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Abstract – In recent years, cities increasingly adopt technological solutions to address complex challenges (De Jong et al., 2015; Bibri, 2019a). Smart cities extend the application of disruptive technologies such as IoT, AI, big data, and autonomous systems into almost all aspects of urban life (Hollands, 2015; Bibri, 2018; Lim & Taeihagh, 2018; Tan & Taeihagh, 2020b, 2021). As technological solutions are rarely socially, geographically, or culturally neutral (Graham, 2002), they present a myriad of challenges to inclusivity. The increased involvement of big tech companies, socio-economic polarisation, and digital divide extend existing biases and limit the effectiveness of regulatory systems (Bianchini & Ávila, 2014; McNeill, 2015; Masucci et al., 2020; Taeihagh et al., 2021). Through a systematic literature review, this research explores - (1) smart city concepts; (2) characteristics of disruptive technology; and (3) our current understanding of inclusive development. We address the following questions – What are the different technologies adopted by smart cities? What are the drivers for cities to adopt disruptive technology? What are the different challenges presented by disruptive technologies towards inclusive development? In doing so, we reveal frictions between the drivers for technological adoption and the barriers for inclusive development, thus extending the discussion on governing disruptive technologies.

Keywords: Inclusive development, inclusivity, disruptive technologies, smart cities, governance, drivers, motivations, barriers, review

Introduction

Smart cities, although hubs for socio-economic and technological development, face several issues that target sustainable and inclusive development affecting variegated aspects of urban planning, policy making, and governance processes. With an increase in the complexity of challenges, coupled

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with a higher rate of urbanisation, cities and their governments are increasingly embracing disruptive technologies as a development strategy, deploying them into various regulatory and entrepreneurial efforts (Kitchin, 2014). In smart cities particularly, ICT now takes a central role in managing urban sustainability (Batty et al., 2012; Kramers et al., 2014; Bifulco et al., 2016). Smart cities also heavily rely on IoT (Schaffers et al., 2011; Zanella et al., 2014; Ge et al., 2018; Viriyasitavat et al., 2019), big data and AI (Al Nuaimi et al., 2015; Hashem et al., 2016; Bibri & Krogstie, 2017b; Allam & Dhunny, 2019; Yigitcanlar & Cugurullo, 2020; Taeihagh, 2021), and autonomous systems (Cohen & Cavoli, 2019; González-González et al., 2019; Lim & Taeihagh, 2019; Yigitcanlar et al., 2019; Cugurullo et al., 2020; Tan & Taeihagh, 2021) amongst others.

This research focuses on the role of technologies and their implications on smart cities and their governance. Disruptive technologies are a new or a combination of existing technologies that provide innovative solutions with limited resources, while having the capacity to grow exponentially and cause major paradigm shifts (Herrera-Quintero et al., 2019; Radu, 2020). Such technologies can affect urban development, ranging from mobility, housing, health, public life and space and governance. Exploring the challenges and opportunities posed by them on smart cities have been limited, particularly their impact on inclusive development. This systematic literature review aims to fill this gap by exploring the different approaches, perspectives, and policies undertaken by smart cities to deal with disruptive technologies, particularly focussing on inclusive development. Some of the proposed questions include: What are the different typologies of technologies adopted by smart cities? What are the drivers for smart cities to adopt disruptive technology? What are the different challenges and approaches in governing them? What measures can cities take to ensure a "technologically inclusive" urban development?

Methodology

The search strategy comprises three groups – the first on the various concepts related to smart cities, the second with relevant keywords and associated effects from advanced and/or disruptive technology, and the third on keywords allied with inclusion and challenges presented to inclusive

development. Table 1 provides a detailed list of the keywords selected based on their recognizability, acceptability, and resonance in academic literature and broader policy discourse. We ran the search strings in Scopus that were combined using parentheses with "AND". We then shortlisted the literature based on several inclusion and exclusion criteria. Firstly, we allow search results in English to capture a wider canon of literature. Secondly, we include literature between January 2009 and January 2021, as the dialogue on technological solutions and smart cities has gained dominance in academic discourse since 2009 (De Jong et al., 2015). Other systematic reviews exploring smart cities in developing contexts also use similar restrictions (Tan & Taeihagh, 2020a). Thirdly, this study includes articles and reviews published in peer-review journals, including empirical studies, qualitative and quantitative case studies, policy design, and evaluation studies. Fourthly, we limit the results to studies having explicit connections to the adaption and governance of various technologies in smart cities.

Table 1: Keywords and associated concepts for cities, technology, and inclusivity

Concepts	Keywords
Cities	smart city(s), smart city development
	intelligent city(s), information city(s), knowledge city(s), digital city(s), IT city(s), IT-city(s)
	sustainable city(s)
	city region(s), metropolitan region(s), urbanisation
Technology	Technology(s), advanced technology(s), disruptive technology(s), novel technology(s), state-of-the-art technology(s), state of the art technology(s), cutting edge technology(s), cutting-edge technology(s), breakthrough technology(s), information technology(s), emerging technology(s), innovation, innovative, high-tech, high tech, big-tech, big tech, big data, data-driven, data driven
	IT platform(s), IT-platform(s), digital platform(s), IoT, internet of things, internet-of-things, AI, artificial intelligence
	automated system(s), intelligent system(s), smart system(s), autonomous system(s), robotic system(s), socio technical system(s), socio-technical system(s), e-governance
	advanced engineering, advanced infrastructure, digital infrastructure, modernisation, informatics, transition(s), transformation(s)
Inclusion	inclusion, inclusivity, inclusive development, sustainable, sustainability, sustainable development
	equality, equitable, equity, integration, accessible, accessibility, neutral, neutrality, uniformity, impartial, impartiality, ethical, transparency, accountability, responsible, responsibility

	Digital divide, polarisation, bias, biased, biasness, partiality, stratification, fragmentation, disparity, inequality, discrimination, discriminatory, marginal, marginalised, marginalisation

Results

Smart cities & Smart sustainable cities

As a concept, smart city is still relatively new, preceded by terms such as "digital city" and "information city", eclipsing both in terms of usage and adoption by governments (De Jong et al., 2015). However, obtaining a clear and consistent definition of smart cities has remained elusive, which indicates a variety of accepted understandings (Schaffers et al., 2011; Yigitcanlar et al., 2018). Smart cities have been used as a strategic device to highlight the significance of ICT in the productive and competitive nature of the city (Caragliu et al., 2011). They are also visualised as complex systems that include human, infrastructure, and process components, such as economy, governance, mobility, environment (Khatoun & Zeadally, 2016).

A large part of the literature on smart cities focusses on the application of advanced technologies, digital or otherwise, in everyday urban life applied across a range of services and infrastructure such as transport systems and energy systems (Schaffers et al., 2011; Kitchin, 2014; Al Nuaimi et al., 2015; Bifulco et al., 2016; Hashem et al., 2016; Ahvenniemi et al., 2017; Allam & Dhunny, 2019; van den Buuse & Kolk, 2019). This branch of literature explores the role of ICT and its extensive deployment in cities that would lead to higher participation and quality of life. The information systems approach in smart cities promotes the intelligent use of ICT for an enhanced quality of life and a sustainable system for managing environmental resources (Ismagilova et al., 2019). However, apart from just focussing on the technological aspects of smart cities, several authors have highlighted the need to focus on human and social capital and knowledge and economic development (Angelidou, 2015; Castelnovo et al., 2016; Lim & Taeihagh, 2018; Bouzguenda et al., 2019). Smart cities and their governance have also attempted to increase social capital through a participatory approach where citizens act as co-creators and collaborators for smart governance models (Gabrys, 2014; Meijer & Bolívar, 2016). The move to a more holistic approach leads us to terms such as "sustainable cities" and "smart sustainable

cities", where technology is not an end itself but should work towards sustainable development (Bifulco et al., 2016; Marsal-Llacuna & Segal, 2016; Bifulco et al., 2018). Smart sustainable cities shape the "techno-scientific, socio-cultural and politico-institutional" structures (Bibri & Krogstie, 2019), connecting concepts of smartness and sustainability (Bibri, 2019b).

Although most conceptualisations of smart cities and smart sustainable cities aim to take a holistic approach, several links to inclusivity remain neglected. More importantly, smart cities often remain an ideological concept, assuming that technology can help cities become equitable, efficient, and economically prosperous (Söderström et al., 2014; Hollands, 2015). Instead of holistic development, smartness is used to pursue business interests for economic development (Kramers et al., 2014), and is presented through a corporate vision of entrepreneurial governance (Hollands, 2015). Even newer concepts such as smart and sustainable cities still rely heavily on a technocentric approach, with smartness only present as a makeshift conceptualisation for economic development rather than inclusive development.

Technological advances in smart cities

This paper focuses on disruptive technologies, i.e., technologies that offer innovative solutions based on limited resources, which bring about rapid changes to the economy and society and grow rapidly and exponentially (Herrera-Quintero et al., 2019).

Data collection through ICT works inconspicuously in the background of daily urban life, built on core technologies such as data processing platforms, sensing devices, wireless communication networks, amongst others (Schaffers et al., 2011; Batty et al., 2012; Bibri & Krogstie, 2017a). This new wave of computing uses urban simulation models and context-aware computing for improving efficiency in diverse sectors such as transport, energy, waste, and water management (Angelidou, 2015; Li et al., 2017; Lin et al., 2017). Despite its advantages, for ICT to contribute towards sustainable development requires its integration, coordination and coupling with other core enabling technologies and a high level of engagement from its users (Bibri & Krogstie, 2017a; Yeh, 2017).

In smart cities, big data encapsulates not just the volume but the complexity, heterogeneity, volatility, and utilisation of data in different sectors, requiring advanced data storage as well as computational systems for analysis and processing (Hashem et al., 2016; Bibri & Krogstie, 2017b; Marjani et al., 2017). Applications of big data analytics range from electric vehicles and smart grids (Al Nuaimi et al., 2015; Li et al., 2017), logistics and cargo transport (Hopkins & Hawking, 2018), managing carbon emissions in smart cities (Giest, 2017), e-government and policy making (Al Nuaimi et al., 2015; Meijer & Bolívar, 2016; Löfgren & Webster, 2020) amongst others. Artificial intelligence (AI) is also used in smart city solutions to process big data, enabling the built environment to support intelligent services in real-time (Kitchin, 2014; Allam & Dhunny, 2019; Yigitcanlar & Cugurullo, 2020; Yigitcanlar et al., 2020). However, the selection of AI needs to be based on its affordability, community acceptance, alignment with the existing sustainability policies as well as on socio-cultural characteristics of the context to achieve sustainable development (Yigitcanlar & Cugurullo, 2020).

The direct application of AI and big data analytics are also observed in autonomous systems, vehicles, and smart mobility systems (Olaverri-Monreal, 2016; Cohen & Cavoli, 2019; González-González et al., 2019; Lim & Taeihagh, 2019; Yigitcanlar et al., 2019; Cugurullo et al., 2020; Tan & Taeihagh, 2021). Autonomous vehicles are expected to be widely adopted in the immediate future by cities and their residents and thus will have a considerable impact on urban forms and mobility patterns (Crayton & Meier, 2017; Yigitcanlar et al., 2019). AVs are promoted by governments and technology companies to increase road safety through automation, ensuring uninterrupted traffic flow, lower energy consumption and freeing up road capacity and congestion (Olaverri-Monreal, 2016; Vleugel & Bal, 2017; Lim & Taeihagh, 2019). As with AI, concerns are raised on the presence of algorithmic bias, constructing ethical rules into AV's algorithms, technical issues in AVs that can cause safety risks, and an overcommitment on AVs with insufficient efforts to manage their potential adverse effects (Lyons, 2018; Lim & Taeihagh, 2019).

Embodying connectivity, IoT and IT platform developments highlight a form of everyday life where daily objects with digital communication systems are part of a larger, immersive, and more pervasive internet system (Schaffers et al., 2011; Zanella et al., 2014; Viriyasitavat et al., 2019). Such

increasingly seamless interactions between many varied and heterogenous objects and domains combined with the ubiquitous computer applications imply that IoT can act as a disruptive technology (Ge et al., 2018). With access to big data, IoT can provide individuals and organisations with opportunities to access a large quantum of data to develop more intelligent and smart futures (Ahlgren et al., 2016; Ge et al., 2018). Smart cities also extensively use IT platforms - interoperable systems comprising a set of stable core components, which are then linked to variable peripheral components (Lee et al., 2020a). Larger smart city developments such as Rio de Janeiro's "smarter city project" (Junior et al., 2018) and Sidewalk Labs' proposal in Toronto (Carr & Hesse, 2020; Mann et al., 2020) are classic examples of IT platform-based urbanism.

Inclusive Development

The adoption of disruptive technologies has brought forward challenges of social sustainability, environmental concerns, urban politics, regulation and governance, equitable distribution, and inclusivity. Broadly, inclusivity in cities is categorised by World Bank (2020) as spatial inclusion, which provides housing, services and access to infrastructure to the citizens; social inclusion where the marginalised population are given equal rights and participation; and economic inclusion, which allows people to have equal access to the opportunities of economic growth in the city. It can be extended to include political inclusion where the citizen and the state share a "rational and non-discriminatory relationship" and environmental inclusion that aims to retain natural resources for future generations (Liang et al., 2021). The current literature on inclusivity in smart cities highlights increasingly relevant issues of digital divide, liveability, participation, and inclusion in the smart city led developments, as well as digital literacy (Sharma et al., 2016; Emejulu & McGregor, 2019) and digital citizenship (Bouzguenda et al., 2019; Emejulu & McGregor, 2019). They also highlight components of social justice that challenge the assumption of a universal advancement of the quality of life by embracing technological solutions.

However, smart cities do not address core urban problems such as poverty and inequality and are also influenced by corporate interests extending the entrepreneurial, globalised turn in urban development (Hollands, 2015; Wiig, 2016). Such systems are also characterised by their socio-technical properties and are hence influenced by inherent politics, its contingencies and shortcomings (Kitchin, 2016). Here, access to ICT is usually not uniform and is provided through a social gradient comprising of physical access to the digital devices, the competence of the users in interacting with digital services, biased algorithmic design, non-neutrality of the data and the designer (Odendaal, 2011; Lim & Taeihagh, 2019; Mouton et al., 2019). Therefore, the definitions of inclusivity and inclusive development and its components of social, economic, spatial, environmental, and political inclusion need to incorporate the impact of the adoption of advanced technological solutions.

Discussion: Drivers and barriers of inclusive technological adoption

To develop the interconnection of smart cities, technology, and inclusivity, it is necessary to understand the motivations of cities for adopting technological solutions, as well as the barriers they present towards inclusive development. The literature highlights several drivers for adopting technologies, including technological and financial advancement, increasing human and social capital, citizen participation and e-governance measures, and promoting economic and efficient management (summarised in Table 2 at the end of the Section).

Smart city projects increasingly apply a mix of technological solutions over a wide range of sectors to finance, scale and build essential infrastructure (Tan & Taeihagh, 2020a; Tan et al., 2021b). They also help establish "economies of scale in infrastructure", develop standards for digital application, and increase the learning curve for the deployment of smart city solutions (Schaffers et al., 2011). Therefore, developing and deploying advanced technological solutions, identifying standardising mechanisms for cloud infrastructure, increasing network scalability, system interoperability, and increasing sensing modalities serve as drivers for cities adopting smart city policies and technological solutions. The financing of infrastructures for smart cities also requires substantial

investment from governments (Tan & Taeihagh, 2020a), taxpayers and private corporations (Yigitcanlar, 2015). Therefore, developing countries such as India often use smart cities as a mechanism to stimulate investment and drive economic growth (Praharaj et al., 2018; Tan & Taeihagh, 2020a). Cities also use smart city projects to source global knowledge and resource investment. Examples include IBM's Smarter Cities Challenge to offer select cities a funded grant and its specialised services such as IoT, IT platforms and big data-driven solutions (Harrison et al., 2010).

The ubiquitous nature of technology in smart cities has also encouraged governments to use them to build human and social capital (Caragliu et al., 2011; Yeh, 2017; Ahad et al., 2020; Zheng et al., 2020). Investment in human and social capital is a key component for smart cities, as they can fuel sustainable economic growth and provide a high quality of life (Caragliu et al., 2011; Tan et al., 2021b). Several smart cities include developing knowledge clusters as part of their objectives, where ICT development is used as a tool for ensuring a sustainable future for its citizens. The operability and utilisation of smart city projects at maximum capacity are also only possible if it has a design and operations team with sufficient technical skills to manage data collection, management, and analysis (Ismagilova et al., 2019; Tan & Taeihagh, 2020a). The mindsets of the citizens play a crucial role in the implementation of ICT-based smart city policies (Goyal et al., 2021), as the user must be open to and get accustomed to the expected changes along with using the services as directed to receive their full benefits (Zheng et al., 2020). Therefore, as implementation and acceptance of smart solutions are strongly linked with a knowledge-based society, developing a higher social and human capital level is a key driver in adopting technologically-driven solutions in smart cities.

Citizen engagement and participation through governance models, where public agencies and people engage in a sustainable dialogue, is also a key driver for the adoption of technological solutions in smart cities (Prpić et al., 2015; Wiig, 2016; Taeihagh, 2017; Pereira et al., 2018; Emejulu & McGregor, 2019; Mossberger & Tolbert, 2021; Tan et al., 2021b). The active role of the citizens in decision-making, selection, and design of the policies and public services increases the confidence in the government through a more direct form of democracy, with lesser intermediaries and higher monitoring of government actions. IT platforms and ICT networks also enable an alliance formation

between the government and the citizens, leading to a consensus from a wider range of perspectives that could contribute towards a more inclusive environment. IT platforms allow citizens to provide a real-time contribution to urban solutions, which encourages a higher level of commitment towards the proposed solutions and helps legitimise the policies implemented (Repette et al., 2021). However, the outcomes from the degree and level of citizen participation are restricted when participation is limited to non-deliberative actions such as consultation, information dissemination or political support seeking (Tomor et al., 2019). Also, incorporating technology in participatory measures is limited to a set of more efficient, affluent, and technologically capable who are better informed of urban policies (Masucci et al., 2020). Therefore, although the adoption of smart solutions can lead to the increase in citizen participation and e-governance measures, their design needs to digital inclusion and target skills and limitations for a clear target community (Gil-Garcia, 2012; Gil-Garcia et al., 2016).

Both efficiency and optimisation of processes in a city are driven by the increased competitiveness between cities for access and utilisation of a limited number of resources. Cities adopt advanced technologies to efficiently access and manage the pool of resources, which lead to their push for adopting smart city frameworks. Smart city frameworks use a combination of ICT, sensors, AI, big data, IoT, and algorithms to manage urban systems, remove redundancies, identify crucial sectors to target, coordinate and integrate, and provide a performance assessment of existing and new services (Angelidou, 2015; Marsal-Llacuna & Segal, 2016; Bibri & Krogstie, 2017c). Optimisation is also a key driver for smart cities to push for the use of advanced technologies, as they are expected to not only provide efficient services to their citizens but also optimise the existing infrastructure (Kramers et al., 2014; Marsal-Llacuna & Segal, 2016). Smart city projects such as the IDEA district in Toronto and IBM's smarter city project rely heavily on data collection mechanisms in smart homes, public squares, transport systems and logistic channels to collect as well as monitor for efficiency (Harrison et al., 2010; Carr & Hesse, 2020).

We can also identify several barriers to inclusive development through the adoption of technological solutions in smart cities. These include the challenges presented by the involvement of

big tech companies, ethical concerns in the design and development of smart solutions, regulatory and policy capacity challenges, and polarisation from the digital divide.

Despite its key role in developing smart city projects, the involvement of big tech companies can work against inclusive development through misaligned goals and unequal distribution of power and leverage. Big tech firms have particularly capitalised on the increasing demand for smart cities and solutions by generating financial investment and scaling up smart city projects (McNeill, 2015; van den Buuse & Kolk, 2019). The expansion of ICT and other urban technologies has also increased the direct and indirect involvement from big tech companies, start-ups, and entrepreneurs, who are now in charge of developing more sophisticated solutions for urban challenges. The involvement of big tech companies in urban development also raises questions if their intentions match the public interests or cater to their own economic gains (Lim & Taeihagh, 2019; Carr & Hesse, 2020) – a challenge for inclusive development. Big tech companies also hold a larger share of capacity and decision-making power in smart city projects (Carr & Hesse, 2020; Repette et al., 2021), leading them to use their leverage for private interests to counter government efforts for digital and social inclusion. In the implementation of AVs in cities, manufacturers and private corporations can potentially program their supporting algorithms to compromise safety to maximise their profit (Lim & Taeihagh, 2019). The direct involvement of big tech and their promoted smart solutions has also led to an increase in the corporatisation of cities in different patterns. Hollands (2015) notes that the size and direction of the corporate interventions take a cautious approach in North American and European countries, whereas examples in Asia take a more ubiquitous approach towards ICT implementation given their history of collusion between private and government entities. This form of corporatisation could open certain sections of the city to an uneven distribution of resources as determined by private interests with limited control from the government, which would work against public interests and inclusivity.

Smart cities involving advanced technologies require a set of social, cultural and ethical norms for developing a healthy and amicable society (Sholla et al., 2017). As society and technology shape each other, it is necessary to observe the dynamics between analytics, simulation and modelling and the ethical issues that are part of the design of applications (Kitchin, 2016). Violations of ethical norms can

present challenges to achieving inclusivity through systemic biases, lack of neutrality, and a lack of clarity in recognising ethical concerns in smart city frameworks and solutions. Particularly, the presence of bias and the lack of neutrality in the design, implementation, operation, and management of technological urban systems (Bianchini & Ávila, 2014) presents challenges towards inclusive development. The process of how data is collected is subject to scrutiny, particularly in smart cities, as the urban population is often unable to opt-out of direct or indirect data collection as it a requirement for many of its services. Data processing is also subject to influence, discrimination, and biases from its designers in statistical input and calculation and can also vary relative to their moral standards (Kitchin, 2016; Lim & Taeihagh, 2019). Most of this data (at times sensitive data) is controlled by private corporations or certain select public agencies and runs the risk of being used in correlated tasks without the awareness or consent of the individual (Hancke & de Silva, 2013; Chan, 2020). Such spurious data collection raises the possibility of systemic biases, with certain vulnerable populations unable to either contribute to and access facilities (Tan et al., 2021a), or unable to prevent any violations of their right to privacy.

Advanced technologies often reinforce existing social and spatial polarisation, with gentrified communities receiving the bulk of attention and investment (Masucci et al., 2020). One of the channels for exacerbating social polarisation and inequality is systematic differences in digital literacy and digital divide amongst the citizens and communities - now an important feature of inclusivity. Broadly, digital literacy is the ability of an individual or a group to use the internet and other digital devices to access and evaluate information that allows them to participate in the community's socio-economic activities (Sharma et al., 2016). Increasingly, the digital divide stemming from digital literacy can be attributed to a disproportional distribution of human and social capital in smart cities (Pick et al., 2015). A patchy access to digital technologies and a structural imbalance between certain sections of the population (Taeihagh et al., 2021) can allow wealthier spatial clusters to function in isolation from the rest of the city. The lack of human capital, particularly a lack of technical skill among government officials and bureaucrats, can contribute to the mismanagement of smart city initiatives and a present challenge in scaling them up (Tan & Taeihagh, 2020a). Therefore, although smart cities increasingly attract and

attempt to develop human and social capital as drivers for technological adoption, ignoring systematic variances can lead to uneven implementation and uptake of technological solutions exacerbating social and economic inequality. Measures such as introducing ICT training from a younger age to the population, may assist in the subsequent adoption of digital applications; other measures still need to be developed to ensure their productive usage (Sharma et al., 2016). Pick et al. (2015) recommend state and federal governments in the United States to increase support for higher education, transparency, support initiatives for certain ethnic groups, and increased funding for public-private partnerships.

Although the adoption of advanced technologies by cities can cause disruptions, there is limited research on their impact on inclusivity due to a lack of regulatory or policy capacity in local governments (Graham, 2002; Lee et al., 2020b; Liang et al., 2021; Taeihagh et al., 2021). One of the direct impacts of a disbalance in power in smart cities is the exacerbation of information asymmetry that can limit the effectiveness of existing governance and regulatory systems. As epistemic communities play a crucial role in distributing information to government bodies, their perception and understanding of newer technologies can shape the agenda and prioritisation for their regulation (Goyal et al., 2021). Accommodating different political interests, private interests from influential stakeholders as well as the market structure can also shape regulatory outcomes through the formation of advocacy coalitions (Goyal et al., 2021). The lack of regulatory frameworks and safeguards can present barriers to equitable design, distribution, and implementation of smart city services, particularly in developing countries (Tan & Taeihagh, 2020a). Therefore, countering challenges to inclusivity requires overcoming a lack of overarching regulatory and policy capacity at various scales of government, which consider the various underlying "strategic, operational, analytical, political, and cultural factors" (Ranchod, 2020). Researchers have also raised concerns about smart cities ignoring the political connotations associated with the expected transformation of public administration. The establishment of parallel smart city governance mechanisms that are placed separately from the existing political systems (Nesti, 2020) present challenges for inclusive development through exclusionary mechanisms. For example, smart cities often require a certain level of bureaucratic autonomy to allow for greater discretion and innovation in decision-making (Ranchod, 2020). The discretionary usage of regulatory

and policy measures can allow governments and corporations to bypass guidelines or benchmarks for inclusive development.

Table 2: Drivers of technological adoption and the barriers they present against inclusive development

Drivers of technological adoption in cities
Investment avenues and implementation of infrastructure
Developing human and social capital
Increasing citizen participation and e-governance
Increasing efficiency and optimisation of services
Barriers to inclusive development
Increased big tech involvement in urban development
Ethical challenges
Digital divide and polarisation
Regulatory and policy capacity challenges

Conclusion and future directions

This article explores the implications, opportunities, and challenges presented by disruptive technologies in urban development and governance, by exploring the intersection of smart cities, technology, and inclusion. It investigates the barriers faced by smart cities and their governments to achieve inclusive development, while unpacking their motivations to adopt increasingly disruptive technological solutions. It reveals certain frictions and mismatches between the drivers for technological adoption and the factors that inhibit inclusivity.

Firstly, although we see a varied conceptualisation of smart cities, inclusivity is not explicitly considered or elaborated in them. Although newer emerging concepts such as smart sustainable cities include the essential role of technology in urban development along with characteristics of sustainability, there is limited research on incorporating core values of inclusivity. Comparable discussions on the application of disruptive technology also rarely address the challenges they present

towards social, economic, and spatial aspects of inclusion, such as the digital divide, digital inclusion, and citizenship. Secondly, the motivations of big tech companies focus on diversifying their portfolio and increasing their share of economic profits, which may not correspond to the public interests such as equitable and inclusive distribution of services. Advancements by big tech also place greater demands on governments' regulatory and policy capacity through an increased information symmetry, greater expertise in specialised technologies, and by using higher power and structural leverage to influence coalitions and policy-makers. As big tech companies take a less cautious approach in implementing products that challenge data security and privacy in developing contexts (Hollands, 2015; Tan & Taeihagh, 2020a), investigation needs to be directed to highlight the vulnerabilities in the less explored contexts, particularly developing countries. Thirdly, further research is needed to establish clear goals for inclusive development that considers conflicting drivers for technology adoption. For example, drivers such as increasing human and social capital can directly bring about challenges such as a systematic variation in technology implementation and uptake due to differences in digital literacy. The interest in using technology applications to attract further investment also presents as an incentive to involve big tech companies with resources in the governance of cities – a barrier to inclusive development.

Resolving such conflicts requires further investigation of governance models that accommodate the advantages of smart solutions while addressing the barriers they present to achieving inclusive development. Examples include the exploration of anticipatory governance models that accept the uncertainty of emerging technology while promoting an active engagement with the development of technology (Cohen & Cavoli, 2019; Taeihagh et al., 2021). Models such as adaptive or agile governance can also prepare cities to manage technological applications, as seen in AV adoption in Singapore (Tan & Taeihagh, 2021). It remains to be seen if adaptive governance can also include concepts of inclusivity, while retaining stability and flexibility in managing uncertainty and other risks.

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