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Valuing othered rationalities in the smart city: examining children's cycling from a justice perspective

Dr Justin Spinney, Senior Lecturer in Human Geography (Department of geography and Planning, Cardiff University, UK) Email: spinneyj@cardiff.ac.uk

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Abstract

This paper seeks to make a contribution at the intersection of children's mobility (specifically cycling) by assessing the extent to which emerging socio-technical smart city systems accommodate children's rationalities. In order to do so it reviews literature on children's mobility, cycling, and participation in design of smart solutions. Through this process I highlight *distributional injustice* where children are marginalised in adult-centric cycling discourses, spaces and smart initiatives. In making this point the review draws attention to the ways in which children are excluded because their more social and playful rationalities of cycling are not *recognized* in adult/ policy readings of cycling. Linked to this, I show that children's rationalities are othered *procedurally* in the development of smart solutions because children are either absent, treated as data nodes, or asked to solve pre-defined problems of transport optimisation. I conclude by foregrounding four elements that could contribute to what smart(er) cycling might look like from a child's perspective: accommodating a plurality of motives with a particular emphasis on less instrumental and more convivial and playful mobilities; physical and urban infrastructures that emphasise social connection; accounting for the relative absence of technologies in children's lives; seeking to 'make children count' in (smart) decision-making processes.

Introduction

As I and others (Harada et al 2021; Spinney 2016; 2020; Spinney and Lin 2021) have argued elsewhere, the forms of urban mobility that tend to count (and are thus counted) are those that can contribute to addressing economically patterned matters of concern. Accordingly, a central policy focus of many municipal administrations is on optimising urban systems with a particular emphasis on transport and commuting. The general rationale is that for accumulation to proceed as fast as possible, goods must be brought to market quickly so their exchange value can be realized, and workers must not waste valuable labour time caught up in unproductive congestion.

In many cities, one of the contemporary manifestations of this rationality is a focus on promoting commuter cycling because of its ability to fix multiple matters of concern with relatively little investment. Accordingly, I have argued (Spinney 2016; 2020) that increasingly, urban cycling is presented as a kind of 'mobility fix' because it is promoted primarily to 'fix' matters of economic concern (e.g. public health, congestion) through mobility where other forms of fixing (such as the spatial fix of road building) have become politically, spatially and economically untenable.

Also central to this endeavour of ensuring efficient transportation is smart technology. A range of sensors and counters are deployed to manage traffic flows; manage fleets of hire bicycles for optimum usage; guide driverless cars; provide data to locate cycle lanes where they can most reduce congestion;

understand the environmental and health benefits of cycling etc. Clearly the available smart technology lends itself to delivering these kinds of metrics: measuring speeds; measuring cyclist numbers in given spaces and times; measuring air quality and noise; measuring calories burnt.

What is considered worthy of gathering data on in the smart city is primarily a product of two things: what a particular administration deems to be worthy of sensing; and what a given technology is capable of sensing: the smart city is therefore best understood as a constantly evolving socio-technical system. Whilst it may not be immediately obvious, both of these are driven by matters of economic concern: a city's governors tend to prioritise the need to understand and optimize the functioning of processes that can enhance productivity/ lower costs; and technology companies present technology for sale that will enhance their own organisational profitability. As a result, what matters to citizens often takes a backseat to problems and solutions defined by other stakeholders.

As this suggests, the concerns of some populations are more likely to be addressed than others. In particular the concerns of working-age people whose concerns may align more with those of productivity and are more amenable to quantitative measurement are likely to take precedence (Loos et al 2020). The concerns of those who fall outside of this – those engaged in work and not labour (mainly women); and those who are less embedded in the paid labour market - children, the retired, many differently able people – are marginalized because meeting their needs is less central to addressing identified matters of (economic) concern (Verlinghieri & Schwanen 2020). As this suggests there are many forms, purposes and participants of cycling that do not fit into or benefit from the prevailing instrumental approach. In this paper I argue that children in particular are one of the groups who if not ignored outright, are assumed to have the same mobility needs as adults. Certainly, the mobility of children is either not measured (and therefore does not count), or is measured only inasmuch as it provides insight in relation to a pre-existing policy agenda (e.g the health benefits of cycling). The result is a conceptualisation of forms of cycling and corresponding spaces designed to accommodate particular forms of mobility that at best fit some adults but marginalise children.

According to many researchers, issues of marginalisation have only intensified in the turn to smart solutions. As Loos et al (2020) have emphasized, many citizens are excluded from the 'mobility digital ecosystem' through which human rationalities are integrated into smart city sensing and decision-making (8). As a result, Robinson and Franklin (2021:238) argue for a demographic perspective on smart cities. They argue that whilst sensor networks give a veneer of ubiquity, particular populations fall between the gaps of data collection producing 'sensor deserts' and specific forms of injustice (238). It is at this intersection of technology, mobility and justice that this paper seeks to make a contribution by examining the extent to which children's 'rationalities' are valued at different stages of smart technology development. In doing so the paper responds to calls to make question of ICTs and mobility central to the WHO's age-friendly city agenda (Loos et al 2020:2); and to put justice at the centre of smart city debates (Strüver et al 2021:1).

This paper focuses on children's mobility and cycling specifically for two main reasons. Firstly, because as work in the field of children's mobilities has shown, far from being a time of 'stability and rootedness',

childhood is integral to mobilities (Holdsworth 2013: 421 in Murray & Cortes-Morales 2019:32). Contemporary childhoods are often the generator for a whole range of trips (Boyer and Spinney 2016); and also increasingly informed by a range of virtual and online communication technologies which shape the character, extent, experience of mobility (Mikkelsen and Christensen 2009) as well as the representation of children in policy discourse. There is therefore a pressing need to engage with children's mobility from their perspective, and in particular the ways in which smart technologies are being utilised both by children and 'for' children. There is clearly a danger that smart technologies whilst technically innovative may be utilised in socially regressive ways that reinforce existing narrow transport ontologies (Middleton and Spinney 2019).

Secondly, there is the issue of cycling as mode of future travel: if adult cyclists in the UK are an endangered species, then children are all but extinct. The National Travel Survey (2022) for England found that in 2021 children aged up to 16 made only 12 cycling trips per year, half that of the average 55 year old (DfT NTS 2023a). The figures for journeys to school are even worse with only 1% of primary school children cycling to school, and just 5% of secondary school children cycling (DfT NTS 2023b). These figures are in line with broader trends over the last 50 years of rapid decline in children's independent mobility more generally (Barker 2008). There is therefore, a pressing need to understand from the child's point of view what cycling (and mobility more broadly) means to children in order to encourage them to cycle on their own terms (Silonsaari et al 2022).

Verlinghieri and Schwanen (2020) have rightly noted that a focus on inequalities and justice is nothing new in work on transport, whilst also noting a renewed impetus to put mobility justice at the centre of research. The range of work is too broad to report on here but includes accounts that have linked issues of justice across different scales of mobility (Sheller 2018); that which has examined the ways mobility acts as a form of capital that can transform or entrench existing patterns of social (im)mobility (Kaufmann et al 2004); work that has examined the politics of space for different users (Blickstein and Hanson 2001; Yavuz and Welch 2014); and that which has examined the differential experiences of the more or less mobile (Adey et al 2014; Spinney & Middleton 2019). Of particular salience is the work of Mullen and Marsden (2016) who argue that transport justice should be grounded in virtue ethics. Such an approach suggests that research should engage directly with the valuations of different groups regarding the purposes and experiences of transport that they wish to be facilitated.

Children have – at least in theory – become more central to city administrators in recent decades embodied in concepts like 'child-friendly cities'. The UN Convention on Human Rights refers explicitly to children in relation to both rights and power. There are ongoing debates around the status of children as 'citizens-in-waiting' and 'learner-citizens' suggesting that they cannot and should not possess full rights and setting up debate around whether they need a set of differentiated rights (Van Der Graaf 2020:6). Certainly, it would seem that procedural and organisational issues have been given priority with regard to children's involvement in policy-making. In the child-friendly city parlance of UNICEF children should be able to 'realize their rights' meaning that children should be able to, "experience quality, inclusive and participatory education and skills development," "express their opinions and influence decisions that affect them," "participate in family, cultural, city/community and social life," and "meet friends and have

places to play and enjoy themselves” [46 cited in Van Der Graaf 2020:7). Whilst some attention in CFC debates is given to children’s mobility and freedom, the emphasis on governance suggests an emphasis on integrating children into adult schemes of governance rather than trying to understand what they might – if anything - do differently in the first place based on their different perspectives. Linked to this, debate is ongoing with regard to whether any rights possessed by children should have power to effect change. Thus whilst a child’s right to be heard and to participate in some democratic processes might be the most widely recognized of all rights, it is less common for children’s views to be acted upon or taken seriously: “...Children may be presented with quasi-shopping lists, and asked what more resources and opportunities they would like to enjoy empty of political power” (Van Der Graaf 2020:6). As this suggests, despite the policy rhetoric, children¹ remain subject to injustice with regard to procedural, distributional and recognition justice (Cook & Butz, 2015, 2019; Robinson & Franklin 2021; Sheller 2018; Verlinghieri and Schwanen 2020).

The paper makes an overall argument around *distributional justice* and exclusion: that children are marginalised in adult-centric cycling spaces and smart initiatives. Cycle lanes for example tend to privilege fast, efficient, individual cycling and join up places that matter to adults; work, retail and residence. In making the point regarding distributional justice, the also review foregrounds the ways in which children are excluded with regard to both recognition and procedurally when it comes to how they view cycling, and the extent to which those views are elicited through smart solutions. I argue that children’s rationalities are subject to *recognition injustice* because they are not afforded the respect and rights given to adult valuations and cycling rationalities that privilege economy, health, safety and environmental concerns. Linked to this I argue that children’s rationalities are othered *procedurally* in the development of smart solutions because children are either absent, treated as data nodes, or asked to solve pre-defined ‘transport’ problems that are instrumentally driven by optimisation logics.

In the first section of the paper I provide some contextualisation of differing conceptions of the smart city. The purpose of this is to understand smartness as a new – or at least evolved - form of social-technical relation inasmuch as the emphasis on computational environments and (big) datafication of human behaviour shapes what counts and is counted with particular effects and outcomes for social life. In the second section I review studies relating to children’s mobility and cycling specifically and contrast this to adult valuations of cycling. In doing so I highlight a tension between instrumental transport rationalities of optimisation, and children’s more playful and social rationalities. In the third section I explore research relating to children and the development of smart solutions, noting ongoing tendencies to marginalise children who are not ‘smart-enabled’; to treat children as sensor nodes; and involve them in solving transport problems defined by adults. I conclude by offering some ideas of what a more inclusive smartness might look like that accommodates children’s perspectives.

¹ Whilst studies reviewed in this paper feature a wide range of ages, they primarily focus on younger children aged 8-14. Accordingly, my focus in the paper when I talk about children is within this age group because issues of smartness play out significantly differently below and above this age range, in no small part because of the accessibility of smart technologies.

Smartness, mobility and justice

The idea of a city dependent on its increasingly embedded digital infrastructure has been evolving over the past 40 years, with proclamations of the digital, information and intelligent going back to the 1980s/90s (Nijholt 2017:4). Concepts like ‘intelligent’ city suggest being quick of mind and responsive to feedback but have been critiqued as elitist and universalist (Rochet 2018). Somewhat differently smartness has positioned itself as appealing to a broader base of citizens with an emphasis on adapting itself to user needs through customized interfaces, self-configuration and self-optimisation (Nam & Pardo 2011:283). As Nijholt (2019) notes, this is achieved through the deployment of a range of devices that can include cameras, microphones and sensors embedded in public and private environments or worn by citizens. (14). The captured data is fed into larger computational systems and analysed with the hope that city governor’s and systems can make more informed decisions (14-15). As such, Smart cities and smart objects – referred to as ‘smart solutions’ in a unified view (Pellegrino et al 2022:475) originate in part from human-computer design interaction with the assumption that they will produce more human-centred and citizen-centred outcomes (Nam & Pardo 2011:283). Accordingly, a reformulated definition of the smart city, is one “...that provides innovative solutions, in collaboration with its citizens and with the support of technology, to solve the specific challenges of its territory in the domains of mobility, economy, governance, environment, living, and people” (Clarival 2023:1).

Whilst smart cities represent an evolution from the intelligent cities concept, both are rooted in the desire for more efficient, optimised and productive city functioning. Writing back in 1990, Batty noted the connection between the competitive advantage of cities and networked infrastructures, arguing that city governors embraced digital ‘intelligent’ technologies to achieve greater innovation, economic development and more efficient governance (Batty 1990 cited in Nijholt 2017: 4). Moving to the smart city concept we see a technological and economic patterning of issues such as traffic control, governance, and energy/ waste management remains at the forefront but with a broadening out to optimise other indicators including lifestyle and leisure, well-being, sustainability, social cohesion, and education amongst others (Nijholt 2017: 4). Both Anttiroiko (2016) and Giffinger et al (2007) suggest that a ‘model’ smart city will seek to integrate and optimise across six factors: “people, environment, economy, governance, mobility, and living” (Anttiroiko, 2016:6; Giffinger et al (2007) cited in Argento et al 2020:205).

The optimisation rationale focused on certain areas of life has led to an emphasis on particular modes of transport and citizens with a corresponding marginalisation of others. Firstly, the focus on technologically-mediated efficiency has focused attention on particular modes such as public transport (and its integration) and private cars (and the ability for them to be shared or autonomous). Hensher for example notes the links between mobility as a service (MaaS) and ICTs as the key to linking up different public transport systems and modes of mobility (Hensher et al 2020; Hensher et al 2021). Similarly, Mladenovic et al (2020) situate the transition to autonomous cars within networked ICT infrastructures.

Cycling has also featured strongly in smart city narratives, most notably around the platformisation of bike sharing systems and again largely with a focus on optimising systems to encourage commuter cycling.

Accounts abound with regard to how to optimise the parking (Lin and Yang, 2011; Midgley, 2011; Paul and Bogenberger, 2014); location (Shi et al., 2018; Zhang and Mi, 2018); and redistribution of bicycles (Schuijbroek et al., 2017) for example. A more critical perspective is also evident that focuses on the data gathering aspects of PBSS and platformised cycling (c.f Chardon 2019; Spinney & Lin 2014; Tyfield 2014). Whether focused on optimisation or critique, these accounts have in common the fact that they remain overwhelmingly focused on optimising adult cycling with children all but absent.

Whilst Clarinval et al (2023) argue that smart cities are transitioning from a strong technological orientation to more inclusive and citizen-led orientations where citizens are required (and expected) to take part in their design (1), they note a continuing lack of modalities to include and understand the perspectives of children in smart city decision making and design (1). My central argument emerging from this review is that children - who possess unique rationalities and perceive different environmental affordances - are marginalised in contrast to economically motivated and adult-centric rationalities privileged in smart cities. My focus on the concept of rationalities prioritises a socio-technical understanding of the smart city in an attempt to de-centre technology. As Robinson and Franklin (2021) have noted, decentring the technical helps us understand the social relations of the smart city where “...on the one hand, data influence what is knowable, and acted upon. On the other, data are the product of an amalgamation of different actors, interests, and social forces” (240). It is at this intersection of technology, mobility and justice that this paper seeks to make a contribution by demonstrating a need to move beyond the performative transport ontology that still underpins smart city research (with or without children) and to embrace a mobilities perspective that acknowledges and attempts to take seriously and count the less instrumental and more playful and social goals of child cyclists. As Murray & Cortes-Morales (2019) have stated: “if we follow or map children’s lives, rather than pre-defining where to start, we allow ourselves to be led by their movements (or stillness), practices and connections.” (70).

Children’s mobilities

There is an emerging literature on children’s mobilities that ultimately owes a debt to work on Children’s independent Mobility (CIM). According to Bhosale et al (2017) CIM is defined as “...the freedom to play and travel in the neighbourhood without adult supervision, either alone or accompanied by peers (Bhosale et al 2017:678). Work on CIM originated in the 1970s - according to one of its founding architects Mayer Hillman – from a concern with the effects of increasing volume and speed of motorised traffic on the ability of children to walk and cycle (Hillman in Shaw et al 2015:1). Hillman’s original study has been followed by many others demonstrating that CIM has decreased over the last 40 years in a range of contexts (Fyhri et al. 2011; Hillman et al 1990; O’Brien et al. 2000; Shaw et al. 2013) and there is now a sizeable literature that focuses on understanding the benefits of CIM in relation to a range of developmental factors including levels of physical activity; cognitive development; social interaction (Bhosale et al 2017:678); and spatial navigation and creative abilities (Esliger et al 2012; Murray & Cortes-Morales 2019:26) amongst others.

Studies in the fields of children’s geographies and children’s mobilities have both critiqued aspects of CIM, notably the developmental approach that normatively assumes a particular idea of independence as the end goal (Murray & Cortes-Morales 2019:26); and a tendency to subordinate children’s valuations and

meanings of mobility to adult-centred policy agendas of optimising health and environmental sustainability (Mikkelsen and Christensen 2009; Silonsaari et al 2022; Spinney 2020). As Murray & Cortes-Morales (2019) go on to point out, CIM studies have helped define a (somewhat moralised) binary of independence/dependence where the latter is associated with an increase in 'passive' automobilities and a consequent "...overall decline in quality of life for children; negative physical and mental health impacts on children; decreased social interaction of children; increased time poverty for parents; as well as the wider societal and environmental impacts associated with children's automobile dependence" (Murray & Cortes-Morales 2019:25). As Murray & Cortes-Morales argue, such assumptions are culturally specific and other readings of automobility and independence are available (Murray & Cortes-Morales 2019:26; c.f. example Sheller 2004; Ferguson 2009).

More recent work has started to problematise such readings, emphasising children's valuations of how they move and what independence means to them which sits at odds with adult rationalities. In their research on Danish children's mobility Mikkelsen and Christensen (2009) have for example begun to re-work ideas of children's independence. Pushing off from the idea that conceptualisations of independence in CIM reflect a culturally-specific and developmental reading of individual agency where the ultimate goal is freedom from adult interference, they contest the notion of independence as always positive and desirable. Their research shows instead that children are often co-present with other adults and children through virtual forms of communication, and that these links and dependencies are often positive and actively sought out (Mikkelsen and Christensen (2009) in Murray & Cortes-Morales 2019:28).

Likewise, whilst studies embedded in the CIM discourse have usefully emphasised decreases in children's mobility, they tend to link it to policy imperatives such as declining physical activity and rising levels of stress and obesity in children defined by public health organisations. The World Health Organisation (WHO) guidelines on physical activity suggest a minimum of 60 minutes per day for children ages 5-17 (Marzi & Reimers 2018:1). Stated physical and mental health benefits of meeting this target are multiple (Bates & Stone 2015:545) yet Marzi and Reimers (2018) note that worldwide less than 20% of children (age 5-17) worldwide meet the WHO target. In the UK, only 20% of children meet the recommended level of activity with a corresponding rise in instances of obesity - more than 1 in 3 are considered obese by the time they leave primary school (Public Health England 2017:n.p). Pushing off from such public health problems, the loss of autonomy to organise their own mobility for their own ends is not seen to be the main problem in many studies of CIM; rather it is the reduction in physical activity and corresponding negative public health outcomes that are cited as the central problem (see for example Hillman et al, 1990; Carver et al 2013; Choudhury et al, 2017). As Mayall (2006) has noted, in such conceptualisations, children's bodies are not sites of "...experience, agency and citizenship, but something that should be managed to contribute to collective future benefit" (cited in Silonsaari et al, 2022:2).

In contrast to a dominant adulteration of mobility in policy and academic literature, a small number of studies have shown that when unsupervised, children are rarely trying to optimise anything beyond their own sensory pleasure (Barker 2003:140; Ipsos-Mori 2010; McIlvenny 2015; Mikkelsen and Christensen 2009; Smith & Dunkley 2018). According to Oliver et al (2016), when walking without adults, children's mobility is less structured, more playful, slower, more exploratory and challenging (Oliver et al 2016:2). A

study by Crawford et al for example demonstrated that children emphasise enjoyment, risk taking and play, whilst parents focused on safety concerns and practical challenges (2017:137). When discussing the walking practices of 9-16 year olds in the UK, Horton et al (2014) emphasise its spatial-temporal characteristics noting its "...boundedness, intensity and circuitousness." (101). They also note its "...characteristic sociality, narrativity, playfulness and taken-for-grantedness" (101). Horton et al (2014) go on to note that, "...walking was not, for these children and young people, most importantly an instrumental means of getting 'from A-to-B'", with many explicitly describing their walking practices as a form of play (104-110). What this points to again is that in contrast to adult valuations, the meanings of mobility for young people are defined by a relative lack of 'function' in an instrumental sense, contributing rather to processes of identity formation, social bonding, making sense of the world and sensory pleasure.

Cycling, children and smartness

Although they are not focused on cycling exclusively, the studies already discussed point to the idea that the instrumental 'transport' function of cycling that currently dominates is less important for children who tend to value "...playfulness, sensory pleasure, mobile sociality, 'coolness', freedom, exploration and escape..." amongst other things (Silonsaari et al 2022:1). Silonsaari et al (2022) confirm these alternative valuations in relation to cycling through examination of the travel of children aged 9-14 to out of school activities. Project workshops with parents and activity organisers noted how adults emphasised the dominance of health and environmental rationalities in framing why children should cycle more (2022:6). A key point that Silonsaari et al highlight is the very different rationalities that emerged from children who for example noted their dislike of cycling buses which turned them off cycling because they were 'silly' and the children knew 'better and more fun' routes to the destination and wished to organise the journeys themselves (6). The importance of autonomy was readily apparent in children's rich descriptions on why cycling was more 'fun' than being chauffeured. Children who were enabled to cycle to out of school activities stated that they enjoyed being more in charge of their schedules, were able to be spontaneous and self-organised and had more freedom (Silonsaari et al, 2022:6). Children in the study also most often associated their new cycling practices with ideas around, "'Enthusiasm', 'joy', 'content', 'pride', 'community' and 'ability to be amongst friends' (ibid). As this attests, children did not see the benefit of cycling as an instrumental activity to achieve higher level goals, but rather as a social and playful end in itself.

Jay et al (2009) come to similar conclusions in their 2009 exploration of the effects of public artwork installations on young people's valuations of using cycle routes. Here they discovered that artworks deemed to be "interactive" or "fun" gave an enriched experience of using the cycle route and helped to, "alleviate some of the boredom of cycling along a route" (Jay et al 2009:11). Reinforcing this, a study by Clayton & Musselwhite (2013) in Bristol (UK) promoted the benefit in designing more playful cycle routes suggesting that they can motivate children to cycle more because the rationale for the journey becomes sensorially-experienced fun rather than access (12). The Sustrans guide 'Routes to Play' published in 2009 clearly reinforces such a message stating that children see no distinction between active travel and play: "walking and cycling provide excellent play experiences in themselves as well as allowing children and young people to get to play spaces and recreational facilities under their own steam." (Sustrans 2009:9).

The key insight from these studies that I want to highlight is that they shift our thinking toward seeing cycling as central to playfulness, social formation and identity construction/ negotiation that sits at odds with accounts that cater for it as 'just movement' and accordingly seek to myopically enhance efficiency and safety. This conclusion is reinforced in an examination of two of the main/ most up to date sources of cycle design guidance: The CROW 'Design Manual for Bicycle Traffic (2007); and Parkin's 'Designing for Cycle Traffic' (2018)².

The Dutch CROW guidance is deemed by many cycle planners and designers to be the gold standard of design guidance given the recent history and mode share of cycling in many Dutch cities. Crow (2007) states that the "...cycling population is characterised by a broad composition in terms of age, gender, physical capacities and reasons for cycling" and goes on to outline how certain capabilities (and corresponding ages might be prioritised in different designs) (26). CROW defines differences between cyclists in terms of physical capacity, defining this in terms of maximal 'muscular work' over a given time (ibid); and mental capacity, the limits of which it argues will be reached much sooner by the young and elderly (27). In such a reading, young (and old) are seen to deviate from a norm of competency that is defined by awareness, speed and control. Such distinctions construct children as 'deficient adults', saying nothing about any other differences between children and adults in terms of what they value in their journeys. Accordingly the resulting design guidelines focus on instrumental requirements notably cohesion, directness, comfort and safety with the only non-instrumental requirement being the need for attractiveness (CROW 2007:31-32) which is defined in relation to the visual landscape and good lighting (64).

Where CROW talks about recreational cycling it distinguishes between cycle touring and mountain biking but refers mainly to the former (85). Two things are notable here: firstly that recreation is seen as distinct from instrumental commuting cycling; and secondly, where recreation is discussed, it is evidently an 'adult' conceptualisation with a corresponding design emphasis on ensuring visual attractiveness with regard to 'idyllic country roads' (91) and comfort (92). There is some mention of other forms of recreational movement in the form of skate boarders (140) and how they might be accommodated to 'reduce the risk of mutual nuisance' (141), but little suggestion that these small wheeled modes of movement are considered to be a legitimate form of mobility. To summarise, there is almost no mention of children in the CROW, and where they do feature, they are assumed to value the same qualities as adults (directness, visual attractiveness) but less capable of attaining them.

One of the most recent updates to cycle design guidance in the UK comes from respected academic and engineer John Parkin's 'Designing for Cycle Traffic' (2018). This represents the state of the art and moves the needle significantly with regard to inclusive cycling, stating that design should be 'inclusive of anyone who wishes to cycle', and should accommodate a wide range of ages from '8-80' (2018:36). Good design

² Arguably the two other most notable sources of design guidance would be Local Transport Note 120 and the London Cycle Design Standards (LCDS). However, I do not directly review them here partly because of space, but also because the former has much in common with the two documents discussed, and the latter (LCDS) does not even mention children, which itself speaks volumes about the status of children in current cycle planning and design.

for all is couched as being that which is “safely rideable on all types of cycles” and attractive and comfortable for all types of rider (37). Despite progression with regard to inclusive design guidance, children remain a notable absence; with discussion around what is required to enable children to cycle centring on bikeability training and providing children with the skills to cope in unwelcoming environments (Parkin 2018: 37). In common with the CROW, despite some recognition of differences between children and adult cyclists with regard to what they might value and are capable of, this is not translated into design parameters or guidance which continue to reflect those of adult (male, able bodied) users.

Despite acknowledgement in the literature of the tendency for children to see little distinction between active travel and play (Sustrans 2009:9), policy and design solutions typically revolve around creating safer routes to school and designated play areas rather than viewing mobility as a site of play and sociality (Bradshaw, 1999 in Barker 2003:137). Such solutions not only reflect adulterated notions of safety and efficiency more than any child-centred notions of play or leisure, but also fail to recognise the importance of micro-scale urban design. The disconnects here point to the presence of recognition injustice where children's readings of cycling as a playful and social practice are marginalised and subsumed into an instrumentalised adult version of cycling as a vehicle to achieve external goals.

Children's participation in the development of smart solutions

In this section I explore work in relation to children and smart solutions to examine the extent to which issues of recognition injustice are preceded by procedural injustices regarding the ways in which children are included in researching smart solutions. I highlight three main ways in which children are excluded: a lack of access to smart technologies; treatment as sensor nodes; and participating in designing smart solutions to pre-defined transport problems. There has been very little engagement with children's cycling and smart technologies so the section focuses on a range of studies that report on adult smart cycling, and children's engagement with smart solutions and smart mobility.

Children's absence in smart cycling

In their review of smart cycling initiatives, Nikolaeva et al (2019) identify a range of social interactions that smart technologies seek to shape, in particular issues around ownership and sharing; parking and cycle lanes; safety; personalisation of experience; and governance (10). Whilst there is mention of the ability to facilitate new and more playful social interactions, the onus of smart cycling innovations is around facilitating and extending existing versions of adult leisure and utility cycling. As Nikolaeva et al rightly note, this suggests that value judgements around the kinds of lifestyles seen as 'rational, desirable, trendy' have already been made, raising questions around “what lifestyles and mobile subjects are left invisible and ignored” (2019:10). Certainly it would appear that the (predominantly urban) 'problems' being solved through smart mobilities (such as smart cycling) are ones of efficiency (e.g the last mile) and excess (e.g obesity and more productive human capital) (Spinney 2016). As Nam & Pardo state, in such a framing, “mobile, virtual, and ubiquitous technologies gain importance [because these] technologies offer benefits to city dwellers in mobile lifestyle” (Nam & Pardo 2011:286). The problem framing here is one that revolves around optimising economic productivity and as such represents the concerns and a particular framing of urban issues that privilege the perspectives of (at best) 'adult' city dwellers. Such a narrow

framing makes some users and uses visible and others invisible because they make up the subject of mobility in particular ways: in smart cycling discourse the imagined user is the young, independent, commuting or leisure cyclist.

A further reference point is Nikolaeva & Nello-Deakin's (2020) paper on velotopian imaginaries. Here Nikolaeva and Nello-Deakin (2020) argue that in current velotopian imaginaries both the more efficient Corbusian city and the more playful/ explorative Constant city are evident. Nikolaeva and Nello-Deakin (2020) illustrate that smart cycling initiatives are often implicitly underpinned by a desire to eliminate inefficiencies. Using the example of bicycle parking they argue that smart-phone applications and smart infrastructures that tell users how many spaces are available or seek to reduce bike numbers through sharing, attempt to overcome inefficiencies including overcrowding, orphan bikes, pedestrian obstructions and bicycle security (315). The purpose of smart mobility in such readings is geared toward maximising flows, minimising time delays, and making efficient use of space: all things that might be valued by a city administration keen to ensure that its citizens and spaces are as optimised as possible. One outcome of this is that smart cycling initiatives focus only on cyclings that are economically productive. The idea emerges of smartness as exclusive in that it purports to want better cities for all, yet its problem-framing and resultant data collection and solutions privilege particular modes and functions. As Schliwa (2019) has argued in relation to cycling specifically: "current tendencies suggest that cycling innovations developed favour those that are already empowered and further marginalise actors in the city that are not participating in the process." (n.p).

Contra to this, Nikolaeva and Nello-Deakin (2020) also trace the threads of a 'Constant' city where the essence of mobility does not reside in connecting A to B, but rather the value of mobility resides in its social and sensory qualities (313). Traces of the Constant city they argue, can be found in smart innovations such as Amsterdam's YellowBackie project which encourages citizens to hitch a bike ride with a stranger and explore the city; or the Derive-inspired Detour project that seeks to re-sign the city to produce more explorative and less direct cycle routes around the city (315). However, as they go on to point out, such initiatives are not only far from mainstream, but even the overt emphasis on the social and playful aspects of mobility is "...more often than not coupled with references to efficiency in the form of time saving, optimised route..." (Nikolaeva & Nello-Deakin 2020:315-6). Thus despite some more playful inducements to cycle, data gathered on cycling remains instrumental in its intent: if smart sensors gather data on adult cyclists average speed, numbers, casualty rates etc, then the solutions that follow – wider lanes, green wave etc – address the 'needs' of adult commuters rather than any other group. The question that arises then, is that even if the spaces produced for cycling are those desired by adult cyclists – and arguably such spaces are performative and pedagogical and play a large part in entraining adults into desiring 'efficiency' – are such spaces suitable stages for children to enact their desired mobilities?

Research into play and smartness is an area that we might expect to engage more with children given their associations with the former. Nijholt (2019) in particular points to the potential for smart technologies when applied to play to help with children's psychosocial and cognitive development (15). However, Nijholt goes on to note that not only are smart sensors less likely to be used to understand 'unproductive' recreational and leisure needs, but that they are more likely to be deployed to stimulate

adult play (Nijholt 2019:15). To demonstrate this point, Nijholt uses the example of the playable cities competition which originated in 2012 in Bristol (UK). Here designers are tasked with using (either existing or new) smart technology with the goal of making more playful urban environments (Nijholt 2019:16). He goes on to note that whilst the contest started with artistic, idealistic and scientific aims, it has been criticised for becoming more of a commercial launch pad to test and reward ideas and technology that might have commercial potential (Nijholt 2019:16); and perhaps more tellingly criticised by the Smart Cities Council in 2013 which argued that the designs and ideas had no 'value' because they didn't make the city more efficient (Nijholt 2019:16). Beyond this, Harper (2017) problematises the fact that designs and interventions developed don't focus on children; rather they focus on "adult ideas of playfulness but fail to reflect the actual behaviour of children. They are like Thomas Heatherwick's rolling bridge – delightful but frivolous one-off follies primarily for adults' pleasure." (Harper 2017 cited in Nijholt 2019: 18). Children are again absent in the deployment of such smart (playable) city initiatives.

Participation in pre-defined problems

An ongoing concern in relation to research on CIM has been the relative absence of children's voices. It is a point of procedural injustice that methodologies to elicit children's valuations of mobility have historically emphasised the testimony of adults, and a limited suite of methods (most often surveys and more recently GIS) (Barker 2003, 2008; Bates & Stone 2015; Chaudhury et al 2017; Hillman, et al 1990; Hood 2001; Jago et al 2009; Murray & Cortes-Morales 2019:57). Such approaches tend to filter out the views of children or at best dilute them with parental and political anxieties, perceptions and priorities. Reflecting on their own experiences of trying to get children's views heard in policy debates, both Barker (2003, 2008) and Kelley (2006) note the continued marginalisation of both qualitative methodologies and children (Barker 2003:141, see also Smith & Dunkley 2018).

Whilst there has been a blossoming of the idea of children as research participants with experiences and perspectives in their own right, Murray and Cortes-Morales note that this has been confined mainly to childhood studies with a much lesser impact on other disciplinary fields where children are a focus (Murray & Cortes-Morales 2019:60-61). The technological emphasis in smart solutions has led many commentators to question the place and the role of people in a smart city. Much of the debate has focused on who gets involved and how. Rochet (2018) for example argues that what companies involved with smart-city development mean when they talk about stakeholders are 'companies, public authorities, regulators, owners and a few NGOs; residents do not seem to exist.' Similarly, Clarinval et al 2023(2) note a continued tendency for child rationalities to be filtered through parents and argue that children have been 'left behind' in smart city initiatives. Whilst children are shown to be keen to participate in decision-making, most studies focus on provision of services for children with little if any input. Where studies have included children, problems tend to be pre-defined and the means of participation adapted to suit them, most commonly a form of gamification (ibid).

Van Der Graaf (2020) for example cites the example of Antwerp in Belgium which aspires to be a smart city with a strategy focused on economy, smart logistics and citizen-focused projects on air quality and mobility amongst others (9). Van Der Graaf notes that despite Antwerp aspiring to be a CFC, children are not mentioned in its smart city vision. Where children are included at the project level it involves a web-

based platform to crowd-source children's views on themes such as playground design. What emerges from such a process is a 'datafied child' related to the ongoing commodification and privatization of space (Van Der Graaf 2020:10).

Pellegrino et al (2022) reviewed 25 studies that involved children in smart solutions in addition to reporting on their own design workshops with children up to 18 years old (Pellegrino et al 2022:475). In reviewing the studies, Pellegrino et al note that despite some movement toward citizen participation in the design of smart solutions, the emphasis has been on equipping adults with the skills to understand and intervene in the creation of smart solutions with much less weight given to children as citizens. Pellegrino et al 2022:476). Accordingly they start from the premise that children need to understand smart solutions and objects but are rarely tasked with the design of these. The results of the Pellegrino et al review appear to confirm the idea that despite children's involvement, the rationality underpinning the smart cities concept remains that of system optimisation. By way of example, one design workshop reviewed notes the key problem areas being predefined: "...children were challenged to link real-world services with smart city dimensions corresponding to environment, economy, mobility, public services, culture, living [...]" (Pellegrino et al 2022:480). At the end of the workshop children noted and bought into the idea that technology should be instrumental for the specific purposes of solving such issues to improve citizens' lives (ibid).

Pellegrino et al's own workshops also seem to confirm the predefinition of the kinds of problems that should be optimised and how. Based in the imaginary smart city of Robopli, Pellegrino et al setup tasks where children could "...practically experience smart city and autonomous vehicle components". Children were given the opportunity to engage by designing and programming smart solutions to 'well known' problems in autonomous mobility domains, and in doing so "experience real challenges and develop skills crucial for their (professional) future." (Pellegrino et al 2022:482). This suggests that the problem being solved is not greater co-definition of the issues, rather it is a lack of involvement in the technical details of designing solutions that is at issue.

Similarly, other projects that use 'smart platforms' for data collection have a tendency to only gather data (e.g. steps taken, kms cycled, time spent active etc) that relate to addressing adult-defined issues such as health outcomes. A recent study by Helbich et al (2016) in the Netherlands is a case in point: the study used GIS-enabled mobile ICTS to record children's movements finding that that local street connectivity and architectural diversity make a positive contribution to CIM. However, the aggregate and objective nature of the data gathered with a focus on health outcomes results in vague policy recommendations that advocate 'place-based' 'accessibility' rather than trying to understand what children value in their mobility (108). In the case of GPS-based methods, whilst these give a sense of where children go, the data is overwhelmingly analysed for what it says about activity levels rather than what children do, or feel about what they do (see for example Helbich et al 2016:103). Hence whilst smart platforms have the potential to gather rich data on children's value creation in less hierarchical structures, these promises are not being met because of a continued insistence for all roads to lead back to questions of economy and efficiency. In many ways such marginalisation of children in smart city data collection is no surprise

given it largely mirrors the neglect of children, older people and those with disabilities in municipal planning more broadly (Annunziata & Garau 2018:589).

Anttiroiko (2016) offers a somewhat more positive perspective. Reporting on the ability of smart platforms to empower citizens and enhance democratic decision making through a series of living lab experiments in Finland, Anttiroiko reports on the potential of smart technologies to address multiple urban economic problems. Despite the predilection for technology in these definitions, we could see it as encouraging that the 'human', and in particular our everyday activities and interactions with our environments remains central to conceptualisations of smartness. Too often however, as Anttiroiko's study demonstrates, a range of potential applications becomes subordinate to narrowly defined policy problems. What is notable in its absence in Anttiroiko's account is any sense that diverse valuations and goals are being addressed, with projects geared towards economic renewal and the participation of citizens interested in furthering such goals.

Bringing this back to the data collection favoured in smart city initiatives, it is clear that data on children's valuations of mobility is not being collected. As van Der Graaf (2020) notes: "In the contemporary data-centered discourse citizens' [children's] voices are increasingly said to be taken over by 'data speaking for them'. When learning about children's urban requirements not only is data said to 'take over', but such practices tend to heavily rely on an adult perspective that can be seen to draw out general assumptions on what children supposedly consider important and how they may behave" (Van Der Graaf 2020:10-11). Despite the democratic potential of smart technologies, such tendencies are if anything only exacerbated when smart technologies consisting of big datasets, remote sensors and algorithms are delegated to represent children's behaviours and valuations. Certainly it would appear that any understandings that do not fit neatly into the pre-determined agendas and technocratic mechanisms of political and economic elites are rendered invisible and do not become policy (2008:184; Kraftl 2015:220; Johnson 2017:106). Where smart city initiatives include children they remain focused on optimisation: whether that be on efficiency, governance or health. This highlights ongoing procedural injustice around children's independence and autonomy and suggests that existing smart city research continues to operate a deficit model where children need to be given the skills to solve adult problems, rather than being seen as citizens in their own right capable of knowing their own worlds and being empowered to change them.

Children as sensor nodes

How citizens are involved with regard to data collection in smart cities is also shown to be problematic. Anttiroiko (2016) argues that smart platforms have the potential to foster inclusivity and creativity by replacing hierarchical structures as a means of control (7). Whilst no innovation platform is ever fully open, smart platforms can widen and deepen the involvement of non-elite stakeholders by providing a means of connection (ibid). This is evident in claims that smart cities are 'citizen-focused' or 'citizen-centric'. However, the citizen in such conceptions is generally understood as "...a user, surveilled subject, data point, and a targeted consumer (Van Der Graaf 2020:5). Within such platforms the citizen tends to occupy a tokenistic position "...framed within political discourses of stewardship, technocracy, paternalism and the market..." (Van Der Graaf 2020:5). There are then significant implications of translating citizens into

'data assemblages', "where data seem to speak for themselves and override people's rights to speak for themselves" (Van Der Graaf 2020:4). Krivy (2018) for example has argued that the extent of citizen empowerment in smart city discourse is limited to that of "...sensing nodes ... or citizen sensors..." (15-16) or as Birchall (2016) states, an 'aggregated dataset' (7). At best, the human in such a vision is one summed and reduced to its role of producing data through a smartphone or other sensing apparatus in order to provide city officials with the knowledge to direct the activity of inhabitants in desired ways (Rochet 2018).

These issues are evident in a 2012 study reported by Esliger et al examining the links between neighbourhood design, children's activity levels and the amount of time spent sedentary in Saskatoon (Canada). Focusing on a large sample of 1600 children aged 10-14, the research used accelerometers to measure the activity of children over a 7 day period, with neighbourhood design as the key variable. The study found that children living in fractured grid pattern neighbourhoods spent less time active and more time sedentary but only on weekdays, with no differences apparent at weekends (522). However, as no GPS data was recorded it is not known whether the levels of activity recorded took place in or beyond the neighbourhoods where children lived (527). A further limitation noted in the study was that waist-mounted accelerometers do not register activities like lifting, water-based activities or cycling and so these will have been undercounted in the study (527). Due to technological limitations, it would appear that what constitutes the social in such studies is narrowed to what can be counted.

Exemplifying the gamification of participation, obsession with optimisation and the reduction of mobilities to nodes is Williamson's (2015) account of the children's fitness tracking game 'Sqord'. The aim of the app is to encourage children to be more active through gamification. Sqord visualises 'activity points' that children can win for activities they have performed, and enables the use of these points as a virtual currency to customise the game interface and their on-screen avatar (Williamson 2015:143). Evidently any activity undertaken is not because of the sensory reward of participating, but of the game-based rewards on offer for hitting certain targets. As this suggests, children's movement (or lack of it) is problematised and the solution provided in the form of a smart technology that renders movement as 'objective' data and metrics rather than subjective, haptic and sensory-embodied knowledge. This example again suggests that children's valuations of their own mobility, and the role that smartness might play in it are ignored in favour of achieving an instrumental goal of more active children. Moreover, the richness of children's mobility is lost in such games in favour of sensing where, when and how much mobility has taken place. Children are not tasked with acting or reflecting on the data they generate beyond a gamified engagement with it.

The lack of recognition of children as even sensor nodes is compounded by issues of procedural injustice with regard to absence of a smart phone, particularly for those under the age of 11/12. As Sergeyeva & Laktukhina (2016) note, to fully participate in the smart city, "digital socialization" is required from every citizen: "If an individual cannot cope with his smart-phone he will not have an opportunity to become a part of the network" (31). As they go on to state, groups that are less likely to participate in data collection include those on low incomes, the elderly and younger children because they are less likely to use a smart phone (ibid). Where children do possess a phone, it is argued that this is mainly related to controlling their mobility than seeking to understand it (Sergeyeva & Laktukhina 2016:31). Accordingly, Loos et al (2020)

highlight the need to involve children in the design of data collection through smart phones so that data collection frameworks are produced that avoid the 'i-methodology' and implicit reproduction of the designer's requirements rather than those of the user (10). It appears that whilst methodologies and the use of smart sensors has diversified, many studies have inherited reductive principles that position children as nodes and data collection sensors with no agency to interpret or act on the data collected from them.

Despite this bleak picture, there are some more positive stories regarding children and smart technologies. Annunziata & Garau (2018) for example recount their attempts to investigate more organic valuations of the mobility of children in Cagliari's (Italy) public spaces (590). Their goal here was to generate alternative valuations of the city that could inform different smart city instrumentation. Hence rather than assuming a functional objective to mobility and gathering data that could support the enhancement of this, the authors' approach the mobility of children with fewer assumptions about the where, why and when of mobility. Similarly, Christensen et al. (2011) utilised a range of 'smart' methodological tools such as wearable GPS sensors in order to observe the routes that children take each day. They allied this with mobile phone surveys in order to gain greater detail on why, how and who with children were moving (cited in Murray & Cortes-Morales 2019:70). Similarly, Clarinval et al (2023) discuss their development of workshops geared toward including and schooling children in smart city concepts (3). Focusing on 12 year olds, a series of workshops, discussions and surveys were used to understand how children would like to participate in smart city development, and what they thought about/ needed to educate them on what the concept meant (6). Highlighting the centrality of mobility and environment to these children (as opposed to governance), the workshops showed that children often thought of transport in relation to smart cities, and particularly cycling (12). Overall, children wanted a participation experience that enabled them to air their views, was playful, where they learned new things, could change their views, and hear new perspectives (14). This suggests a strong need for greater procedural justice with children positioned as citizens with valid points of view rather than just 'citizens in waiting'. What perhaps remains problematic about the workshop concept is that it doesn't seem to fully acknowledge the normative role it plays in instilling in children particular orientations and rationalities that underpin smart cities; rather with its focus on issues like planning, the proposed format runs the risk of reinforcing the idea that smart cities must feature technology and should optimise rather than question existing rationalities.

Conclusions

The studies reviewed in this paper largely suggest a failure to recognise the differing perspectives of children; a failure to procedurally involve children in problem definition and data collection; and a corresponding failure to accommodate their needs in public space. In particular, Verlinghierei and Schwanen (2020) have argued that methodology and therefore procedural justice is a particular area where research on mobility justice needs strengthening (5). In line with this, a key issue emerging from this review is the idea that the smart components of research do not escape from positivist transport rationalities, serving instead to reproduce the idea of optimising children's mobility, and particularly their cycling practice, because of prior recognitional issues that discount the importance of children's worlds; their failure to realise that many children are not 'equipped' with the sensing technology of the smart

phone and thus become ‘sensor deserts’ of the mobile kind (Robinson and Franklin 2021); or that even when equipped, children are reduced to nodes to collect data answering problems pre-defined by the rationalities of others. This sits starkly at odds with the embodied, affective, liberating and social valuations of cycling produced by children themselves. However, these immaterial aspects are rarely captured through the technology employed and thus remain outside the frame. There is clearly an opening here in that if smart technology is to be used, it should be employed to capture and represent these aspects of cycling so that they can become more central to the conversation of why cycling is valued. In doing so, the voices of a different public can be represented.

As Cook and Butz (2015) have argued in relation to the mobility of displaced people in natural disasters, regardless of distributional outcomes, justice cannot be achieved if procedures – such as methodologies that only gather data that some stakeholders deem important - reproduce subordinating power relations by excluding particular voices, experiences and understandings. The implication as Schwanen (2020) points out in relation to cycling in London is that governors must change their processes and procedures to ensure that a greater diversity of experiences and practices are accommodated. As Verlinghieri and Schwanen (2020) point out, such an approach “...begins to understand transport justice not as a state of affairs but in terms of ongoing process, power relations and struggles over praxis, meaning and values that are actively shaped by the places and spatial configurations as part of which they unfold” (3).

The question I ask therefore is what smartness might look like if approached from the perspective of children and as valuing their lived experiences regarding what matters with regard to mobility? Children’s neurologically significant predilection for exploration and play, lack of concern with organisation and the future, and subordinate societal status mean that they are predisposed to use and value spaces and technologies in different ways from adults. These are rationalities that arguably fit less well into existing manifestations of smart urban cycling its their focus on efficiency, technology and data mining (Spinney & Lin 2018; 2021).

Whilst engaging children using ICTs can offer a starting point to understand how children move and interact with virtual and physical infrastructures, there is an urgent need to develop child-centred smart methodologies that allow othered elements of children’s mobility to come to the fore, and that create participatory spaces where local power dynamics can be addressed and children’s voices can be heard and acted upon (Johnson 2017:105). In particular there is a need for child-centred smart methodologies that not only elicit ‘unadulterated’ understandings of children’s mobility (Kraftl 2015; Mikkelsen & Christensen 2009; Walsh et al., 2010; Wake, 2011, 2017), but that enable and empower children to speak directly to decision makers and professionals in the ideation and creation phases of data gathering.

By way of confluence, I foreground four elements that might contribute to a reconfigured smart cycling agenda: Firstly the goals of smart cycling would be to accommodate a plurality of motives with a particular emphasis on less instrumental and more convivial and playful mobilities; secondly, physical infrastructures would emphasise the social in both their iteration (co-design) and seek to facilitate other sensory engagements; thirdly the objects and technologies of smart cycling would take into account the relative absence of technologies in children’s lives (e.g the absence of smart phones for many younger children);

finally the governance of cycling would accommodate the absence of technology in children's lives and seek to 'make them count' in decision-making processes in other ways (for example by seeking to understand what they do and where they go in ways less dependent on IoT and ICT). Taken together these elements emphasise an aspect of smart solutions that seems to have gone by the wayside: that of engaging all citizens in decision-making (Nam & Pardo 2011:286).

In summary I emphasise the importance of child-centred and co-design methodologies in realising smart mobility. Engaging with both individuals and communities who can often still see the world with an unchecked sense of imagination is an opportunity that designers have begun to recognize as offering a counter-narrative to the prevailing power-narratives (often experienced implicitly as socio-economic and political issues) that define the adult world. Thus, co-design with children can provide an un-rivalled perspective on the assumptions and failures of the modern world, by allowing outcomes to emerge from their world without being prescribed by the limitations of an adulterated perspective. In line with Silonaari et al (2022), I am not arguing that child-centred rationalities are better or worse than those of adults when it comes to cycling; rather that we need to recognise and better understand the differences between the two and the ways in which they co-exist, intersect and conflict at times.

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