transport and traffic updates (e.g. www.tfl.gov.uk) and demand responsive smart technology services [7] use real time data from vehicle and passenger movement. In the first category, information, provided by the service provider to passengers, can be used to help plan all aspects of their prescheduled journey: route, ticket purchase, signalling the driver and navigation around the trip. Transport operators in the second category are responding to client travel requests, to accommodate mobility needs through flexible routes, e.g. dial a bus ride, carpool services, and provide information. These services can improve access to transport for people who are less mobile and less able to stand for long (for example at a bus stop). Smart mobility systems comprise vehicle technology; intelligent transport systems (e.g. traffic management); data; new mobility services. [26]

A more socially-oriented analysis can expand on the conceptualisations of mobility as a person-environment relationship [40, 48] to include digital environments, and as practice [28] to incorporate practices of data generation, registration and use. Following (Elliott and Urry (2010) smart mobility relies on digital networks, in addition to mobile physical objects and people, and involves data collection and analysis at scale [5] and can be conceptualised as a data-driven service. From this perspective, as digital data can be understood as shaping people's opportunities for (transport) mobility. The potential of smart transport services to meet the travel and mobility needs of citizens, is therefore constrained by the data to use to design and run smart transport – and shaped by ways these data are being looked at and used. We must therefore develop awareness not only of the data available as e.g. evidence for policy *but also* the data *not* available [44] and the 'gaps cracks and silences' in data [46] as both have consequences in the design of smart services. Data biases are endemic in research on smart ICT and older people and may result from the technologies available (including software and research instruments) to sample selection and respondent recruitment systems, research design and methods [19] (p. 7). Consequently, a 'lack' of digital data is an indication of power asymmetries in access to networked media devices, in connectivity required to generate and display the data, such as home or mobile internet, but also in biased research agendas and instruments can reinforce the exclusion of those without access to the data for analysis, manipulation and (re)presentation, or of those whose data does not get collected or used [44]. These bias both originate in and reproduce an age-discriminatory culture through generational approaches that frame new technologies as the domain of younger groups.

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4 Mobile communications, older people and the smartphone

Following Campbell [9] (p. 9) the term ‘mobile communication technology’ can be used to refer to ‘devices and services that supported mediated social connectivity while the user is in physical motion’. In light of the previous discussion mobile ICTs can further be understood as resources for transport mobility (for example using a journey planning application; buying paying for transport fares; using an online travel navigator while driving) and for walking in the city (for example, using a map). In the context of smart city systems mobile media use has profound social consequences of ongoing datafication ‘not only means of communication but increasingly also [as a means] of generating data’. [8] (p. 387) Intelligent transport can be seen to typify this shift towards data-enabled services: ICT capability and data becomes intrinsic to social institutions such as public transport systems, and practices, including participation in leisure and cultural activities. [44].

Older groups are especially disadvantaged in this respect. Research into the use of smart mobile ICTs by older people is both limited and fragmented [19] (p. 12). Older people have been most commonly considered a minority in digital communications systems, in terms of both access and use of ICT. Although age remains a main demographic factor with regards to inequality of digital access, skills and ICT use alongside income and education [16] differences in engagement with media technologies are not usefully explained as generationally located, i.e. by birth cohort [23] (p. 2). In countries with high internet diffusion rates older groups have been the fastest growing user groups of smart technology. In 2017 internet use figures among 64- to 74- year old adults were counting 70% or over in one in three EU member states. New smartphone users today are mostly older people. Where available, data confirms that older individuals tend to rely more on mobile Internet access than a landline connection (e.g. [18]; Pew Research Center in [38]) Across the EU in 2019 52% of adults aged 55 to 75 were using mobile devices to access the internet on the move with figures ranging from 85% in Sweden and Norway to 28% in Italy [18]. However, there are also segments of older demographics who are not using digital media devices such as computers, tablets and smartphones. As indicated in these figures there is currently a variation in mobile internet usage among older groups across Europe. Importantly, there are also significant intra-group differences in smartphone usage. Rosales and Fernández-Ardèvol [38] triangulated qualitative interviews, smartphone tracking and survey data demonstrating how the currently limited (ie. less intensive use compared to other generations) usage of smartphones by older people is at the same time diverse: They see three categories of older mobile phone users, the basic, the proficient and the advanced and highlight the importance of research that accounts for the significance of diversity in the media practices of older groups. Proficient users for example 'often have extensive experience with digital technologies' and have adopted smartphones as part of their digital media use (62). Citing Kitchin (2014) Rosales and Fernández-Ardèvol [38] call for attention to '[d]ata granularity … in order to take into account the different ways in which older people, as a minority in the digital world, use digital media, and therefore better incorporate their uses into intelligent systems. ' (p. 63)

Age-biased data stock can potentially have a far- reaching consequences for social inclusion in a smart city environment where data trails generated by mobile connectivity are creating new digital tools for research, for example social media use proxies used to map city areas and deploy city services. Writing about the reliance of social media by local governments Zook [49] notes how the use of geosocial media networks and geo-tagging data and metrics derived from them can provide useful insight and policy direction. At the same time there is a risk of solidifying existing inequalities between citizens. The following section uses the example of a physical infrastructure (traffic lights) and a digital infrastructure (journey planning and map apps) to illustrate some of the tensions, gaps, age bias and opportunities related to the use of digital data in transport and mobility in the city.

5 Smart mobility for all? Pedestrian walking speeds in the built and digital environment

This section discusses the example of transport infrastructure (pedestrian crossings) and journey planning applications and online maps to navigate the city of London. London has led developments in smart transport and in all age-inclusive transport, with measures such as free bus passes for all its residents of a pensionable age (65+) and free children's travel on busses and in the city's underground and over-ground train system, and Transport for London corporation's (www.TFL.gov.uk) free journey planning app, live transport updates available on screens in city bus stop network.

Walking speed values, pedestrian crossing lights and digital journey planners

The case of pedestrian crossing lights, that regulates traffic flow in cities in the UK and internationally, is a characteristic example of measurement that uses demographic information data that are no longer representative inadequate provision in city and transport mobility. The current value of pedestrian speed used in the UK road traffic control system and internationally, comprising roads and traffic lights is 1.2 meter per second (ms) / 75m per minute / 4.5km per hour. [13] (p. 5). This value, and the systems built on this basis, both built/material and many popular digital apps use to calculate average pedestrian speed that originates in the mid-twentieth century (early 1960s) [27]

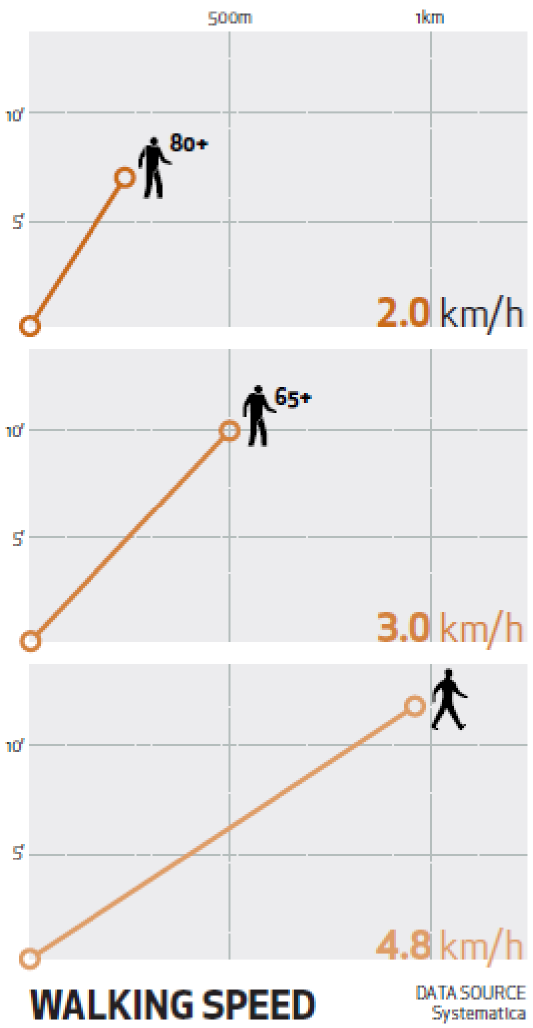

Image source: Arup et al. 2015, p.50

a time when the average age of the population was much lower and traffic was many times lighter and less complex.[i] Older people today travel more than their peers did 20-25 years ago, with everyday trip rates higher and activities outside the home being more common [34]. However, most pedestrians over 65 are unable to cross the road in time at traffic lights, and the walking speed of 76% of men and 85% of women over 65 is slower than the assumed normal walking speed of 1.2 metres per second [3]. The length of time before traffic lights turn green implicitly favours vehicles rather than pedestrians. [21](p. 67). The average pedestrian walking speed value corresponds to competent walking for adults under 65 years of age. The typical values of pedestrian walking speed are: 0.84 meter per second (ms) for people over of the age 65 to 80, and 0.55 for people aged 80+. In light of this average walking speed standard the 1.2 ms value used in pedestrian crossing and live maps is more often than not inadequate for older pedestrians.[ii] The current assumed walking speed at 1.2ms is higher than what can be achieved by a significant and growing proportion of the population, particularly the older people. As a consequence, most pedestrians over 65 are unable to cross the road in time at traffic lights with the walking speed of 76% of men and 85% of women over 65 being slower than the assumed normal walking speed of 1.2 metres per second [3]. Smart technologies, e.g. as trialled by TfL to detect the number of pedestrians and vary the time they have to cross a road, can be used to address this age bias.

Digital navigation apps To illustrate the use of average walking speed values by the three most popular city navigation and journey planning applications we used the example of a walk from London's Waterloo station to the London Bridge station (1.8 km walking distance). The figures below show how long it takes to walk from London Waterloo station to London Bridge station according to *Google maps* (figure 1) *Transport for London* journey planner (figures 2, 3, 4, 5) and *Citymapper* (figure 6)

Google maps use the same standard value of 1.2 ms as the default for their walking speed internationally (see here for an example from India). By contrast *Transport for London*'s journey planer (TfL.gov.uk) includes three options of walking speed values (figures 2, 3, 4, 5): The average (1.2ms), corresponding to the industry standard of average adult up to 65-year-olds, the slow (0.8ms), corresponding to 65-80-year-olds, and the fast, at 1.4ms. The second most popular travel app in London, *Citymapper*, uses a similar value to TfL's 'fast' walking speed value. (Figure 6)

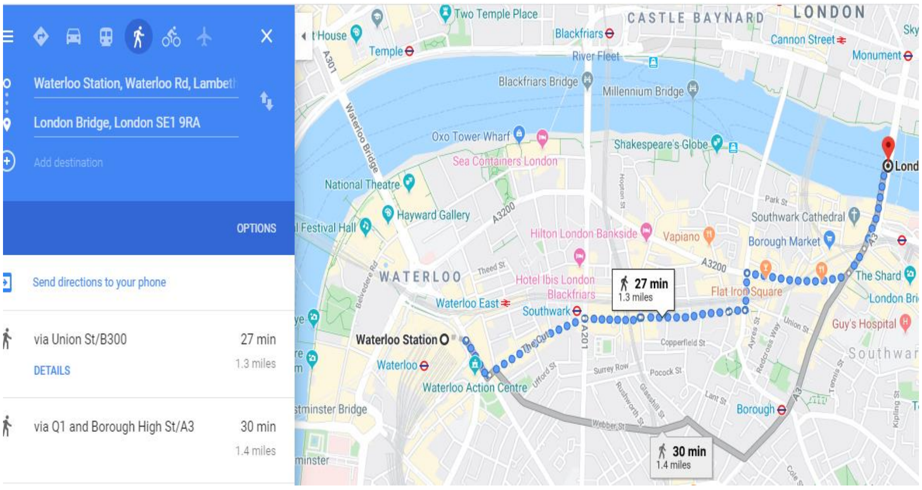

Figure (1) According to Google maps walking from London Waterloo to London Bridge (selected option of 1.8 km walk) takes 27 minutes

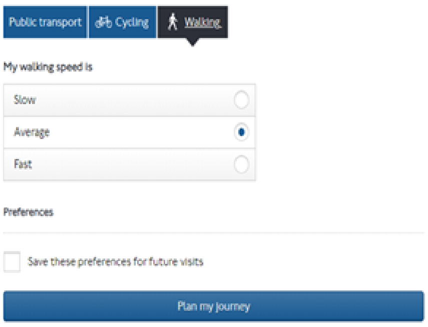

Figure (2) TfL journey planner options include public transport, cycling and walking at different speeds

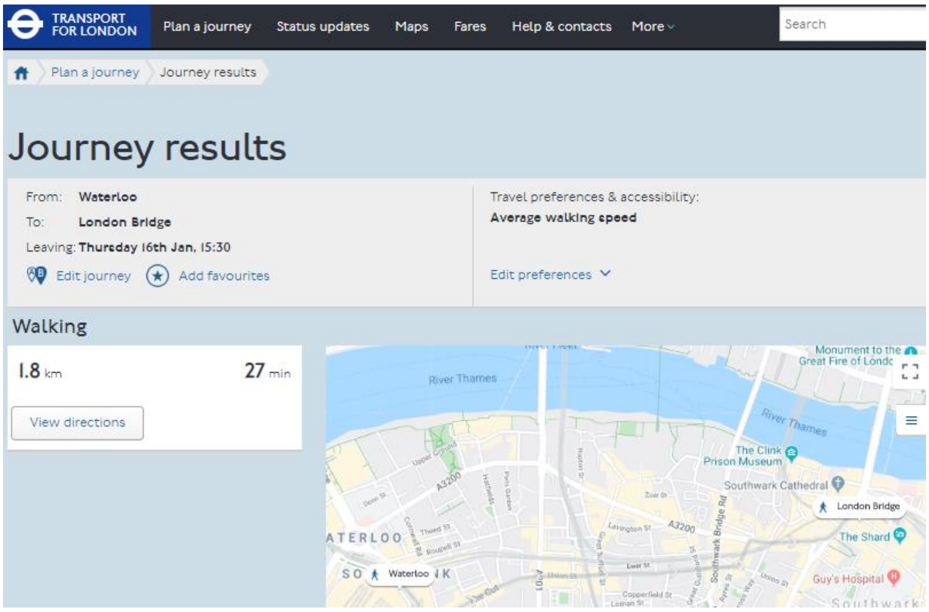

Figure (3) Walking from London Waterloo to London Bridge at average speed takes 27 minutes according to the TfL journey planner

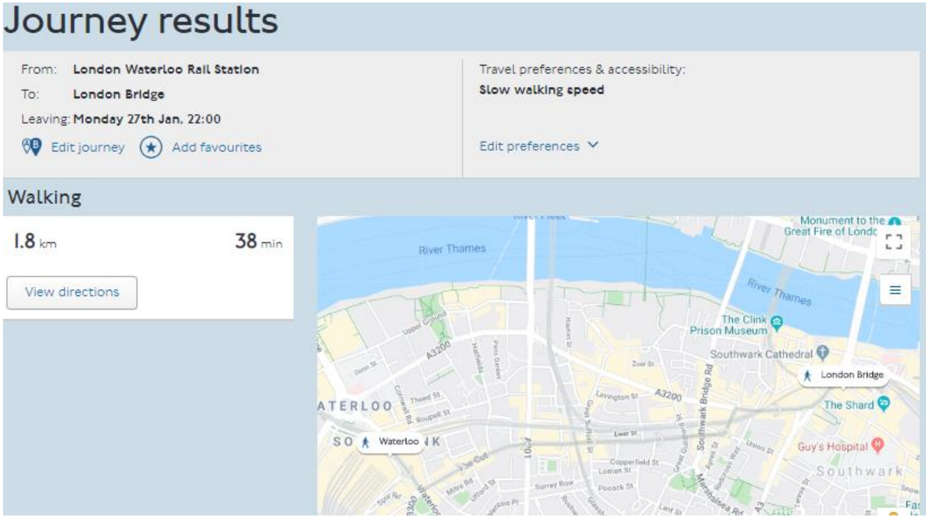

Figure (4) Walking from London Waterloo to London Bridge at slow speed takes 38 minutes according to the TfL journey planner

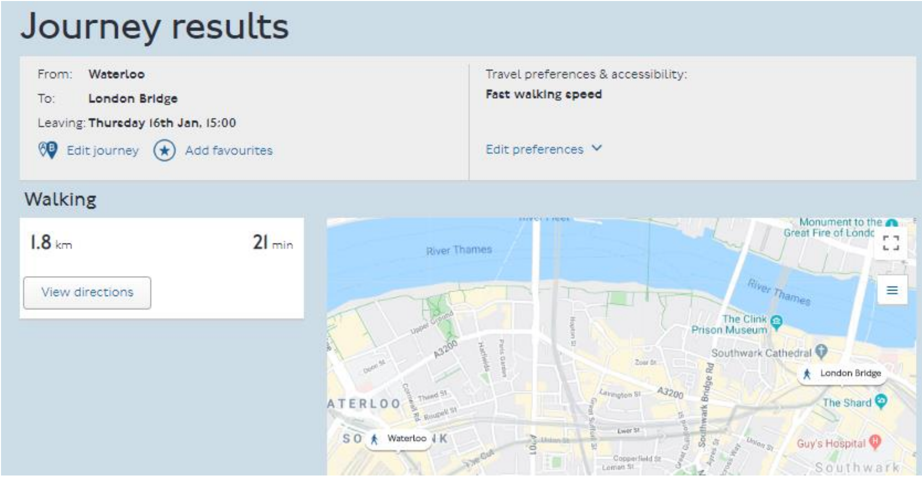

Figure (5) Walking from London Waterloo to London Bridge at fast speed takes 21 minutes according to the TfL journey planner

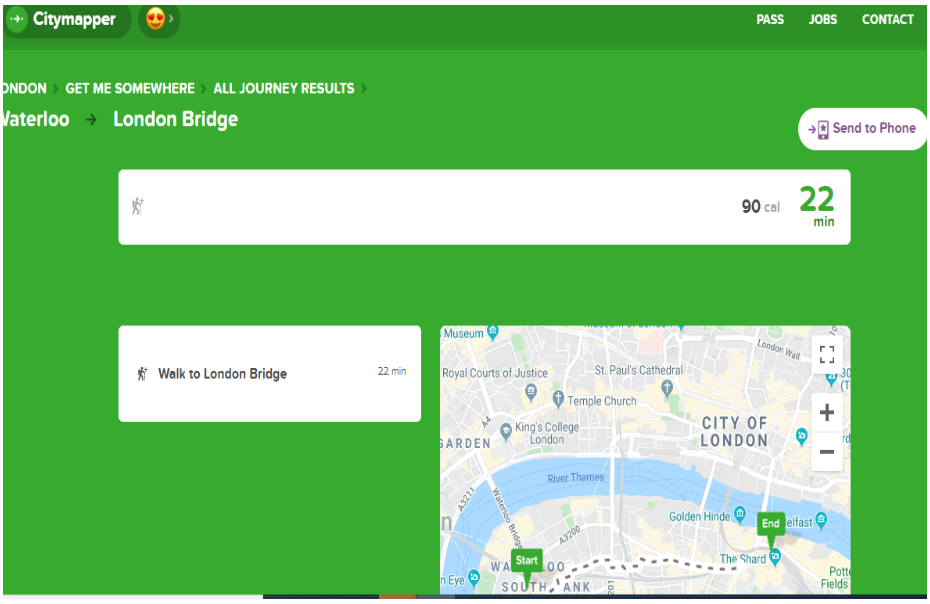

Figure (6) Walking from London Waterloo to London Bridge takes 22 minutes according to *Citymapper*

5.1 Age bias

Hundreds of new apps have helped to make people's journeys more efficient. Travel information plays an important facilitating role in mobility practice: Research has found the more mobile older adults attribute their higher levels of mobility to carefully pre-planning their trips through the use of information [29]. Travel information can be used to plan a forthcoming journey, allowing individuals to choose between different modes and routes. Travel information can encourage people to choose a different mode to their usual one, especially important for reducing habitual or default car trips [34] (pp. 26-27). Lack of travel information can be a key barrier to getting out and about for older people.

Age-biased average walking speeds in journey planning apps persist at the intercession of digital ICT, data, mobility. As critical social gerontology and studies of media technology have demonstrated age bias discriminating against older people are a relationship of cultural assumptions in the design of a service [43] of available data sets, [38] of common misconceptions surrounding generational use of ICT used widely in public and policy debates [42], promoting the perception that generation alone is the most significant variable in explaining engagement with digital media [24].

Un-noticed and not acted upon these deeply entrenched assumptions and cultures reproduced in data bias and in the design of transport apps may discourage walking or using public transport with effects on public health, the environment as well as inclusion: The data bias of the apps, particularly about the wider lived experiences of older groups, and other excluded and disadvantaged populations, ‘feed into a wider subjective sense that these experiences are undervalued or [un]acknowledged, which ultimately exacerbate feelings of inadequacy, vulnerability and frustration.’ [45] (p. 181)

6 Concluding remarks: Age, inclusive mobility, and the smart city

What does the example of default pedestrian speed values show us? Smart city systems combine physical, digital and data infrastructures, and cultural bias, such as those surrounding age, may operate across all these levels. The mundane example of pedestrian speed values used in traffic lights as well as in digital maps and journey planners demonstrates both this bias (in maps, journey planners and pedestrian crossing lights) as well as how smart transport solutions can create more inclusive places in the city (e.g. TfL). The example of pedestrian walking values also demonstrates the significance and social consequences of the embedding of cultural assumptions and values in city infrastructures (such as traffic control) and digital transport applications (such as route planners), for example in further discouraging walking or the use of environmentally sustainable transport such as buses. Referring back to the research questions ‘how transport (and) mobility practices interact with mobile ICT use in smart cities?’ and ‘what do we know about the transport mobilities of older people?’ this article used to frame its investigation of smart mobility and/in old age: Mobility is both resource-dependent (as transport research has demonstrated) as well as a resource for citizenship (freedom of movement). Therefore, an understanding of the consequences of mobility practices and their implications for citizenship and inclusion requires an understanding of the social relations, particularly the power relations that mutually constitute the production, distribution and exchange of resources (see [33]) . The preceding discussion highlighted the role of digital data trails generated though media use (such as the mobile telephone/smartphone) as well as through IoT (for example smart train payment systems, smart traffic lights) and both are areas that require attention in research into age relations. In the context of age-biased social relations that mutually constitute the generation and use of digital data [43] data-driven mobility can be shaped by partial datasets, such as those combining health data relating to medical conditions, poor health and vulnerability associated with old age. These data are generated by ICT systems, both by the end-user (though use of smarty mobile phones) and embedded into systems (IoT). As Mosco [33] (p. 19) contents, it is therefore 'essential to consider the implications for cities [and their citizens] of communication systems that are almost seamlessly integrated into the structures of everyday life.' Once we consider the knowledge gaps around the mobile media and ICT practices of older people it might cause little surprise that ICT-based solutions can be age-discriminating. (see e.g. [38])

On a broader level we need new conceptualisations of smart city and its domains and dimensions, away from technology-centric models and motivations of urban betterment largely driven by technology advocates [49] to reflect the messiness of the city and its politics and enable more refined taxonomies of smart city aspects [15]. A more inclusive, and sustainable, conceptualisation of smart cities entails more inclusive thinking around smart places [2], mobilities [6] and publics [12] for the city to have more agency in these debates. These discussions are expected to grow in importance given the trends in urbanisation, ageing and datafication. As cities incorporate significant changes in forms of mobility into their (infra)structures, diversity remains core normative value of social inclusion in in digital design [30, 43]. An age-inclusive environment for pedestrians and public transport users will enhance mobility as well as have clear public health and the environmental benefits.[iii] This paper therefore extends the proposition for alternative conceptions of smart cities and smart citizenship [10] that bring age-relations to the centre of critical investigations of ICT, data and socio-economic justice.

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[i] This situation is not unique to transport but characterises most urban infrastructure that was built during the post WW2 era and was designed for a younger society.

[ii]Most of the data have been captured from movement of pedestrians actually walking and crossing the roads (excluding all others) [13] (p. 6)

[iii] A growing body of evidence has been highlighting the role of walking, cycling and the use of public transport contribute to better health and wellbeing and sustainability outcomes. [36]