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Computationally Networked Urbanism and Big Data-driven Decision-Making Processes for Internet of Things-enabled Smart Cities

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Abstract

The objective of this paper is to integrate and inspect current evidence on Internet of Things-enabled smart cities. Using and replicating data from ESI ThoughtLab, KPMG, McKinsey, and Osborne Clarke, we performed analyses and made estimates regarding computationally networked urbanism and big data-driven decision-making processes. Data were inspected by harnessing structural equation modelling.

Keywords: urbanism, big data, Internet of Things, smart, city.

JEL Classification: L81, O14, O32, Q55

1. Introduction

Smart city driving forces mobilize the advancement and deployment of networked digital technologies into a rhetoric and rationale in which the latter are furthered as well-founded, feasible ways out to the discomforts of urban life, clarifying social matters, managing local and regional economies, and facilitating civic projects (Kitchin et al., 2019).

2. Problem Statement

Cities of scale harness various smart city technologies (Atwell & Lăzăroiu, 2019; Coatney, 2019; Eysenck et al., 2019; Harrower, 2019; Kenrick et al., 2019; Pera, 2019; Slaby, 2019) to organize urban services and infrastructures (Atwell et al., 2019; Durkin, 2019; Fielden et al., 2019; Hollowell et al., 2019; Krech, 2019;

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Popescu Ljungholm, 2019a, b; Trettin et al., 2019), and to regulate public-sector operations. Smart cities are stimulated by and replicate certain patterns of power (Bekken, 2019; Durst, 2019; Gray-Hawkins et al., 2019; Hyers, 2019; Lafferty, 2019; Sheller, 2019; Wingard, 2019) and governance (Byrne, 2019; Eskridge, 2019; Groener, 2019; Keane, 2019; Lyakina et al., 2019; Sion, 2019), also modeling formations of economic advancement (Kitchin et al., 2019).

3. Research Questions/Aims of the research

Q1 The big data-driven infrastructure bolstering smart cities may operate as a platform for constant economic growth. Q2 Smart cities are mainly designed to generate consumers, that is to articulate and cover specific markets with the capacity and the intention to meet the expense of products and services. Q3 Urban agglomerations are instrumental in terms of the development of the innovation process and of determining suitable markets. The objective of research is to prove that smart cities configure a regulating design for gathering data on the features and behaviours of citizens and companies in the built settings. Cities purchase smart things, systems, and platforms while supplying services and infrastructure to users. (Clark, 2020).

4. Research Methods

By using and replicating data from ESI ThoughtLab, KPMG, McKinsey, and Osborne Clarke, we performed analyses and made estimates regarding computationally networked urbanism and big data-driven decision-making processes. Data were analysed using structural equation modelling. The interviews were performed online and compiled data were weighted by important variables (age, education, geographic region, race/ethnicity, and gender) harnessing the Census Bureau's American Community Survey to represent thoroughly and unequivocally the demographic organization of the United States. Sampling errors and inspection of statistical relevance comprise the impact of weighting. Stratified sampling procedures were used and weights were redesigned not to surpass 3. Standard margins of error are +/-2% at the 95% confidence level. For tabulation grounds, percentage points are calculated roughly to the next whole number. The preciseness of the online polls was determined by resorting to a Bayesian credibility interval. Confirmatory factor analysis was used to examine the consistency and cogency of measurement tools. An Internet-based survey software program was handled for the distribution and inspection of responses.

5. Findings

As a data-driven industry, smart cities concentrate on the design, advancement, and arrangement of an evolving kind of cross-platform, service-assimilated technology, outcomes that improve infrastructure operation and diversify services. Urban innovation networks function as the pivotal drivers furthering technology and enabling data exchange. Big data-driven urban innovation networks facilitate

interaction among urban operating systems and the dissemination of policy knowledge by use of horizontal networks. Urban knowledge insists on the capacity to collect, concatenate, process, and inspect massive volumes of datasets concerning public sector practices, assisting in the carrying out, operation, and design of big data-driven areas, and in articulating elaborate and networked systems of platforms (Clark, 2020). (Tables 1-10)

Table 1. Most required alterations to enhance smart cities' living setting (%)

Availability of affordable housing	56
Reducing traffic congestion and improving transport/mobility	80
Improvement of recycling/waste management and infrastructure for recyclable waste collection	79
Availability of green spaces/parks	74
A living environment that is more accommodating to elderly and disabled residents	68
Reducing pollution	76
Reducing the carbon footprint	74
Urban redevelopment	65

Sources: KPMG; our survey among 4,800 individuals conducted February 2020.

Table 2. Actions required to enhance transportation and mobility in data-driven urban areas (%)

Improved walkability and safety for pedestrians	76
Constructing more rail and underground transport links	78
Building infrastructure for electric vehicles and providing incentives to electric vehicle owners	79
Tighter regulation of private cars and vehicles	75
Constructing more bicycle lanes/bicycle paths	77
Installing cameras/sensors to record traffic violations	76
Smart tolls and smart parking	76
Studying feasibility of driverless transportation models	78

Sources: KPMG; our survey among 4,800 individuals conducted February 2020.

Table 3. How smart cities can cut down the expenses of living (% change in standard yearly costs)

Effects of dynamic electricity pricing, home automation, home energy and water consumption tracking	-0.8
Effects of remote monitoring, telemedicine, online care search, lifestyle wearables, integrated patient flow management	-0.7
Effects of e-hailing, car and bike sharing, congestion pricing	-0.3
Effects of digital land use and building permitting, open cadastral databases, peer-to-peer accommodation platforms	-2.6
Effects of home security systems, personal safety applications	0.8

Sources: McKinsey; our estimates.

Table 4. To what degree do you think that project finance structures will be used to fund the roll-out of smart technology in the next three years? (%)

Strongly agree	18
Agree	60
Disagree	19
Strongly disagree	3

Sources: Osborne Clarke; our survey among 4,800 individuals conducted February 2020.

Table 5. Key actions to accelerate education development in smart cities (%)

Encouraging continuous education/lifelong learning	64
Developing education programs that encourage creativity and risk-taking	66
More funding for education and research in science, technology, engineering, and mathematics (STEM) disciplines	70
More smart city and innovation technology training for professionals at different levels	72
Developing education programs/courses/training in artificial intelligence, data analytics and machine learning	71
Providing mandatory coding/programming training starting from primary school	68
Attracting top scholars and professors to do research/teach in your city	64

Sources: KPMG; our survey among 4,800 individuals conducted February 2020.

Table 6. How smart cities can configure an innovative kind of digital commons (%)

Impact of digital platforms for making local connections *% feeling connected to their local community*	
Baseline	28
Impact of local connection platforms	21
Resulting baseline	49
Impact of local citizen engagement applications *% feeling connected to their local government*	
Baseline	18
Impact of local citizen engagement applications	27
Resulting baseline	45

Sources: McKinsey; our survey among 4,800 individuals conducted February 2020.

Table 7. How smart city applications can be instrumental in articulating a safer urban environment (%)

Fatalities *% decrease in addressed fatalities by application*	
Gunshot detection	2.8
Predictive policing	4.9
Real-time crime mapping	3.6
Personal alert applications	0.7
Data-driven building inspections	0.8
E-hailing (private and pooled)	0.7
Congestion pricing	1.4
Intelligent traffic signals	0.8
Crime incidents *% decrease in incidents by application*	
Predictive policing	12.5
Home security systems	14.3
Real-time crime mapping	12.4
Smart surveillance	5.7
Personal alert applications	4.4
Smart streetlights	5.3
Emergency response *% decrease in average emergency response time by application*	
Emergency response optimization	21.1
Personal alert devices	1.6
Smart surveillance	4.8
Real-time crime mapping	2.8
Gunshot detection	0.8
Home security systems	0.6
Intelligent traffic signals	8.7

Sources: McKinsey; our estimates.

Table 8. What are the upsides that your urban area has obtained from its smart city investments? (%)

Reduce budget deficits	264
Reduce capital costs	67
Improve competitiveness	56
Promote economic development	54
Improve sustainability/resiliency	37

Sources: ESI ThoughtLab; our estimates.

Table 9. Where residents think that smart cities should make transportation investments (%)

Using data to improve transportation routes	66
Improving the speed/reliability of public transportation	63
Using real-time data to respond quickly to traffic issues	62
Offering payment accounts for all transportation modes	62
Sharing data with public on traffic, roads, etc.	58
Providing more travel options (bikes, ferries, etc.)	57
Providing electric vehicle charging stations	56
Using my data to personalize travel suggestions	55
Planning for autonomous vehicles	54
Exploring drones/driverless trucks for moving goods	51

Sources: ESI ThoughtLab; our survey among 4,800 individuals conducted February 2020.

Table 10. How smart cities can be sustainable and clean (%)

GHG emissions, % decrease by application	
Building automation systems	2.6
Home energy automation systems	2.7
Dynamic electricity pricing	1.9
Distribution automation systems	0.8
Energy consumption tracking	0.6
Smart streetlights	0.3
Demand-based microtransit	0.5
Intelligent traffic signals	0.8
Congestion pricing	0.9
Integrated multimodal information	0.8
Smart parking	0.6
Smart parcel lockers	0.7
Bike sharing	0.6
Parcel load pooling	0.5
Real-time public transit information	0.6
E-hailing (private and pooled)	0.4
Car sharing	0.3
Digital tracking and payment for waste disposal	0.6
Waste collection route optimization	0.3
Water consumption tracking	0.4
Leakage detection and control	0.3
Water, % reduction in water consumption by application	
Water consumption tracking	7.6
Building automation systems	1.5
Leakage detection and control	15.5
Smart irrigation	0.6
Waste, % reduction in unrecycled waste by application	
Digital tracking and payment	13.8

Sources: McKinsey; our estimates.

6. Conclusions

By collecting and processing digital information concerning particular urban undertakings, mobilities, and infrastructures, cutting-edge smart big data-driven technologies make cities more manageable, coherent, sustainable, and safe. In smart cities, urban activity is made coherent and responsive by the use of data gathering and mining, by harnessing improved digital infrastructure, instantaneous information, and ubiquitous computing to further performance in city administration and to enhance the standard of living for citizens. Implementation of computerized systems, interconnected sensors, and Internet of Things are instrumental for the coherence and optimization of data-driven decision making in sustainable, digitally networked urban areas (Halegoua, 2020).

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