Bus Inf Syst Eng 63(1):71–77 (2021)
https://doi.org/10.1007/s12599-020-00674-9

CATCHWORD

City 5.0

Michael Rosemann · Jörg Becker · Friedrich Chasin

Received: 6 February 2020 / Accepted: 4 October 2020 / Published online: 1 December 2020

Keywords City 5.0 · Liveable city · Smart consumption · Elimination of restrictions

1 The Notion of 4.0 and 5.0: From Smart Production to Smart Consumption

Over the last decade, the notion of Industry 4.0 has become the overarching design paradigm for the comprehensive digitization of manufacturers. Primarily represented by the idea of smart production, Industry 4.0 symbolizes an environment in which digital technologies like robotics, the Internet of Things (IoT), advanced manufacturing, and data analytics facilitate a highly flexible production environment. This environment has led to the development of factories in which traditional limitations of production are disappearing. First, the shortfalls of human labor and their impact on production quality are largely eliminated by extensive automation. Second, the long-lasting economic restrictions related to small lot sizes evaporate, and the goal of a cost-effective 'lot size one' becomes feasible because of highly adaptive, robotic processes and machinery, as well as entirely new forms of production (e.g., 3D-printing). Third, latency costs (e.g., delayed sensing of a machine problem) are also disappearing as built-in sensors provide continuous and even predictive insights into the status of the production environment.

Although Industry 4.0 (Lasi et al. 2014) can be seen as the 'industrial revolution' of the digital age, it is largely invisible from the viewpoint of a citizen. Its main benefits are new levels of cost-effectiveness in a production system and previously unseen production flexibility, but the products themselves (e.g., cars and the experience in using them), are in most cases not fundamentally impacted by Industry 4.0.

While companies around the world still strive to implement (parts of) Industry 4.0, the academic and professional discourse has already extended the goalpost by introducing the new symbolic notion of Industry 5.0. There are different interpretations of 5.0 in the industrial context, including closer collaboration between robots and humans (Nahavandi 2019; Ozkeser 2018) and democratization of knowledge (Özdemir and Hekim 2018). However, an even more significant difference of the next generation of design paradigms is the shift from smart production to *smart consumption* (Kowalkiewicz et al. 2017). While 4.0 thinking tends to focus on production time, 5.0 focuses on the time and the experiences during the consumption of a product. Digital technologies like sensors and cloud computing have facilitated a 'continuous connectivity' between a product's provider and its consumer (Siggelkow and Terwiesch 2019) such that selling a product is no longer the end of a relationship, but the beginning. Traditional production principles, such as make-to-order and make-to-stock do not sufficiently reflect this possibility. As prominent examples like smartphones and Tesla cars show, products can instead follow a *make-to-evolve paradigm*. These products are upgradeable and continue to develop new capabilities tailored to a changing context and the users'

Accepted after two revisions by Ulrich Frank.

M. Rosemann
Centre for Future Enterprise, QUT Business School, Brisbane, Australia
e-mail: m.rosemann@qut.edu.au

J. Becker (✉) · F. Chasin
ERCIS, University of Muenster, Muenster, Germany
e-mail: joerg.becker@ercis.uni-muenster.de

F. Chasin
e-mail: friedrich.chasin@ercis.uni-muenster.de

profiles. This expansion from the smart factory (Industry 4.0) to smart consumption is the core idea of Industry 5.0.

Whereas Industry 4.0 has made production frictionless, Industry 5.0 strives to make consumption frictionless. As a result, Industry 5.0 is much more tangible, and relevant, for citizens than Industry 4.0. In particular, citizens tend to have a utility-oriented view, and the 'smartness' of their consumption is qualified in terms of whether a solution can eliminate citizens' restrictions in consuming a service or not. Against this background, eliminating established restrictions of consumption is moving to the center of attention. Considering the history of digitalization from this perspective, elimination of restrictions is what digital technologies do best. For instance, the emergence of over-the-top solutions like WhatsApp, Skype and Zoom has eradicated communication costs such that an economic restriction (affordability) to engaging in a conversation has disappeared. Similarly, restrictions to accessing information have disappeared with the ubiquitous presence of search engines and the comprehensive digitization of information. A third example is the disappearing costs of data storage, which have all but evaporated with freemium-based cloud services (e.g., Dropbox). While the elimination of restrictions was already a goal of Industry 4.0 (e.g., no restrictions during production), 5.0 extends the goal to 'no restrictions during consumption'.

The symbolic meaning of 5.0, and with it a focus on eliminating restrictions to consumption, can be deployed to many organizations. The literature has covered, for example, the nature of Retail 5.0 (Kowalkiewicz et al. 2017) and Government 5.0 (Kowalkiewicz and Dootson 2019). One might further imagine the concepts of Entertainment 5.0, which materializes in on-demand services (no time constraints to consumption) or Education 5.0, a lifelong learning system in which personalized education is provided independent of location in a subscription mode, ensuring continuous educational wellbeing.

The following sections elaborate on how the notion of 5.0 impacts another macro-organization – cities – and how they, as complex, human-made systems, benefit from the symbolic design paradigm labelled City 5.0. To begin with, we position the new concept of City 5.0 in the context of the widely discussed and researched notion of the 'smart city'.

2 (Smart) City and Liveability

Current estimates are that about 70 percent of the world's population will live in cities by 2050.[1] This unbroken trend towards urbanization increases the complexity of the challenges cities are already facing, including traffic congestion, environmental damage, inadequate and outdated infrastructure, unaffordability, non-scalable healthcare and education systems, social disaggregation, poverty, and limited resources like water, energy, healthcare, and housing. The extent to which cities master these challenges is often measured in terms of the "liveability" metric, which determines the attractiveness of a region as a place to work, live, invest, and conduct business (Giap et al. 2014). Specifically, a liveable city is "safe, attractive, socially cohesive and inclusive as well as environmentally sustainable"(Lowe et al. 2013). By providing services and opportunities, a liveable environment influences its inhabitants' quality of life and wellbeing. Aspects of liveability can be structured differently depending on the granularity (Giap et al. 2014; Woolcock and Elliott 2009) of the five following core dimensions (EIU 2019; Giap et al. 2012):

Stability, Safety, and Public Governance This category represents basic human needs and encompasses the prevalence of petty and violent crime, (traffic) accidents, the threat of terror, military conflict, and civil unrest/conflict. A shake-up of social harmony by, for instance, conflict can endanger stability. Public governance aids here by providing effective policy and by acting transparently and with accountability. A fair and efficient justice system fosters a society's stability. Key Performance Indicators (KPIs) like the number of civil protection alarms measure this dimension of liveability.

Healthcare and Social Services Access to basic medical support (e.g., general practitioners, pharmacies) within a reasonable time and at a reasonable distance, along with advanced healthcare services like special medical support centers foster a citizenry's health. Social services, which refer to social infrastructure communities need, comprise childcare, youth services, community centers, public toilets, outdoor public seating, and post offices. An example of a typical KPI is the availability and quality of healthcare services per capita.

Infrastructure, Housing, and Environment Infrastructure refers to a mixture of land use, which can include transport networks, housing, and open spaces like playgrounds and public parks; the road network, public (intermodal) transport, and international transport and travel connections; affordable, quality housing; reliable energy, water and telecommunications, including high-speed Internet connectivity; and the environment, such as the climate and the threat of extreme weather conditions. Examples of KPIs in this dimension are the average distance to well-connected transportation hubs and access to affordable housing that has access to all essential services.

[1] https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html (accessed 21 Oct 2020).

Employment and Economy The employment and economy dimension refers to open, business-friendly policies in the public domain, such as available space for new businesses and incentive schemes for entrepreneurs. Economic activities also depend on the availability of viable, highly qualified employees locally. Employment and income are examples of KPIs, as they and lead to growing or declining economic opportunities. Other KPIs in this category are the availability of and access to consumer goods and services.

Culture and Education The culture and education dimension comprises sporting and cultural facilities and the availability of private and public education. Accessibility to and availability of educational opportunities refer not only to primary and secondary schooling, but also to tertiary education and educational opportunities for adults, including senior citizens. The provision of vibrant, cultural services catering to the demands of all facets of the local population is another indicator of cultural well-being. Exemplary KPIs to measure this category are access to affordable education and culture and entertainment for the majority of the population.

The concept of a 'smart city' centers on how contemporary technologies can contribute to improving these dimensions of liveability. When the term was first introduced in the 1990s, "smart city" had a strong technical connotation as the application of information and communications technologies (ICT) in cities. If the term is considered in analogy to the common understanding of the term "smart X" (e.g., smart energy and smart retail), a technologically oriented definition applies. As characteristics of a smart city, Washburn and Sindhu (2009) see *"the use of smart computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient"* (p. 2).

However, technology-driven definitions have been criticized for not putting the citizens at the center, as the goal of a smart city has to be improving citizens' quality of life (Hollands 2008). The overarching goals of a smart city are sustainability, inclusion and participation, and – at the foremost – liveability (i.e. life quality and wellbeing; Caragliu et al. 2013; Chourabi et al. 2012; Dameri 2013; Hollands 2008). Berry and Glaeser (2005) showed that a high level of human capital (i.e. people with high levels of education) attracts more highly skilled workers. Accordingly, smart cities must be based on more than ICT to achieve their goals of improved social, economic, environmental, and cultural development. Thus, Caragliu et al. (2013) defined a city as being smart "when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory governance" (p. 6). Although this definition highlights the importance of factors other than ICT, this definition is still not sufficient, as it is limited to specific elements of a city's infrastructure, such as transportation and waste management. In what follows, we discuss how the concept of City 5.0 enriches as a new metaphor our understanding and ambitions with regards to the idea of a smart city, a city which is not just characterized by the advanced use of relevant technologies, but by the capability to increasingly overcome restrictions faced by its citizens.

3 City 5.0: Smart Consumption within a City

Cities are special kinds of organizations. With citizens as their 'customers', they are complex socio-material systems with a plethora of stakeholders. Cities are expected to provide a variety of essential services that add up to a liveable environment of dedicated sub-systems (e.g., work, transport, energy, safety, entertainment). As public systems, cities focus on the provision of services that everyone can access (lack of exclusivity) and without competition between citizens (lack of rivalry). Goods that lack exclusivity and rivalry are called public goods.

Therefore, City 5.0 could be defined as

> *a liveable city that is (re)modelled with the aim of eliminating restrictions for its citizens by using digitalization for the provision of public goods and services.*

The underlying hypothesis is that a city without restrictions in the delivery of public goods and services becomes a *liveable city*, as it is inclusive and free of friction. The notion of 'liveability', as already explained, describes the overall contribution of the urban environment to the quality of life and wellbeing of its residents.

Digital technologies come with significant affordances to overcome established restrictions, but technologies on their own would not be sufficient. Instead, re-modelling of established city structures, systems, and processes is likely to be required. Such new models could comprise new business models for the provision of services (e.g., markets in which one set of stakeholders subsidizes the elimination of restrictions for another set of stakeholders). Another example could be crowd-sourcing models in which citizens provide their assets (e.g., garages) or capabilities (e.g., assisting a visually impaired person across the road) in an attempt to overcome restrictions. These examples show an important difference between the dominating understanding of a smart city, with its provider-centric focus on

developing and offering technology-enhanced services, and the City 5.0 metaphor, with its consumer-centric concentration on eliminating restrictions. As such, City 5.0 rests on the combination of capitalizing on the new affordances of digital technologies and revised (business, resourcing) models, with the ongoing aim of overcoming restrictions.

To guide the strategic priorities of City 5.0, we classify five types of restrictions that are present in a city. The first four restrictions refer to the aspects of "accessibility" and "availability", while the fifth refers to "awareness":

Economic restrictions Charges for consuming services in a city have an exclusive impact on citizens who cannot afford these services. For example, entering the city of London during peak hour is an expensive undertaking and an economic constraint for some citizens. The provision of free WiFi-services in public parks is an example of eliminating economic constraints, as is free public transportation in Tallinn, Estonia, and Luxembourg. Economic restrictions can inhibit innovation and business since barriers like poor or absence Internet connections can impede economic opportunities (Waters 2016).

Spatial restrictions Cities tend to grow rapidly, and lack of space creates bottlenecks. Related restrictions include long distances that must be travelled to work and competition for space (e.g., during peak hours). Long distances from homes to jobs are a physical restriction (Wachs and Kumagai 1973), which is often explained with reference to the concept of "geography of opportunity" (Galster and Killen 1995; Rosenbaum 1995). Studies have shown that a geographical mismatch between a citizen's home and job contributes to unemployment and creates dependence on public support programs (Opp 2017; Osterman 1991; Rosenbaum 1995). Initiatives to overcome such constraints include distributed government offices that allow public servants to work at co-working spaces and to "consume" public services closer to their homes/offices. Another example is the emergence of autonomous vehicles that will allow shorter distances between cars, leading to denser use of space.

Temporal restrictions A city that is only 'on' at certain times (e.g., public transport, shopping, government services) comes with temporal restrictions. These restrictions increasingly compromise liveability when global working models are used. The regulation of opening hours for retailers or governmental offices sets temporal restrictions that require new digital, self-serving solutions like the Amazon Go store and robotic public services.

Individual restrictions A citizen's physical and cognitive abilities can prevent him or her from using public goods and services. A physically impaired person can be restricted in reaching the location where he or she can consume a public good or service, and public services that require a certain level of cognitive ability can pose a barrier to cognitively impaired citizens. Digital technologies can help to eliminate these restrictions by introducing navigation aids for the physically impaired and specialized digital interfaces and digital assistants that lower the cognitive bar required for using public goods and services.

Discoverability restrictions Even when consumption of public goods and services is not restricted by economic, temporal, spatial, or individual factors, citizens are often unaware of their availability. Consumption in a City 5.0 requires reversing the prevailing paradigm that a citizen has to discover offerings of public goods and services such that public goods and services have to "discover" the citizens to ensure that they are provided to those who need them. Such information can include location-based security notifications and alerts following environmental hazards, bomb threats, or car traffic restrictions (e.g., permission to use only electric vehicles selective city areas).

Of course, there are other types of restrictions, such as legal restrictions, that digital technologies can also help to address. For instance, Germany was prohibiting charging an electric vehicle at a private charging station, as it would require the charging station's owner to comply with energy laws since he or she was essentially selling energy. With digital technologies, instead of measuring the transferred energy, the time spent parked at a charging station could be billed, rather than the energy. In any case, digital solutions for legal challenges remain rare.

Since the "charging" example could also be seen as overcoming economic and spatial restrictions, it shows that restrictions do not necessarily occur in isolation, so a City 5.0 initiative might target more than one restriction. For example, the city of Brisbane funded the live web streaming of performances like the La Scala Ballet in 2018 to ten locations in rural Queensland, Australia. The simulcast allowed citizens outside Brisbane to enjoy the performance, overcoming spatial constraints, free of charge, addressing economic restrictions. One could argue that this project converted a private good, a ballet performance, into a public good.

The notion of a 'city without restrictions' is proposed as the tangible, operationalizable interpretation of City 5.0. City stakeholders could identify and rank restrictions in their cities and then assess how available digital technologies or revised business and resource models could assist in addressing them. The cities' focus will, of course, vary depending on their context and ambitions. For example, a city that is eager to attract entrepreneurs might focus on overcoming restrictions like access to co-working spaces, venture capital or mentors, while a city that

prioritises targeting an ageing population might concentrate on economic (e.g., free public transport) and geographic (e.g., pick-up from home) restrictions.

A city without restrictions is an ideal state that, realistically, can never be reached. However, in the context of City 5.0, it is the provision of a goal rather than its achievement that is essential and that is expected to drive innovation and improve liveability. As such, the proposal of a city without restrictions is comparable to the aspirational, but often unrealistic, intentions of other approaches like Six Sigma and its ambition of 3.4 mistakes per one million opportunities (Pepper and Spedding 2010). Thus, City 5.0 has a symbolic character. It does not comprise detailed methods, techniques or technologies, but rather provides a further re-interpretation of an ideal city beyond the known smart city. Through this symbolic value, the notion of City 5.0 serves as a facilitator for the transition of city environments with a focus on facilitating the constraint-free access to public goods and services.

4 A Framework for City 5.0

Bringing together the ideas of a smart city, with its focus on liveability, and the ideas of a restriction-free city, integrates the types of restrictions and the dimensions of liveability into a City 5.0 framework (Fig. 1). All of the fields in the matrix must be addressed through collaboration of researchers, public administrations, private service providers, and citizens. In many cases, and as outlined above, digitalization will help to overcome restrictions. For example, ubiquitous access to healthcare services could be enabled by telemedicine services in a City 5.0, as telemedicine enables more citizens to participate in medical services free of the restrictions that come with the physical distance or traffic concerns. In addition, education is becoming more digital by enabling communication without the temporal and physical restrictions between school and students and their parents (e.g., schoolinfoapp).

With this framework, information systems research at the intersection of restrictions in consuming public goods and services and aspects of urban liveability will advance the development of the consumer-oriented and restriction-free cities of tomorrow. The framework also uncovers conflicts between restrictions. For example, offering free public transportation (eliminating economic restrictions) requires a public investment that can subsequently interfere with eliminating other restrictions. Reducing pollution by introducing a toll to drive into the city brings new economic and spatial restrictions.

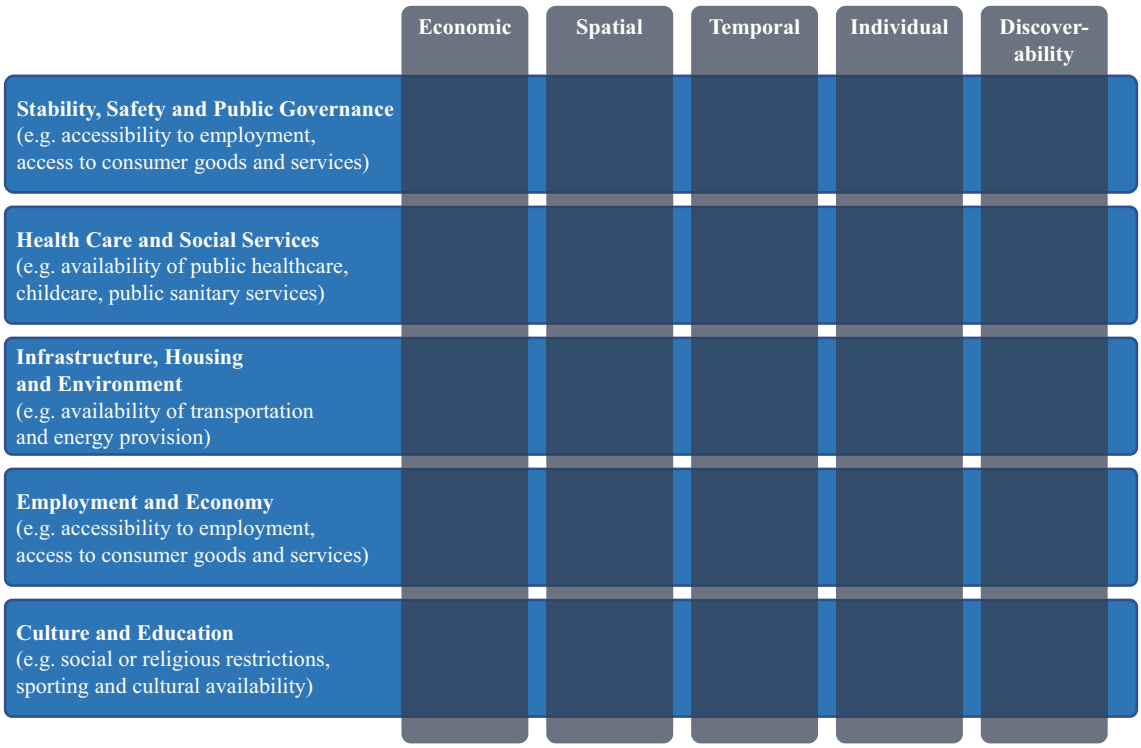

Fig. 1 Framework for City 5.0

5 Closing Remarks

The paradigm shift from 4.0 to 5.0 describes a symbolic shift of attention. Applying the new 5.0 paradigm to cities shows the implications of a transition from a provider-centric to a consumer-centric model of services and how it leads to a focus on the restrictions that remain in citizens' lives.

There is no doubt that the smart city stream of activity and research will continue to produce digitally-empowered, sophisticated solutions for cities of tomorrow. Often triggered by the emerging affordances of digital technologies, such progress (e.g., smart lighting, smart waste) is invaluable. However, City 5.0 provides an important complementary view, as it identifies the elimination of restrictions as an overall design goal. This goal provides an important goalpost for smart city initiatives and allows to assess them in light of their impact on overcoming existing restrictions.

We want to highlight that, with City 5.0, we propose to focus on eliminating restrictions as an inherent goal for better city environments. Identifying technological opportunities like improving lighting of a city through the introduction of smart lighting, for example, remove restrictions for a particular group of citizens as it has the potential to provide a cost-effective solutions for the provision of a safe environment, and via this eliminates restrictions in the life of citizens who otherwise would not use the cities infrastructure. Therefore, our aim is not to advocate individual 'smart' solutions but to advocate and to manifest a paradigm shift towards seeing technologies as an instrument for eliminating citizens' restrictions in accessing public goods and services.

The introduction of a City 5.0 comes with implications in terms of how consumption and ethical questions are addressed against the background of restriction-free access to public goods and services. A comprehensive discussion of these implications is beyond the scope of this article. However, bringing research and professional attention to citizens who are the most constrained can help to create a value-driven, human-centered investment framework that addresses the most severe restrictions first and increases social value for citizens most in need. For example, cities have started longevity initiatives in which the restrictions of senior citizens are identified and addressed.

We see the paradigm shift to a City 5.0 not as an alternative way of ensuring the integration of ethical and sustainability issues in the context of creating robust and resilient societies in our digitalized world (see e.g., (Berniker 2017; Floridi 2014)), but as a platform for these ideas to flourish and to be implemented. Economic, social, and environmental challenges, when unaddressed, result in restrictions that will move into focus. With cities representing dominant living environments, the challenges within these environments can take extreme forms like in the cases of poverty, inequality, and pollution affecting urban population the most (Bambrick et al. 2011; Hardoy and Pandiella 2009). Hence, the focus on citizens' restrictions has the potential to benefit those in need and to serve as a self-guarding mechanism, because consequences of unethical or unsustainable consumption create new restrictions for citizens disqualifying such consumption from the City 5.0 vision.

The question of in how far the vision of City 5.0 sufficiently addresses a holistic view on how our society ought to be, for instance, to question the accumulation of power and resources as an acting principle towards embracing diversity and richness of experience (Ito 2017) represents one of the main avenues for further research enquiries. However, in the current globalized economic and political environment, immediate actions towards improving short and long-term liveability are required. While we continue to observe reluctance of individuals, organizations, and nations to put sustainability concerns at the center of individual and organizational conduct, the idea of a citizen-centric elimination of restrictions can become a common ground for effective initiatives to emerge.

We expect City 5.0 to trigger future research, addressing important methodological questions like how to design an approach to 'restriction lifecycle management' or how to identify default response strategies for identified restrictions as well as research into the exploration of the relationship between restrictions and restriction elimination solutions.

Funding Open Access funding enabled and organized by Projekt DEAL.

References

Bambrick HJ, Capon AG, Barnett GB, Beaty RM, Burton AJ (2011) Climate change and health in the urban environment: adaptation opportunities in Australian cities. Asia Pac J Public Health 23(2):67S–79S

Berniker E (2017) Only a ten hour week – Architecture for a sustainable society of plenty. CreateSpace Independent Publishing Platform

Berry CR, Glaeser EL (2005) The divergence of human capital levels across cities. Papers in Regional Science 84(3):407–444

Caragliu A, Del Bo C, Nijkamp P (2013) Smart cities in Europe. In: Deakin M (ed) Smart cities: governing, modelling and analysing the transition. Routledge, New York, pp 173–195

Chourabi H, Nam T, Walker S, Gil-Garcia JR, Mellouli S, Nahon K, Pardo TA, Scholl HJ (2012) Understanding smart cities: an integrative framework. In: Proceedings of the Annual Hawaii International Conference on System Sciences, pp 2289–2297

Dameri RP (2013) Searching for smart city definition: a comprehensive proposal. Int J Comput Technol 11(5):2544–2551

EIU (2019) The global liveability index 2019. https://www.greenme.it/wp-content/uploads/2019/09/report_citta_piu-vivibili.pdf. Accessed 21 Oct 2020

Floridi L (2014) How the infosphere is reshaping human reality. The Fourth Revolution. Oxford University Press, Oxford, p 265

Galster GC, Killen SP (1995) The geography of metropolitan opportunity: a reconnaissance and conceptual framework. Hous Polic Debate 6(1):7–43

Giap TK, Thye WW, Yam TK, Linda L, Ling AGE (2012) Ranking the liveability of the world's major cities: the global liveable cities index (GLCI), World Scientific

Giap TK, Thye WW, Aw G (2014) A new approach to measuring the liveability of cities: the global liveable cities index. World Rev Sci Technol Sustain Dev 11(2):176–196

Hardoy J, Pandiella G (2009) Urban poverty and vulnerability to climate change in latin america. Environ Urban 21(1):203–224

Hollands RG (2008) Will the real smart city please stand up? Intelligent, Progressive or Entrepreneurial? City 12(3):303–320

Ito J (2017 Resisting reduction: a manifesto. J Design Sci. https://jods.mitpress.mit.edu/pub/resisting-reduction/release/17. Accessed 21 Oct 2020

Kowalkiewicz M, Dootson P (2019) Government 5.0: the future of public services. QUT Chair in Digital Economy. https://www.chairdigitaleconomy.com.au. Accessed 21 Oct 2020

Kowalkiewicz M, Rosemann M, Dootson P (2017) Retail 5.0: check out the future, QUT PwC Chair in Digital Economy

Lasi H, Fettke P, Kemper HG, Feld T, Hoffmann M (2014) Industry 4.0. Bus Inf Syst Eng 6(4):239–242

Lowe M, Whitzman C, Badland H, Davern M, Hes D, Aye L, Butterworth I, Giles-Corti W (2013) Liveable, healthy, sustainable: What are the key indicators for Melbourne neighbourhoods? University of Melbourne

Nahavandi S (2019) Industry 5.0 – A human-centric solution. Sustain 11(16):92

Opp SM (2017) The forgotten pillar: a definition for the measurement of social sustainability in American cities. Local Environ 22(3):286–305

Osterman P (1991) Welfare participation in a full employment economy: the impact of neighborhood. Soc Probl 38(4):475–491

Özdemir V, Hekim N (2018) Birth of industry 5.0: making sense of big data with artificial intelligence, 'the internet of things' and next-generation technology policy. Omics 22(1):65–76

Ozkeser B (2018) Lean innovation approach in industry 5.0. Eurasia Proc Sci Technol Eng Math 2:422–428

Pepper MPJ, Spedding TA (2010) The evolution of lean six sigma. Int J Qual Reliab Manag 27(2):138

Rosenbaum JE (1995) Changing the geography of opportunity by expanding residential choice: lessons from the Gautreaux program. Housing Policy Debate (6:1), Taylor & Francis, pp 231–269

Siggelkow N, Terwiesch C (2019) Connected strategy: building continuous customer relationships for competitive advantage. Harvard Business Press, Harvard

Wachs M, Kumagai TG (1973) Physical accessibility as a social indicator. Socio-Econ Plan Sci 7(5):437–456

Washburn D, Sindhu U (2009) Helping CIOs understand 'smart city' initiatives. Growth 17(2):1–17

Waters J (2016) Accessible cities: from urban density to multidimensional accessibility. In: Rethinking sustainable cities: accessible, green and fair. 1st edn, Bristol University Press, pp 11–60

Woolcock G, Elliott W (2009) Measuring up?: Assessing the liveability of Australian cities. State of Australian Cities (SOAC)