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POLICY BRIEF

THE TECHNOLOGICAL TRANSFORMATION OF URBAN PLANNING IN THE AGE OF 'SMART CITIES'

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Abstract. *This policy brief discusses the impact of digital technologies on urban planning using the currently predominant smart city discourse. It highlights that digital technology and smart city development offer a key momentum for cities in the Global South, including Indonesia, to develop locally relevant, context-informed urban planning, management, and monitoring paradigms and configurations. This may contribute to mitigating the adverse impact of the largely uncontrolled urban development that is typical in these countries. On the basis of global reviews of smart city initiatives, the review stresses that harnessing the benefits offered by smart city initiatives entails the development of strategic, comprehensive solution packages aimed at achieving specific policy goals. These need to include not only digital solutions but also the accompanying and necessary social–organizational processes to remove the barriers inherent to the existing social systems, which may hinder realization of the benefits offered.*

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KEY POINTS

- The potential of using emerging digital technologies and data-driven solutions to reform planning theory and practice is culminating in a worldwide discourse around “smart cities”.
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- Looking at early smart city indicatives across the globe, very few cases couple technology with policy instruments to address specific urban challenges. Digital transformation on an urban scale is unlikely to take place simultaneously over all policy domains. Smart city development is progressive in nature, consisting of a combination of radical and incremental changes. Its core value lies in empowering people to make informed decisions. The city-level digital twin represents a new endeavour to bridge the professional and disciplinary silos in city and infrastructure planning, management, and operation.

- Three use cases are described. The first concerns exploiting traffic data to improve asset management and citizens’ quality of life, a use case that demonstrates that major investment in technology is not a prerequisite for reaping the benefits of digitalization – city planners can improve policy decisions by innovative exploitation of currently existing data sources. The second focuses on a smart parking application in the city of Barcelona that led to a wave of research focusing on exploiting crowd-sourced data to improve city parking. Finally, the city data exchange in Copenhagen is described, an integrated data platform that helps eliminate the data silos that have historically been present in such smart city programmes.

- Traditional technology-led investments in data and connectivity do not naturally translate into better socioeconomic outcomes. A strategic approach to smart city development in Indonesia could be developed by assessing the potential of smart city pilots to contribute to comprehensive solution packages addressing specific local policy goals. In relatively developed urban areas in Indonesia, the existing good coverage of mobile and internet access suggests great potential for developing a digital economy (e.g. digital and integrated payment systems for public transport and online shopping). A policy option could be to improve access to basic public services and infrastructure in underdeveloped areas. The rise of new sub-centres requires good digital and physical connection with the existing employment centres, and development of the local economy tends to take time. It is therefore important that infrastructure and urban development plans are transparent and consistent over time, giving businesses confidence and certainty for long-term investment in line with planning priorities.

INTRODUCTION: AN OUTLINE OF THE CHALLENGES FOR URBAN PLANNING IN THE GLOBAL SOUTH

The year 2007 marked an important milestone in societal development when the percentage of the urban population exceeded 50% globally for the first time in history. Although the shift is a result of decades of development, its momentum has largely been maintained by urbanization processes in the Global South: the UN's 2018 Revision of the World Urbanization Prospects estimates that approximately 90% of the increase will be concentrated in Asia and Africa.[100] World Bank data shows that the urban population was below 15% in 1960 in Indonesia, but this percentage rose to over 55% by 2017.[101]

This ongoing process of *urbanization* represents the first of three major challenges for planning theory and practice discussed in this report. The rate of urbanization is both quantitatively and qualitatively different in developing countries from that experienced in the Global North. In the context of the social, political, and economic difficulties experienced in developing countries, this poses a serious problem for urban planning. Despite significant differences among developing nations in terms of the drivers and barriers of urban development and planning, a common feature is the degree, role, and influence of global market forces and foreign investment. *Globalization* processes are not confined to the economy: global competition for capital among cities also contributes to the emergence of global networks of multilevel governance. This, in turn, limits the possibilities for local and national planning. *Multilevel governance* started to develop from reorganization processes among different levels within the public and private sectors as a result of simultaneous power-migration downwards to sub-national levels (e.g. local or regional governments, grassroots networks) and upwards to supra-national levels (e.g. the United Nations, the European Union, and international corporations) on the one hand; and between the public and private sectors as a result of the spread of the neoliberal development model on the other.[102] Although processes of downward authority migration may strengthen the position of urban planning at a local level, they inherently hinder national-level planning and, consequently, attempts to balance regional inequalities. In parallel, the authority of governments and planning departments for city and regional planning is subject to contestation in the face of the workings of global capital.

The issues discussed above have serious consequences for cities in terms of environmental impact; rising inequality within cities and between urban and rural areas; and emerging polycentric power distribution patterns, leading to issues with coordination, accountability, legitimacy, and democratic quality in public policy-making, implementation, and service delivery. However, urbanization has also produced positive outputs in the form of increased efficiency in terms of access to services and opportunities, reducing overall environmental impact (albeit at the expense of the immediate and surrounding areas), economic growth and innovation (although the rate of urban poverty is rising faster than in rural areas), and social development, for example, in access to education and women's employment (but this access is differential because of significant inequalities between wealthy and poor neighborhoods).

In terms of planning theory and practice, countries of the Global South are therefore unlikely to be able to successfully build on knowledge and experience produced in the context of the Global North, as neither the remains of outdated planning practices from the colonial era (corresponding to early-20th-century practice in the Global North) nor the neoliberal model (in the absence of a stable, consensus-oriented neoliberal society) offer sufficient solutions to local problems. Consequently, it is necessary to develop new planning paradigms and configurations locally that better fit the context in order to harness the benefits promised by emerging technologies. The potential of using emerging digital technologies and data-driven solutions to reform planning theory and practice is culminating in a worldwide discourse around "smart cities". Smart city technologies relevant to modernizing city planning are introduced in the following section.

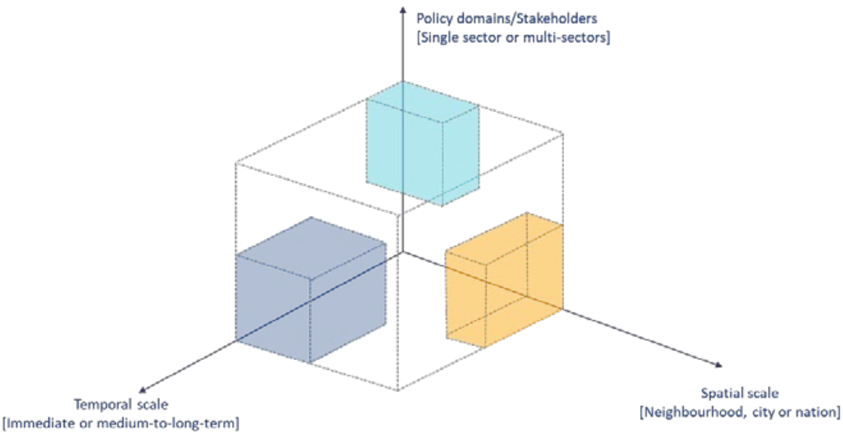
REVIEW OF TECHNOLOGY TRENDS IN URBAN PLANNING

[100] United Nations. 2017. *World Urbanization Prospects 2018.*
[101] World Bank. 2018. World Bank Open Data.
[102] L. Hooghe, G. Marks, and G. W. Marks. 2001. Multi-level governance and European integration. Rowman & Littlefield.

An Overview of the "Smart City" Agenda

The term "smart city", though poorly defined in academic terms, epitomizes a wide range of policy initiatives and corporate projects around the world that aim to utilize the power of data and digital tools for city planning, management, and operation. The transition to smart cities is driven by several factors and challenges, including increasing urbanization, growing stress on resources, inadequate infrastructure, rising environmental challenges, and rapidly improving technology capabilities.[103] Given the wide diffusion of smart city initiatives across the globe, the variety of local contexts and purposes of these initiatives has made it hard to identify shared definitions and common interests at a global scale. To facilitate the policy discussion, the paper proposes the following three key dimensions for disentangling the nexus of smart city initiatives (Figure 13).

Figure 13: Key Dimensions of Smart City Initiatives



Source: Authors' elaboration

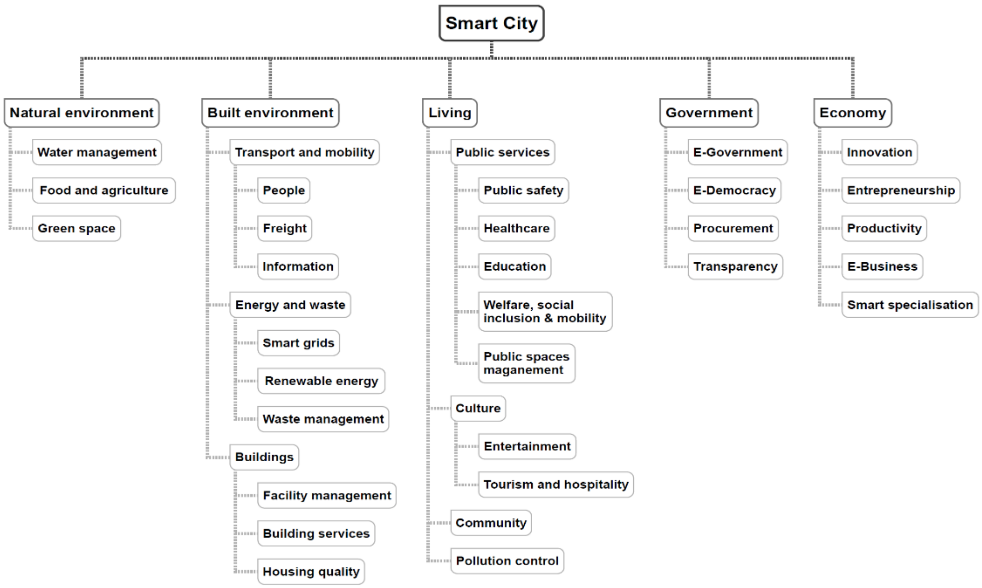
The first dimension is the policy domain and main stakeholders that the smart city initiative targets. Some initiatives may focus on a single sector (e.g. energy-saving for office buildings), while others may be crosscutting and involve a wide range of stakeholders. The second dimension is the temporal scale related to either the initiative itself or the expected impacts. This dimension raises a critical question about mediating the relatively short political cycles and the continuity and durability that some smart city initiatives require in order to achieve the expected outcomes. The third dimension is the spatial scale, including both context and location and institutional and administrative scale in which the smart city initiative takes place. A common approach of implementing smart city initiatives is the creation of demonstrators or pilots, which tend to focus on a small geographic or sectoral domain. The majority of small-scale smart city pilots aim to address the main concerns about the political, financial, and technical risks, particularly when the application of an emerging technology is the main component of investment. However, the scalability of such pilots (in terms of upscaling the initiative to a longer time span, other sectors, and/or larger spatial scale) has proven to be more complicated than previously anticipated. One reason for this is that "*despite the continuous rhetoric around the smart city agenda seeking to solve city challenges, many demonstrators have ended up as technology demonstrations*".[3] In fact, although desired policy outcomes are expressed in most cases in order to justify investment, very few demonstrators present technology as part of a comprehensive solution package to address specific city challenges.

Figure 14 summarizes the main policy domains of existing smart city initiatives. It is shown that existing smart city initiatives cover a wide spectrum of policy domains, ranging from interventions aimed at short-

[103] Future Cities Catapult. 2018. *Smart City Demonstrators - A Global Review of Challenges and Lessons Learned*.

term (real-time) dynamics in cities (e.g. transport monitoring and control) to initiatives serving medium-to-long-term social outcomes (e.g. improving the mobility of the disabled, increasing productivity through labour-augmenting/saving technologies). Studies of existing smart city initiatives also reveal that the majority of initiatives involve the application of new technologies and data to improve the provision and operation of urban infrastructure and services. Given the wide spectrum of policy domains, a critical question arises regarding the dilemma of addressing multiple policy outcomes.

Figure 14: Main Policy Domains of Existing Smart City Initiatives



Source: revised based on Neirotti et al. 2014. Current trends in smart city initiatives: Some stylized facts. *Cities*. Elsevier Ltd. 38. Pp. 25–36.

As illustrated above, the smart city agenda covers a wide range of policy domains. A relevant question has been raised by Hollands in his early critical review of smart cities: Can cities give the same priority to all aspects of the smart city agenda, or do some elements automatically take precedence over others?[104] As all cities differ in their history, and economic and political make-up, prioritization of the smart city agenda needs to engage with the specific political and socioeconomic context of the city. Given the diversity of city functions and systems, digital transformation is unlikely to take place simultaneously over all policy domains. While some urban systems and policy domains may see immediate efficiency and productivity gains from digitalization (thus potentially taking up the digital agenda relatively quickly), some sectors tend to be more inertia-prone. However, the inherent inertia of these city functions does not necessarily indicate local protectionism or conservativism; and understanding the underlying causes of the inertia requires empirical investigation. The results of this investigation must inform the prioritization of the smart city agenda.

Many policy challenges are complex and crosscutting in nature (e.g. the housing affordability issue seen in London, the UK), which renders digital technology alone ineffective, as the root causes of the problem are non-technical in nature.[105] It is thus important to examine the design and implementation of digital technologies in relation to specific policy goals and aspired outcomes. The misalignment between digital technology (as the means) and urban policy goals may undermine the success and legitimacy of smart city initiatives.

[104] R. G. Hollands. 2008. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*. 12 (3). Pp. 303–320.
[105] ONS. 2017. *Housing affordability in England and Wales: 2017*. Office for National Statistics.

In conclusion, smart city development and implementation are progressive in nature, consisting of a combination of radical and incremental changes. Their core value lies in empowering people to make informed decisions in both the private and public domains and incorporates the smartness of citizens instead of referring merely to the deployment of smart technologies. A shift in focus has been witnessed in smart city practice – from demonstrating technical functionality to a more citizen-centric solution design targeting specific urban challenges and policy goals.

Technological Trends in Urban Planning

This section discusses the emerging smart technologies that are relevant to the planning, operation, and management of cities and which are part of the smart city discourse. To provide a constructive overview of the technological trends in urban planning, this section will discuss digital technology in relation to its relevance to urban challenges and policy goals.

Online Open Data Sources and the Associated Data Analytics

Urban planning, as a policy instrument for stipulating the strategic development of cities, requires good-quality data input. Traditional data sources for supporting urban planning include structured census data (e.g. population and economic census) and administrative or geographical surveys of land and buildings. Conventional data sources have great analytical advantages in terms of coverage and quality assurance. However, they are usually conducted every few years, thus only representing a cross-section of the economy. Their spatial resolution tends to be limited subject to the setting of statistical units. In the particular context of developing countries, which feature a relatively fast rate of urban development and a high level of informality in terms of social and spatial development patterns, the emerging online open data provide a new source of information that can complement conventional data sources. Online open data sources typically include administrative data derived from the "open government" initiatives across both developing and developed countries, social media data, online communities (e.g. themed forums), job posting sites and service records of smart-device applications. These new online data are usually "big data" and come with detailed timestamps and geo-location information, which provide useful information for urban planning professionals to understand the dynamics in cities that are difficult to capture in structured statistics. Use cases of online open data for urban planning include mapping the spatial structure of cities, verifying the population and employment in fast-growing cities, and identifying the commuting patterns of both formal and informal jobs.[106]

GIS-Based Data Visualization and Integration

The Geographic Information System (GIS) has been widely used as an interoperable framework for gathering, managing, and analysing geospatial data. GIS enables planners to run a variety of queries and analytics on a wide range of spatial data, such as the spatial distribution of the population, employment, buildings, and ecological features. The use of GIS for urban planning can be categorized into three levels: visualization, data integration, and automation.

The first level is to visualize geospatial data from a single source. The second level is to integrate data from multiple sources to enable better decision-making. One example is the London Infrastructure map – an interactive tool that integrates information on growth projections, infrastructure investment, and local planning policies on one geographic map of London.[107] The service gives citizens, developers, urban service providers, and utilities a clear picture of what developments are taking place, and informs the timing of infrastructure projects to reduce disruption and the phasing of land development to improve investment efficiency. The second level (data integration) is likely to be the mainstream application of GIS-based data analytics for urban planning in the next couple of years.

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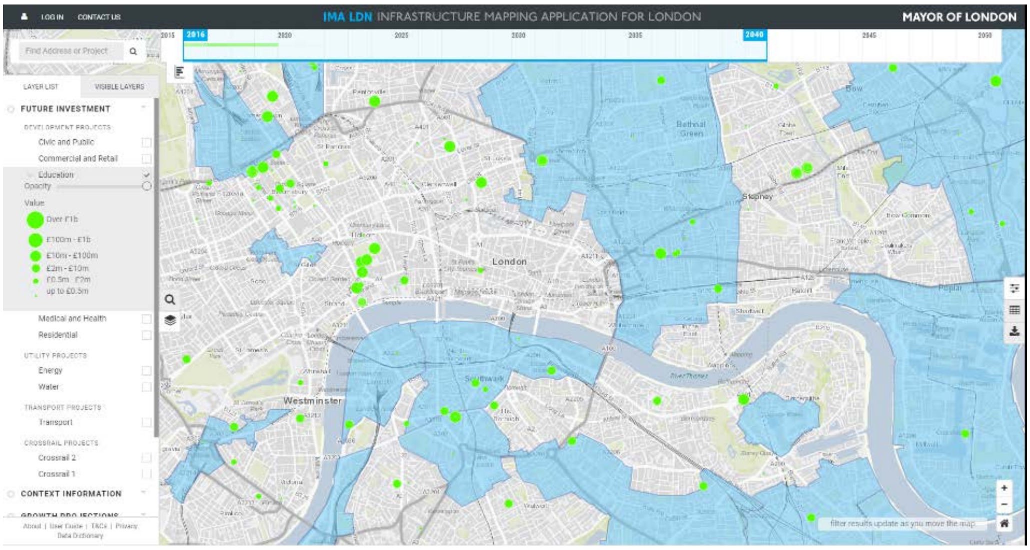
[106] L. Wan, S. Gao, C. Wu, Y. Jin, M. Mao, and L. Yang. 2017. Big data and urban system model – Substitutes or complements? A case study of modelling commuting patterns in Beijing. *Computers, Environment and Urban Systems*, (October), 0–1.
[107] The London Infrastructure Map.

Figure 15: Screenshot of the London Infrastructure Map – Locations for Future Investment in Education in Central London



Source: [London Infrastructure Map](). 2018.

The third level is the automation of tasks in urban planning, which is largely enabled by artificial intelligence (AI) through machine learning. The third level represents a qualitatively different paradigm of data and algorithm use and raises deep questions about what processes can and should be automated in urban planning considering issues related to the regulation, accountability, and ethics of algorithm-based decision-making. This provides an opportunity for contemplation about the future role of urban planning within the ecosystem of a city. Given the inherent complexity of urban planning as a policy instrument aimed at medium-to-long-term development goals, system-wide automated decision-making will not replace public debate, which is an indispensable element of policy-making. However, the automation of certain tasks within the existing planning workflow may bring immediate efficiency gains, which can be explored subject to pre-emptive measures of risk mitigation.

City-Scale Data-Sharing Schemes

Another technological trend that has been widely witnessed in many cities is the development of city-scale data-sharing schemes. The London Datastore is one such example.[108] The Datastore is a free and open data-sharing portal, where citizens, business owners, researchers, and property developers can access more than seven hundred data sets to help them understand the city and develop solutions to London's problems. This initiative goes beyond the simple purpose of providing free data access and treats data as a type of infrastructure that underpins the growth of cities. The data-sharing scheme represents a new data-centric, open approach to promoting urban economic development that encourages citizens and businesses to devise innovative solutions to tackle pressing urban challenges.

City-Level Digital Twin

The worldwide smart city initiatives have accumulated into a new body of knowledge on how digital technologies can help cities deliver better political and socioeconomic outcomes. As one of the latest efforts in this vein, the UK National Infrastructure Commission (NIC) has proposed a new strategy for planning, building, and managing future infrastructure as a digitally connected, interdependent, and dynamic system.[109] The new strategy highlights data as an emerging form of infrastructure and

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[108] The [London Datastore.]()

[109] National Infrastructure Commission. 2017. Data for the Public Good. NIC Report.

promotes effective data-sharing across the infrastructure of industry through collaboration and standardization. Such ambition is epitomized in the endeavour of building a “digital twin” model for key national infrastructure, which combines standardized data on all infrastructure assets, and features real-time monitoring and intervention, as well as medium-to-long-term predictive capability through advanced data analytics. The digital twin model will optimize the use of resources (e.g. energy and water), improve efficiency at system level, and inform policy-making on planning and managing infrastructure. Although the actual role and contents of the national digital twin, as proposed by the NIC, have not been articulated, this new initiative calls for an unprecedented level of coordination and collaboration across disciplinary and professional boundaries.

In terms of the policy implications for city planning, the city-level digital twin concept addresses a serious knowledge and practice gap – urban professionals involved with cities and infrastructure tend to work in disciplinary and professional silos, and methods for appraising major urban development options are thus not “joined up”, which makes it hard to assess effectively the wider impacts of policy interventions. It also relates to the issue of mediating short-term urban management measures (e.g. smart traffic lights) and medium-to-long-term policy goals (e.g. productivity growth and sustainability). The city-level digital twin explores digital technology as an intermediary for sharing intelligence across disciplinary and professional boundaries and linking different policy timescales, such that system-level inefficiencies and risks can be identified that are otherwise difficult to discover from silos. The integrated intelligence may stimulate new collaborative approaches to policy research and practice and strengthen public debate.

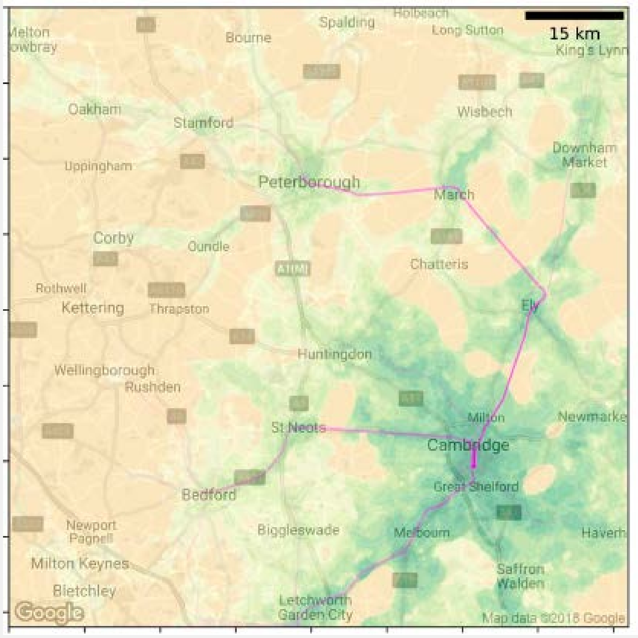
Box 1: Case Study – Exploiting Traffic Data to Improve Asset Management and Citizens’ Quality of Life

This use case demonstrates that major investment in technology is not a prerequisite for reaping the benefits of digitalization – city planners can improve policy decisions by innovative exploitation of currently existing data sources.

Infrastructure is key to the functioning of all modern societies. Effective management of the networks of highways, pipes, electric cables, and other assets is critical to the economic, social, and cultural well-being of citizens. An important part of infrastructure asset management is criticality analysis – a structured methodology that provides a proactive approach to the assessment of business impacts of assets for the organization. Criticality analysis is used as a tool to inform investment planning, maintenance prioritization, and monitoring. However, carrying out an accurate criticality analysis is often hampered by the availability of good-quality information.

In collaboration with Smart Cambridge, the Centre for Digital Built Britain demonstrated how large publicly available data sources can be exploited to inform criticality analysis across transportation networks.[a] This project made use of data obtained through the Google Maps API to examine the accessibility of two major research campuses across the city and to analyse the effectiveness of bus schedules and travel times. The output of this data analysis were “heat maps” (see the figure below) that facilitated visualization of the accessibility of points of interest from across the city.

Carrying out such analyses for other key points of interest and performing a weighted overlay of the heatmaps helped city planners identify areas that need prioritization for public transport investment and the provision of bus routes. Furthermore, transportation data were also used to analyse the criticality of road segments for accessibility to the city’s hospital. Criticality was calculated by weighting the appearance of different routes in the transportation recommendations from the Google Maps API. In the following figure, the purple routes are considered critical. The higher the criticality, the larger the influence of these roads on travel times to the hospital. The more intense the colour is, the more critical they are.



Given a random sample of destinations of origin and counted how many times each route appears in the recommendations, these routes are then overlaid on the map with a colour scale proportional to the times they have appeared in Google's recommendations. This weighting is then done in proportion to the population density of each point on the map. This helped the city's highway asset managers to determine when and where to conduct road maintenance, thereby making more efficient use of ever-dwindling funding. Moreover, it ensured that investment in infrastructure provided maximum value to citizens, and most importantly that it had an indirect impact on quality of life by improving accessibility to health services.

[a] Smart Cambridge; A. Salvador-Palau and J. Roozenbeek. *Accessibility and Criticality in Cambridgeshire using Google data*, April 2018.

Box 2: Case Study – Barcelona Smart City: Innovative Use of Crowd-Sourced Data

The Barcelona Smart City team, set up in 2011, implemented several programmes across the city focused on exploiting digital technologies to improve service provision across the transport, energy, waste, and water infrastructure. As part of this initiative, Barcelona developed a smart parking application, ApparkB,[a] that allowed drivers to pay for parking using their mobile phones instead of parking meters. This spawned a wave of research that focused on exploiting crowd-sourced data to improve city parking. Recently, the data collected through this app were exploited to predict parking space availability and to guide drivers to available parking spaces.[b] Drivers enter the address of the destination where they are going and select their planned arrival time. Accordingly, drivers see the forecast availability of parking spaces at the location entered, visualized through an easily understandable colour code: green (high probability), orange (medium probability), or red (low probability). This allows the city to effectively manage traffic in urban areas, reduce stress for drivers, improve air quality (and hence public health), and increase overall citizen satisfaction.
Acknowledging the importance of data governance and management, the city has set up a "city data analytics office" led by a chief data officer responsible for the unified management of public data. This office will *"… use public data to provide information that helps to resolve the challenges facing the city, as well as providing services for the various municipal units*".[c]

[a] ApparkB.
[b] BSM.SA. 2017. B:SM launches new updates of the ApparkB and AreaDUM applications.
[c] Barcelona Digital City. 2017. City Data Analytics Office.

Box 3: Case Study – Copenhagen: The City Data Exchange

Copenhagen is set to become a smart, carbon-neutral city by 2025. A number of smart city programmes have been initiated across all sectors to support this goal. One of the key steps taken by Copenhagen in 2016 was the development of an integrated data platform – The City Data Exchange. The objective was to help eliminate the data silos that have historically been present in such smart city programmes. The project began by identifying more than sixty-five sources of open data on the city, ranging from demographics to weather and crime statistics. The core idea was that by combining different data sets, such as those submitted by citizens and businesses, the platform would enable advanced analytics to improve areas such as green infrastructure planning, traffic management, and energy usage. Therefore, the core component of the data exchange is the integration of data from private companies and open data from public authorities, and the creation of a marketplace to allow data suppliers to find data customers. Key to the development and functioning of such a marketplace is the establishment of an organization external to the city council, which is responsible for providing data analytics and support to third-party developers to use data in their applications. Moreover, the organization is responsible for facilitating processes to allow businesses and researchers to access data available on the platform.[a] Copenhagen is the first city in the world to attempt to monetize its data (and those of other organizations) through a city data market and has set the trend for other cities to follow suit. It is, however, currently unclear how this platform has led to innovative applications to improve city management and citizens' quality of life.

[a] N. Hill, G. Gibson, E. Guidorzi, S. Amaral, A. K. Parlikad, and Y. Jin. 2017. *Scoping study into Deriving Transport Benefits from Big Data and the Internet of Things in Smart Cities*. Department for Transport.

IMPLICATIONS FOR THE GLOBAL SOUTH AND INDONESIA

The cultural and socioeconomic context in which planning operates in the Global South is substantially different to that in the Global North. The unfolding digital revolution, and smart city initiatives in particular, provide the momentum to reform the existing urban planning practice in these countries to better fit the local context, and to develop context-informed solutions to local problems. The Indonesian Government has already expressed interest in smart city solutions and launched 25 smart city pilot projects in 2017, with the aim of expanding the number of participating cities to a total of 100 by 2019.[110] Our review emphasized that traditional technology-led investments in data and connectivity do not naturally translate into better socioeconomic outcomes. Thus, developing a strategic approach to smart city development in Indonesia could be achieved by assessing the potential of smart city pilots to contribute to comprehensive solution packages addressing specific local policy goals. These could extend to the social–organizational changes that are necessary to realize the benefits of digital technology deployment. Investment into digital infrastructure, for example, the Palapa Ring Project, provides a critical window of opportunity to digitally connect elements of the dispersed geography of Indonesia featuring more than 17,000 islands.[111] The project may become a strong catalyst for local socioeconomic development, particularly in rural areas, by promoting digital connectivity. However, for the project to achieve these aims, it must be accompanied by a comprehensive solution package addressing the cultural and structural barriers that may prevent the digitally deprived population living in underdeveloped areas from harnessing the benefits of digital connectivity (e.g. education programmes, and the establishment of community centres providing access to computers and the internet). Moreover, given the development disparity between urban and rural areas in Indonesia, digital strategies may be differentiated among different locations to fit the local context. In relatively developed urban areas, the existing good coverage of mobile and internet access suggests great potential for developing a digital economy (e.g. digital and integrated payment systems for public transport and online shopping). In underdeveloped areas, however, improving access to basic public services and infrastructure could be prioritized. Remote medical services, real-time weather information, on-demand public transport solutions, and e-commerce for marketing local products are all potentially useful digital applications enabled by the Palapa Ring Project.

The 2015–2019 National Medium-Term Development Plan (RPJMN 2015–2019) highlights 136 areas in 7 provinces with a high disaster risk index. Rural areas in identified regencies are considered the least capable of effectively coping with disasters. Digital connectivity enabled by the Palapa Ring Project brings new possibilities for disaster and emergency response. For example, establishing a centralized national disaster response system that is able to coordinate the efforts of multi-agencies seems highly beneficial. In turn, considerations about the impact of extreme events also need to be incorporated into the planning, construction, and management of both digital and physical infrastructure to ensure the resilience of these digital assets.

Urbanization in Indonesia reflects post-suburban development processes driven predominantly by the privatization of land management in fringe areas of core cities.[112] This leads to mega-urbanization representing a shift from monocentric to multicentric metropolitan regions driven by market processes serving mainly the middle- to upper-income layers of society. As a result, a growing number of urban poor are excluded from urban development. Opportunities exist to improve their access to infrastructure and public services through the coordinated action of local authorities and market players. However, the role of the private sector, often driven by foreign investment, is ambiguous. On the one hand, it does ease the pressure on the public sector by responding to the ever-increasing local and regional needs of housing, employment, and service provision. On the other hand, private-sector-driven development further decreases the national and local public sector's authority and powers over planning by overtaking land management, infrastructure, and service provision in fringe developments; and it contributes to differential development and "urban splintering", further worsening regional disparity.[113] Smart city solutions underpinned by data and digital technologies can have both positive and negative

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[110] Republika. 2017. Ministry launches 100 smart city movement.
[111] Indonesia Investments. 2018. Internet Infrastructure Indonesia: What About Progress on the Palapa Ring?
[112] T. Firman and F. Z. Fahmi. 2017. The Privatization of Metropolitan Jakarta's (Jabodetabek) Urban Fringes: The Early Stages of "Post-Suburbanization" in Indonesia. *Journal of the American Planning Association*. 83 (1). Pp.68–79.
[113] S. Graham and S. Marvin. 2002. *Splintering urbanism: networked infrastructures, technological mobilities and the urban condition*. Routledge; V. Watson. 2009. Seeing from the South: Refocusing urban planning on the globe's central urban issues. *Urban Studies*. 46 (11). Pp. 2259–2275.

impacts in this context.[114] Modernizing planning theory and practice in the Global South thus implies the development of a convincing narrative of how market-driven development serves only a specific segment of the population (i.e. those who can afford to pay for it) and regards them as "customers" rather than citizens. In contrast, the public sector must use the digital revolution and the powers that data can offer to "*provide public goods even when markets are non-existent, and protect against externalities even when payment systems are not in place*".[115]

Smart city initiatives could potentially become a strong policy instrument to rebalance the regional disparity in Indonesia. The concentration of investments and growth in the Jakarta city region has created a strong agglomeration economy, while spreading the growth and sharing the prosperity with the wider region may benefit society as a whole. The rise of new sub-centres requires good digital and physical connections with existing employment centres, and development of the local economy tends to take time. It is therefore particularly important that infrastructure and urban development plans are transparent and consistent over time, giving businesses confidence and certainty for long-term investment in line with planning priorities.

Further implications of smart city technologies for the countries of the Global South are discussed in more technical terms below: data collection and processing; data analysis and sharing; and socioeconomic benefits and risks.

Challenges of Data Collection and Processing

All data-driven solutions, processed with the help of digital technologies, are only as good as the data they use. However, high urbanization rates and the quick pace of change in the Global South pose significant issues for collecting accurate and good-quality data that can be acted upon.[116] Thus, it is crucial to develop and implement data-collection methods and technologies that substantially reduce the time required for data collection; and which are capable of producing data that accurately and representatively reflect the real-world processes that are being measured. With the increasing importance of the private sector in land management, issues of data ownership and ensuring access to data are critical for public policy-making, implementation, and monitoring. This implies a need to develop legislation and data-sharing agreements across the organizational landscape. Missing or intentionally excluded data may lead to biased analyses that fail to adequately represent real-world processes. Nevertheless, data availability is likely to remain incomplete and data-processing technologies must be able to cope with patchy and missing data. No data, algorithm, or software (e.g. method of data processing) is ever "objective". Being predominantly developed in Silicon Valley, it is particularly important to review the algorithmic processing methods (and the assumptions built into these) with regard to their appropriateness and fitness to represent real-world processes in Indonesia.

Data Analysis and Sharing

Data analysis and sharing relate to translation of the results of data processing (modelling, simulations, or automated decision-making) into intelligence for policy-making and economic development. Successful data analysis requires both appropriate knowledge of the context in which the results are to be interpreted and a high level of understanding of how these results are obtained through algorithmic processing (i.e. the assumptions and uncertainties involved). Thus, training for planners and public officers in digital solutions is crucial.

Data sharing and open-access data can support economic development in two ways: first, by overcoming siloedness through integration and improving interoperability among both infrastructure and service sectors; and between city management and planning by using more accurate and near real-time data to underpin planning and monitoring decisions and processes (e.g. between different levels of government). This has critical relevance in the Global South, where private-sector-led development might not necessarily agree masterplans or public consultation processes, and the public sector might have little leverage over fringe developments. Second, data sharing and open data are also associated

[114] A. Luque-Ayala and S. Marvin. 2015. Developing a critical understanding of smart urbanism? *Urban Studies*. 52 (12). Pp. 2105–2116.
[115] T. Sager. 2011. Neo-liberal urban planning policies: A literature survey 1990–2010. *Progress in planning*. 76 (4). Pp. 147–199.
[116] B. Cohen. 2006. Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in society*. 28 (1–2). Pp. 63–80.

with innovation and entrepreneurial economic development. Open data can help develop locally appropriate forms of heterogeneous or hybrid configurations of infrastructures and public services through local (community) entrepreneurialism. By doing so, it can contribute to addressing urban inequality, which also manifests itself in access to centrally provided networked infrastructures and public services often limited to certain (wealthy) districts in the cities of the Global South, including Indonesia.

Co-Factors and Socioeconomic Benefits and Risks

Harnessing the benefits of emerging digital technologies implies finding a role for public sector planning in processes of policy-making, implementation, and monitoring where these are deployed. Scholars have demonstrated in various contexts across Asia, Africa, and South America how the smart city agenda may serve to further deepen urban inequalities and splintering. However, with the correct governance processes in place, digital smart city solutions may also contribute to the development of more controlled urban development. One example of this is the potential of digital solutions to re-engage citizens in public debates and consultation processes in Indonesia. This could involve the development of legal and regulatory frameworks for the use of digital technologies in city planning, management, and monitoring, and governing the digital interfaces created among these. The transformational potential of smart urban solutions can only be realized if these are used to treat the structural failures of current governing processes of the emerging combinations of central-state and private-sector provision. Therefore, attention must be paid to "*how smart technologies – data analysis, software systems, networked infrastructure and new digital systems such as sophisticated control and pricing technologies – are used to more intensively unbundle and rebundle users, space, services and networks*".[117]

[117] A. Luque-Ayala and S. Marvin. 2015. Developing a critical understanding of smart urbanism? *Urban Studies*. 52 (12). Pp. 2105–2116.