Urban Planning
Open Access Journal | ISSN: 2183-7635
Volume 6, Issue 4 (2021)

Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development

Editor
Dalit Shach-Pinsly

COGITATIO

Urban Planning, 2021, Volume 6, Issue 4
Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development

Published by Cogitatio Press
Rua Fialho de Almeida 14, 2º Esq.,
1070-129 Lisbon
Portugal

Academic Editor
Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel)

Available online at: www.cogitatiopress.com/urbanplanning

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2021, Volume 6, Issue 4, Pages 135–138
https://doi.org/10.17645/up.v6i4.4905

Editorial

Digital Urban Regeneration and Its Impact on Urban Renewal Processes and Development

Dalit Shach-Pinsly

Faculty of Architecture and Town Planning, Technion—Israel Institute of Technology, Israel; E-Mail: dalitsp@technion.ac.il

Submitted: 23 September 2021 | Published: 17 November 2021

Abstract
Urban renewal is one of the main motivations of city regeneration. Urban renewal strategies mainly relate to demolishing old buildings and redeveloping new buildings instead, improving buildings and deteriorated areas, infilling new buildings within existing urban fabric, integrating new communities into old and rolling-down areas, and so on. In parallel to this situation, the modern world is in the wake of the 4th Industrial Revolution, which is characterized by a merger of physical and digital spaces and is consequently affecting cities and their quality of life. Therefore, urban regeneration must take into consideration these digital innovations and harness the emerging technological changes into new development of urban renewal processes and decision-making approaches. This editorial introduces the topic of digital urban regeneration, by discussing possible methodologies and decision-making approaches and presents the thematic issue on "embedding digital technologies into urban renewal processes and development."

Keywords
digital technologies; environment analysis; new models and tools; urban planning and design; urban regeneration; urban renewal; urban technology

Issue
This editorial is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

Over the past decades, mass housing buildings were developed following the post-WWII renewal. Nowadays, these housing buildings are old (50–70 years old) and many do not meet the current construction requirements, such as building materials, small apartment sizes, digital and communication systems, green building standards, earthquake-resistant requirements, infrastructure systems, and so on. Therefore, these buildings do not provide a high quality of life for their residents. Because of the large quantities of these mass housing projects and their spread in many cities around the world, these post-WWII buildings now have major potential for urban regeneration processes (Jeffry & Pounder, 2016; Kleemann, et al., 2017).

In parallel to this situation, the modern world is in the wake of the 4th Industrial Revolution, which is characterized by a merger of physical and digital spaces and is consequently affecting cities and their quality of life (Jeon & Suh, 2017). Urban regeneration must take into consideration these digital innovations and harness the emerging technological changes into new development of urban renewal processes and decision-making approaches. Choi and Kim (2017) mention that many cities around the world are preparing to be smart cities via urban regeneration. In addition, these technological changes can also strengthen housing and urban reaction to future pandemic influence, which will improve the urban environment.

There are many topics that must be taken into consideration when integrating digital innovations into urban renewal development. For example, given the existing technology-based tools for assessing various aspects of the built environment, there is a need to understand how to assimilate them into the urban renewal planning process. In addition, there is also the effect of the technological leap on urban renewal development. Over the

last year and a half, the world has experienced major changes due to Covid-19, including the planning world. Perhaps, this is the great upheaval and change that will cause a major impact for integrating digital innovations into urban renewal development, which underlie the idea of this thematic issue.

This thematic issue joins articles from four continents and 11 countries: Austria, Cyprus, Germany, India, Israel, Latvia, Lithuania, Poland, Taiwan, South Africa, and the United States, bringing together a wide range of research that tie together urban regeneration and digital technologies from different perspectives such as: modern digital planning and ICT; real vs. virtual city planning process; integrating digital twin technology into planning decision making; evaluating urban renewal alternatives based on new digital assessing approaches; integrating smart city methodologies in urban renewal planning process; and digital placemaking and post-pandemic urban regeneration development.

The assembly of articles begins with Shadar's (2021) "Crisis, Urban Fabrics, and the Public Interest: The Israeli Experience," in which the author wonders whether additional urban elements tie together urban fabrics to cope with crises, particularly pandemics, in light of urban planning changes (in practice and theory) over time and demonstrates it in line with the interests of the Israeli state. Shadar (2021) concludes that state interests embodied urban fabrics that integrate community values and proximity to green areas, suitable for individual coping with crises such as the Covid-19 pandemic and proposes viewing these urban elements as suggesting significant involvement of public representatives in future urban renewal efforts.

In their article "Real vs. Virtual City: Planning Issues in a Discontinuous Urban Area in Budapest's Inner City," Benkő et al. (2021) examine whether ICT in urban planning and design can contribute to contemporary neighborhood planning. The authors analyze the transformation of Corvin neighborhood in Budapest and the surroundings of Szigony Street from a new point of view. They conclude that urban planning and development are still essentially based on traditional top-down approaches and digitalizing of planning alone will not solve past planning problems that affect the urban fabric of a neighborhood.

In "Integrating Digital Twin Technology Into Large Panel System Estates Retrofit Projects," Duch-Zebrowska and Zielonko-Jung (2021) analyze urban renewed areas based on the incorporation of digital twin technology into large panel systems in Eastern European countries. Digital twin technology provides feedback on the retrofit of large panel systems at every stage and can be used to increase the level of information and active social participation in projects. Their main goal is to create an open access tool used by diverse design teams from different countries working on separate systems on the same regenerated area, with the exchange of experiences from lessons learnt.

The next two articles relate to the aspect of neighborhood planning evaluation. In "Multiparametric Analysis of Urban Environmental Quality for Estimating Neighborhood Renewal Alternatives," Shach-Pinsly et al. (2021) developed a 3D-GIS multiparametric scenario analysis (including walkability, energy levels, sense of security, water permeability, etc.) for evaluating the performance and quality of the built environment as part of the decision-making process for neighborhood renewal alternatives. The multiparametric analysis is demonstrated on a peripheral neighborhood of low-medium socio-economic status, where there is a significant value for understanding the urban performance of renewed areas. They emphasize the importance that urban renewal processes will harness such models in the decision-making approaches to improve assessment processes and understand future performance of the built environment.

An additional concept for evaluation is demonstrated in "Spatial Accessibility in Urban Regeneration Areas: A Population-Weighted Method Assessing the Social Amenity Provision," by Gutting et al. (2021). They developed a population-weighted accessibility index based on minimal open data for determining the small-scale pedestrian accessibility to basic amenities in urban neighborhoods, demonstrated in four urban regeneration areas in Dresden, Germany. They demonstrated the possibility to map neighborhoods with both high and low population densities and poor and high accessibility to basic services for evaluating neighborhood regeneration measures for future decision-making.

The article "Area-Based Urban Renewal Approach for Smart Cities Development in India: Challenges of Inclusion and Sustainability," by Praharaj (2021), examines the impact of the smart city approach on the spatial design, social, and economic inequities of the urban space by raising a timely question of whether the digital urban renewal strategies, put forward by Indian cities, provide a practical approach for shaping inclusive and sustainable cities. Praharaj's (2021) findings indicate that emphasizing digital urban renewal of selected urban sites, categorized as "smart cities," leads to deepening social polarization, gentrification, and could be a reference for adopting relevant policies and strategies in diverse cities in future planning.

Zgórska et al. (2021), in "Can the Pandemic Be a Catalyst of Spatial Changes Leading Towards the Smart City?," focus on developing a conceptual framework based on two trends affecting current urban development: the influence of Covid-19 on the functionality of urban structures and the notion of "smart cities," both affecting residents' quality of life. Their study shows that the Covid-19 pandemic can become a catalyst of urban change towards the smart city and smart solutions support such changes.

On the same themes of smart city and ICT, Das (2021) in his article "Revitalising South African City Centres Through ICT" investigates whether existing cities in the

Global South can be revitalized through smart use of ICT, demonstrating it through urban regeneration processes in three South African city centers: Bloemfontein, Port Elizabeth, and Pretoria. His findings indicate that ICT in city centers of Global South countries need significant reinforcement and are not used considerably in many essential city activities, such as monitoring crimes or displaying real-time information in public places that enable city centers to become more vibrant and livable compounds.

In recent years digital placemaking has become an emerging concept. In "Public Space at the 'Palm of a Hand': Perceptions of Urban Projects Through Digital Media," Ioannou et al. (2021) analyze the impact of digital social media on the perceptions of communities and on placemaking processes, using the case of Nicosia's Eleftheria Square in Cyprus. Their aim is to better understand digital platforms and tools for identifying places and communicate information. The outcomes show that the perceptions of urban projects through digital media are more fluent and not static by constantly updating information and with social media providing a more accurate and updated picture of society's changing perceptions of public space.

In "Digital Placemaking for Urban Regeneration: Identification of Historic Heritage Values in Taiwan and the Baltic States," Shih et al. (2021) provide an interesting overview of the diversity of digital placemaking strategies in three different countries: Taipei (Taiwan), Riga (Latvia), and Kaunas (Lithuania). They map out potential benefits and challenges related to digital placemaking roles in heritage and urban regeneration areas. They developed space-matrixes for placemaking and digital placemaking by identifying defined zones of spatial structure with the highest potential in terms of placemaking or digital placemaking. Spatially, digital placemaking opens up a "hybrid space" between the physical and the digital world, expanding the range of ways a person can experience the surrounding physical space.

Finally, the thematic issue concludes with an article that relates to the Covid-19 pandemic. The Covid-19 era forced the world to move towards the virtual dimension, also for teaching urban regeneration. In "Scanning for Cultural Competency in Online Urban Planning Programs," Garcia (2021) aims at exploring how urban planning/regeneration programs were prepared to deal with the situation inflicted by the Covid-19 pandemic. The article aims at providing the state of the art of online urban planning and regeneration teaching and learning, which is of crucial interest to the planning academic community and think about the way of teaching place-based disciplines with remote teaching and digital tools. He concludes that online urban planning programs must make additional efforts and develop more social collaborative learning, site activities, and visits to overcome the difficulty of understanding communities without site visits and in-person community engagement.

Acknowledgments

I would like to thank the COST Action CA18137—MCMH EU—European-Middle-Class-Mass-Housing, supported by COST (European Cooperation in Science and Technology), that enabled the creation of this thematic issue.

Conflict of Interests

The author declares no conflict of interests.

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About the Author

Dalit Shach-Pinsly, PhD, is an architect and urban designer. She is currently a researcher and senior lecturer at the Technion–IIT. She was a partner investigator in the H2020-MG-9.2-2014 MIND-SETS—Mobility Innovations for a New Dawn in Sustainable Transport Systems. She was a senior researcher of FP7-DESURBS-EU-Designing Safer Urban Spaces. Formerly she joined the College of Built Environments at the University of Washington as a post-doctoral fellow sponsored by the competitive Marie Curie EU IOF Fellowship (2008–2011).

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 139–149
https://doi.org/10.17645/up.v6i4.4370

Article

Crisis, Urban Fabrics, and the Public Interest: The Israeli Experience

Hadas Shadar [1,2]

[1] Department of Architecture, NB Haifa School of Design, Israel; E-Mail: hadass2@013.net
[2] Faculty of Architecture, Technion—Israel Institute of Technology, Israel

Submitted: 15 April 2021 | Accepted: 8 June 2021 | Published: 17 November 2021

Abstract
The relation between urbanization and pandemics is not new. In fact, the "reformative" urban plans of the late 19th and early 20th centuries sought the addition of green patches, reliable running water systems, good sanitation, and sunlight to fend off the common ailments of the industrial city. No wonder then that these urban planning elements are also compatible with the Covid-19 era, as ample green and low-density areas are supposed to ensure or at least support quality of life and good health, even amid the health crisis we face today. This article examines whether additional elements tie together urban fabrics and coping with crises, particularly pandemics. To answer this question, I examine national urban planning in the state of Israel from the mid-20th century onwards. Urban planning in Israel has implemented theories and precedents from Europe and America; however, Israeli planners have also included nationalist-ideological contents in their work, so that the state and its interests have dictated their planning. The article concludes that the state interest of producing a cohesive society has created Israeli urban fabrics with community values and proximity to green areas, which are better suited for individual coping with crises involving the denial of personal freedom, whether due to a pandemic or any other reason. Accordingly, it proposes viewing these elements as suggestive of the need for significant involvement by public representatives in future urban renewal efforts.

Keywords
communality; Covid-19; ideological planning; state planning; urban fabrics

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Cities and Pandemics: Nothing New Under the Sun?

Following the Covid-19 outbreak, the past year has seen multiple articles that have associated contagion through human interaction and density (e.g., Kaushal & Mahajan, 2021), particularly urban density (Liu, 2020). It was found that in metropolises, contagion rates were higher due to the density of residential spaces (Bereitschaft & Scheller, 2020; Carpentieri et al., 2020). Trains and airplanes travelling between metropolises helped spread the virus (Gupta et al., 2021). Within the cities, the highest contagion rates were in poorer neighborhoods (Ito & Pongeluppe, 2020), among other things due to the large number of occupants in each housing unit (Mendes, 2020; Wasdani & Prasad, 2020). The main problem, however, was found with regard to the urban *experience*, which is based on interactions with strangers outside one's immediate social network, in random encounters in commercial areas, cultural venues, and public transportation. Indeed, the frequent human friction is a leading cause of contagion (Iranmanesh & Alpar Atun, 2021).

Other recent studies have pointed to the human need for the comfort provided by green spaces in times of lockdown (Carpentieri et al., 2020; Ugolini et al., 2020; Zhu & Xu, 2021), particularly in cities (Tendais & Ribeiro, 2020). Some argue that in the city, green areas should be considered critical infrastructures (Gugerell & Netsch, 2020).

The virus is new and so are the articles—but what about the conclusions? An examination of urban design theories that developed in the aftermath of the Industrial Revolution shows that there is nothing new

under the sun. Indeed, the desire to provide better quality of life to its inhabitants, and particularly avoid the epidemics that spread in its poor conditions, pushed planners to come up with solutions. Indeed, some of the most influential urban theories of the turn of the 20th century sought to "reform" the faults of the industrial city. They aimed at giving back to the city what it had lost due to excessive urbanization: order, peace, clean air, daily presence of nature, and healthy living conditions such as natural light, ventilation, and hygiene (garbage disposal and sewage systems; Jabareen & Eizenberg, 2021).

For example, Howard's (1898/1960) garden city was based on zoning designed to prevent the industrial zones from polluting the air, and especially on low-density housing around parks to prevent illness and renew the inhabitants' direct contact with nature. Similarly, Tony Garnier's *cité industrielle* was based on zoning and green urban housing blocks with low-concentration and low-level housing that was not to exceed tree height (Wiebenson & Garnier, 1969). La Corbusier's *cité radieuse* (1929/1947, 1933/1967) was based on zoning and tall buildings set within an infinite garden, to provide the inhabitants with sunlight and landscape despite high density.

In the same context of public health and contact with nature, we can also mention urban fabrics. One of them is landscape architect Leberecht Migge's Green Manifesto, developed in 1919, shortly after the Great War. Migge called to base German housing on single-family homes with auxiliary farms to provide for their domestic consumption (Haney, 2007). Another fabric worthy of mention is the *zeilenbau* (row houses, slab buildings) approach developed by Walter Gropius to prevent the building of dense and dark urban blocks and ensure the tenants' "solar rights" (Giedion, 1954).

Note, however, that these green solutions did not settle for "reforming the industrial city" by providing its inhabitants with improved housing conditions. Some of them threw the baby out with the proverbial bathwater by doing all they could to rid the city of its urbanity, seen as the mother of all sins. Thus, in physical terms, some of these theoretical solutions did not include the basic building blocks of the pre-industrial city, such as streets, boulevards, urban blocks, and well-defined squares (Krier & Economakis, 1992). Humanly speaking, the fabrics planned were stretched too thin to enable meaningful encounters. Functionally, the mixture of urban uses was cancelled. For all those reasons put together, these solutions failed to provide the conditions for the urban pulse: they provided inappropriate infrastructure for urban diversity and spontaneous interactions between the inhabitants throughout the day and night.

Accordingly, it appears that the years 2020–2021 tell us little that is new. The high urban density and intense human interactions typical of good urbanity also promote contagion—the Covid-19 outbreak in low urban density makes it easier to maintain the social distance imposed in the early months of the crisis. It therefore appears that anti-urban, thinly populated, and thickly green spaces are indeed optimal for fending off pandemics.

The present article explores whether this is indeed the case, or whether there are additional deep undercurrents that associate the struggle against pandemics with anti-urban theoretical fabrics and concrete precedents. To answer the research question, the following will examine the Israeli experience in urban design, designated mostly for the country's Jewish citizens and executed by the Ministry of Housing (in different periods, also referred to as Ministry of Construction and Housing). The article will focus on the urban fabric: the relationship between the constructed and open areas, the configuration and interrelations of the buildings, and the road system.

Israel was selected as a case study for three main reasons. First, its state architects were informed by European and American theories that contained anti-urban elements. This was because they studied in Europe or from architects educated in Europe, making Israel a case study of Western theories and precedents (Shadar, 2014). Second, Israeli planning applied these to the construction of new towns and neighborhoods on lands that were empty or considered empty. Accordingly, Israeli town planning often articulated a complete planning concept that did not have to take certain constraints into consideration (Shadar, 2014). Finally, Israeli planning included certain elements in addition to the European ones. Naturally—as may be expected in the implementation of precedents or theories in a different culture and location—the copy turned out somewhat different from the original. In particular, it was charged with local ideas. The article examines these ideas to identify undercurrents that connect the anti-urban fabrics and the perceived need to cope with emergencies.

The specific examples in this article are drawn from studies of the development of state planning throughout Israel's history (Shadar, 2010, 2011, 2013a; Shadar & Oxman, 2003). These suggest that Israeli state planning may be divided into distinct periods, not necessarily differentiated by geographic or demographic characteristics. Therefore, examples faithfully representing the planning periods have been selected.

2. The Israeli Experience and International Precedents

Upon the establishment of the state of Israel in 1948, the State Planning Department was created, headed by Arieh Sharon (Sharon, 1976). The department's plan for the decentralization of the Jewish population and for planning new settlements was published three years later. The 1951 plan offered a uniform pattern for the new towns and neighborhoods. Their scheme was radial, with the urban center at the geographical center and the residential neighborhoods around it. Both the center and the neighborhoods were separated by green areas, with

only a single road dedicated to connecting the neighborhoods to the urban center, and the neighborhoods to each other (Sharon, 1951). The explanation provided by the planners was based directly on the bitter experience of the European industrial city: "The old cities in Europe as well as Israel," they wrote, "are built as a monotonous sequence of houses, streets and residential neighborhoods that stretch to infinity, making the inhabitants' lives unbearable" (Sharon, 1951, p. 8). The construction in the disjointed neighborhood followed the same logic: the houses were small, with few housing units each, and bathed in large green areas within each neighborhood; some also included an auxiliary farm. A neighborhood center was planned for each (Sharon, 1951; Figures 1 and 2).

What were the direct precedents for the Israeli planning? As suggested, local planning learned from the theories and precedents that rejected the model of the European industrial city—despite the fact that neither Israel nor pre-1948 Mandate or Ottoman Palestine contained any such cities. The direct precedent for the Israeli planning was the new towns planned in Britain during WWII and built thereafter (Shadar & Oxman, 2003), and the indirect precedents were Howard's garden city theory and American town planner Clarence Perry's neighborhood unit. Both the neighborhood unit and the garden city were direct precedents of the new British towns and indirect precedents of the Israeli planning.

Figure 1. The new town of Kiryat Shmona: Disconnected neighborhoods. On the right and in yellow, auxiliary farm neighborhoods. Notes: From top to bottom, it is written "residential areas," "auxiliary farms," "commercial center," "industrial zone," "regional services," "green spaces," and "agriculture." Source: Sharon (1951, p. 37).

Perry (1929/1974) considered the neighborhood a community unit revolving around central community institutes, with reasonable walking distances of some 400 m from the neighborhood center to the most distant house. British town planning, which combined the two sources of influence, and the Israeli planning that studied it, took a step further, connecting the thinly populated residential neighborhoods of the garden city to the community neighborhood unit to the point of actually imposing communality on the residents: It was difficult to get out of a neighborhood separated from others by green belts (Abercrombie, 1945; Merlin, 1971). Similar to the new British towns, the Israeli neighborhoods featured an oval road system, regardless of topography, that lengthened the roads and infrastructures, and was in fact wasteful in terms of water, sewage, drainage, electricity, road, and sidewalk infrastructures.

In the 1960s, that concept of the neighborhood as a disconnected unit was not revised, but due to the waste involved in the oval road system, it was modified to become straighter and the building positions were also changed (Cecik, 1968). With the improvement in construction capabilities, the open plan model was adopted, recalled from the heritage of Le Corbusier, as was

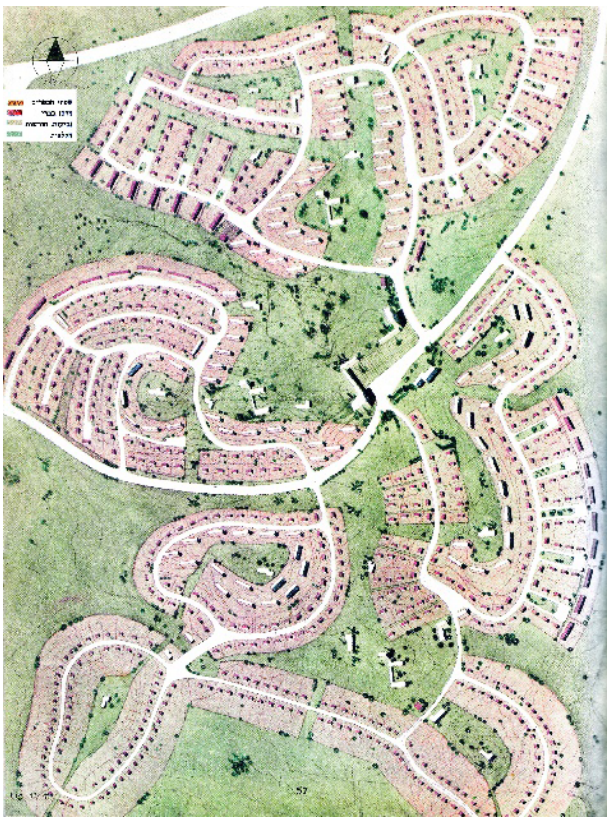

Figure 2. The neighborhood unit plan in Ashkelon's southern neighborhoods. Notes: From top to bottom, it is written "village areas," "rural center," "plantings, groves," and "agriculture." Note that the legend refers to the urban neighborhood as if it were a village. Source: Sharon (1951, p. 57).

Gropius' *zeilenbau*. Both were averse to the (industrial) city and sought to turn their back on it, by positioning the buildings in a way that did not create urban spaces such as streets or squares and keeping the open space dominant. Following the same logic, the buildings were turned to face the endless communal green areas, as if expressing the idea that it is there that the coveted quality of life lies (Figures 3 and 4).

In the 1970s, Israeli planning gave up on the extensive green belts between the neighborhoods, as experience had shown that in Middle Eastern countries the green areas on the drawing boards turned yellow and fallow in real life. Instead, the neighborhoods were separated by broad motorways crossing the city, in keeping with the Western trend of privileging the comfort of motorists over that of pedestrians (Jacobs, 1961). The condominiums in the neighborhoods became taller and denser. Vehicle traffic reached only the edge of the plot, into the parking bays, so that the heart of the neighborhood was inaccessible to motorized traffic. Within the neighborhood, a communal green courtyard was planned, towards which pedestrian routes were channeled. This is where the neighborhood public buildings and domestic consumption stores were located. Both the courtyard and the public institutes and small shops were known to the neighborhood residents only, who overlooked them from their rooms, from their terraces, and in many cases also from their house entrances. The community-neighborhood courtyard was surrounded by residential buildings usually no more than 4–6 stories high, to prevent a situation where the neighbors were too many and therefore too anonymous (Harlap, 1973, 1977; Figures 5 and 6).

Here too, the precedents were European and American. Having the courtyards surrounded by residential buildings was typical of planned European construction in the late 1960s and 1970s (Golany, 1976). Separating pedestrian from motorized traffic was the order of the day in British town planning, from which the Israeli planners learned (Ritter, 1964). Add to that the

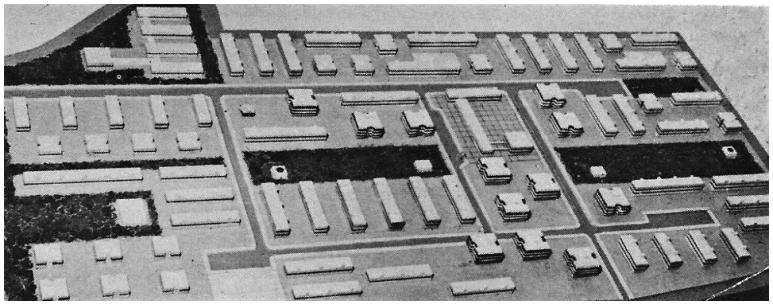

Figure 3. Model of neighborhood construction in Netanya, combining *zeilenbau* and the open plan. Source: Ministry of Housing (1964).

Figure 4. *Zeilenbau* condominiums in Netanya. Source: Ministry of Housing (1964).

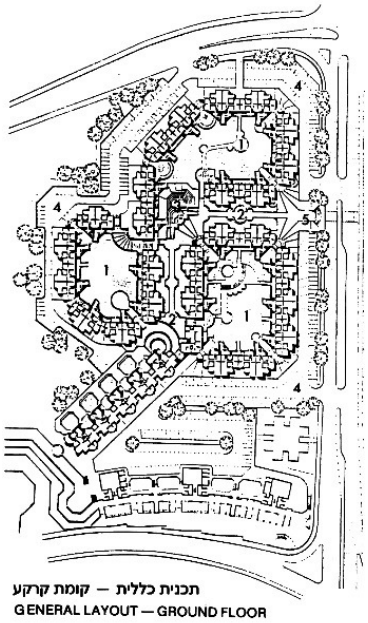

Figure 5. Complex planned by Salo Harshman in Gilo, East Jerusalem. General layout: Ground floor. Source: Harlap (1988, p. 113).

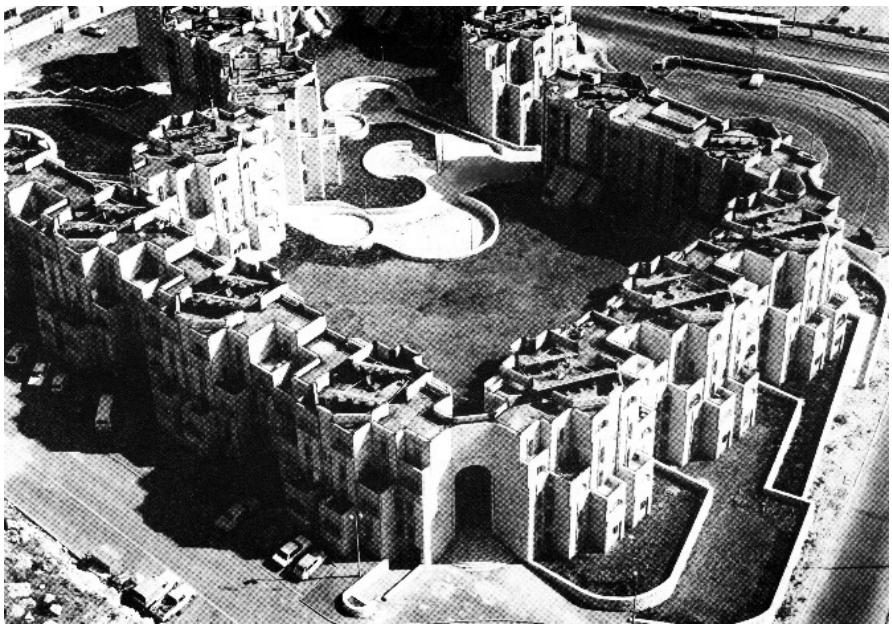

Figure 6. Overview of the complex planned by Salo Harshman in Gilo, East Jerusalem. This design means that the tenants see each other and the inner green area from their apartment windows. Source: Harlap (1988, p. 114).

precedent of the New Jersey suburb of Radburn (1929), planned by Clarence Stein and Henri Wright, which was based on having the houses face the green areas, where intra-neighborhood traffic was strictly pedestrian (Stein, 1949).

In the 1980s, the seed was sown for a sea change in state planning in Israel, which sprouted in the 1990s. It relied on various lessons learned from the failures of the previous models (Paldi et al., 1989). And as usual, the new model adopted was inspired by the Western town planning. The model this time was "the return to the traditional city," meaning the European pre-industrial city, with its streets, boulevards, squares, and urban blocks (Krier, 1984; Krier & Economakis, 1992). In Israel, most of whose artificial towns were built out of an anti-urban agenda, there were few urban models to learn from, or to wax nostalgic about (Knox, 2005). Therefore, the idea was to learn from Scottish town planner Patrick Geddes, whose plans for Tel Aviv were drawn from 1927–1929, under the British Mandate rule. Geddes' plan provided a judicious basis for Tel Aviv's development based on an open, hierarchic network of streets. The urban pulse of the country's business capital was the reason why the Geddes Plan became the model, rather than other historical precedents such as Sitte's (1889/1945) theory of city building according to artistic fundamentals, or Taut's (1919) crown city theory.

Indeed, within a few years, in an atmosphere of intensive planning motivated by the massive immigration of Jews from the former Soviet Union, houses were planned on the edge of mixed-traffic (pedestrian and motorized) streets, which were multi-purposed (housing and commerce), and urban blocks were outlined (Safdie, 1991; Shinar, 1990; Figures 7 and 8). In 2000, urbanity represented Israel in the Venice Biennale. The curator, architect Hillel Schocken (2000), defined urbanity as "intimate

Figure 7. Mixed-use main axis in Neve Zeev Neighborhood, Beersheba, by AMAB Architects (1990s). Each building was planned by a different architect.

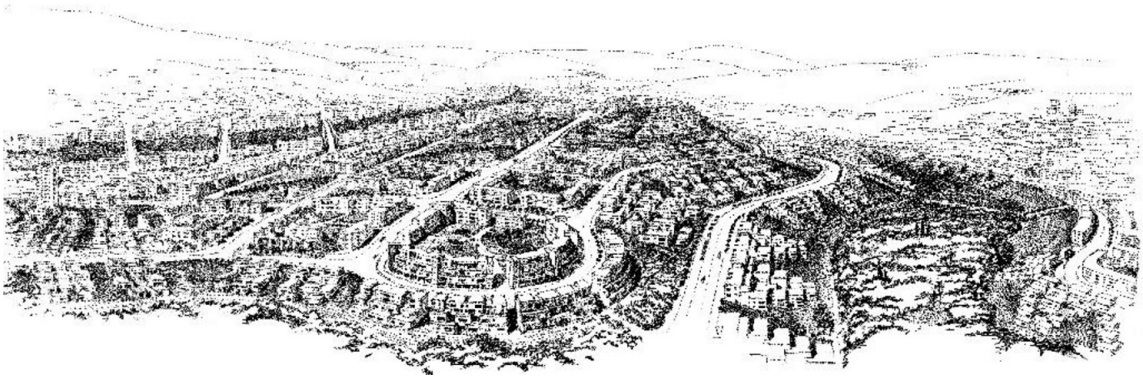

Figure 8. Kaiser Neighborhood in Modi'in, 1992–2000. The city is designed with urban blocks or standalone buildings facing the streets, as opposed to the past, when the buildings would face internal green areas and the streets would be planned particularly for motorized traffic. Source: D. Kaiser, M. Kaiser, and I. Leckner—Architects & Town Planning (personal communication, 2012).

anonymity." In other words, the anti-urban approaches were dead, replaced by revived approaches that celebrated urbanity and constructed it based on the finest Western urban insights.

3. The Ideological Undercurrents Feeding the Adoption of Urban Precedents

Was Israeli planning informed only by copying and learning from Western precedents and theories? The answer, as suggested in the introduction, is negative. Precedents are adopted out of prosaic reasons: They are learned in the local schools of architecture (indeed, they have been), or brought with Jewish architects immigrating from Europe or America to Israel. But this is not enough. In order for an architectural precedent to become established in a different country and culture over the long term, it must also match the overt and covert ideology of that country and culture (Shadar & Oxman, 2003). This is the story of Israeli state planning.

In the 1950s, during the first years of statehood, the green planning articulated primarily the passion for the land (Cohen, 1970) typical of recent immigrants who seek to establish themselves in the new territory. The added value of those disjointed neighborhoods was communality. In this case as well, we could say that this is historically international value, since the modernist city was overcrowded and alienated, certainly compared to the villages from which people had moved to the city in the years of the Industrial Revolution. Nevertheless, the need for community was very much local and critically so in Jewish-Israeli society of the 1950s, which was made up of a huge diversity of immigrants from all over the world, whose arrival doubled the country's population within three years.

In the 1960s, the years of the open plan or *zeilenbau*, green belts still dominated the plans and landscape, but were more practical in character. Apartments were bigger, allowing greater scope for family life, albeit not yet at a sufficient level. Accordingly, the green areas between the row houses were supposed to provide an extension of individual daily life, and particularly of the communities. Thus, the values of attachment to the land and community were still powerful.

In the 1970s, Jewish-Israeli society underwent a significant transformation. As a result of two wars, in 1967 and 1973, and the growing dominance of the younger generation, particularly second-generation Asian and African immigrants, the heterogeneity of Israeli society, that was successfully subdued over the previous decade (Eisenstadt, 1989), gained public visibility. Ethnic tensions rose to a fever pitch until the ruling party was replaced in the 1977 elections, for the first time in 29 years. Nevertheless, the housing fabrics planned at the time—condominiums with rigidly defined inner courtyards, to which the rooms and pedestrian traffic routes were directed (Mertens & Golani, 1973)—still enforced the "community." The housing blocks forced the gaze to turn into the inner courtyard, and from balcony to balcony, imposing an inner convergence of the tenant "community," involving acquaintance and daily contact among the neighbors—even if that was not desirable to them. It is no coincidence that the car, which enabled moving out of the neighborhood, remained in parking bays in the rear. Ostensibly, this provided extra safety within the neighborhood. In fact, however, it was designed to deny the individual freedom to leave the neighborhood. This can be seen as a rearguard attempt by the planners to fend off the now externalized social heterogeneity that frightened them by forcing Israeli society into a melting pot that has long since melted away (Shadar, 2013b). In terms of values, the planners sought to promote the sense of community. The value of attachment to the land was largely abandoned. It was only partly articulated in the green courtyards at the heart of the neighborhood. Conversely, community became a dominant value, precisely because it represented a fantasy more than a reality.

The social transformation mentioned above—the externalization of Israel's social heterogeneity—sowed the seeds of the "return to the traditional city" in the 1980s and boosted the growth of the pro-urban fabrics in the 2000s. The establishment architects, who failed in their rearguard action to unify Israeli society, adopted the principles of urbanity, and managed to imbue them with ideological significance. This time, it was about the individual, democratic freedom of moving across the city and selecting the public institutes and commercial outlets out of the huge urban supply spread along continuous, mixed-traffic streets that are open to all users. Demetri Porphyrios (1992, p. 10) argued in the Introduction to Leon Krier's book that "the traditional city… underlines the individual and the contingent"—the Israeli planners of his day would surely have agreed.

The Ministry of Construction and Housing that employed the state planners followed the same agenda. The personal freedom insight also produced organizational changes. Whereas in the past, a few construction companies dominated all the work initiated by the ministry, and the architects planned the housing fabrics—from the community courtyards to the building details—now planning became privatized as well. Various contractors built in the neighborhood and various architects planned it: The neighborhood planners were different from the neighborhood segment planners, who in turn were different from the building architects (Shadar, 2014).

The process gained momentum. With the slowing down of the 1990s immigration from the former Soviet Union, the ministry continuously reduced its direct construction projects—that is, reduced its own power, as opposed to the power of the individual. The ministry focused on its administrative and guiding role. Its most significant contribution in the 2000s was issuing construction manuals that outlined the conditions for encouraging urbanity: from street planning manuals

through guidelines on planning urban gardens and green passages to manuals for condominium planning (Frisher, 2009; Lerman, 2008; Parhi-Tzafrir Architects & Geoda, 2011; Shapira & Han, 2008; Trop & Sarig, 2012).

The reduced role of the Ministry of Construction and Housing as an active builder was accompanied by the expanded role of the urbanity discourse in academic and public circles. This change in public opinion is indicated, for example, by multiple Facebook groups dedicated to urbanity and Henri Lefebvre's (1968) "right to the city" (Figure 9; e.g., the Israeli Facebook groups Renewed Urbanity in Israel, Forum for Urban Renewal, and Urban Design Research Group). Competitions for promoting urbanity are held frequently, as are conferences on the same subject (see, e.g., Israeli Urban Forum and its conferences, such as the Acre Urbanity Conference; The Israeli Urbanism Forum, n.d.). An urban design lab and urban clinic were established at the Tel Aviv University (2015) and the Hebrew University of Jerusalem (n.d.), respectively. The frequent destruction of old housing blocks in favor of new and much denser ones is euphemized as "urban renewal." The ideology mobilized to justify this celebrates urban density and the need to maintain the green areas outside the cities. Although the motivation is entrepreneurial, and the funding for the destruction and reconstruction is private, the Ministry of Construction and Housing supports the growing trend, which largely erases the old neighborhoods built by the same ministry in the 1950s and 60s, as described above (Ministry of Construction and Housing, n.d.).

How can this transformation be summarized? Growing individualism, together with the demand for individual freedom at the expense of the idealized communality in the early years of statehood, and its imposed version later encouraged the transformation in housing fabrics into urban ones. At the same time, they encouraged an establishment, academic and public discourse that privileged individual interests, private enterprise, and dense and vibrant urbanity with multiple uses and building types and celebrated that urbanity as the exclusive ideal. As a by-product of this ideological development, the state—practically the only entrepreneur, planner, and contractor during its first thirty-forty years—gradually reduced its powers and deliberately strengthened the free market in the construction area, as in others (Bareli et al., 2005).

Therein lay the rub, however. Socially, neoliberalism, which relied on the value of personal freedom, proved detrimental to the various forms of institutional communalism. The cut back on social benefits, privatized health, and education no longer took responsibility for housing young couples and the needy, and left the individual citizens to their own devices, supported by only a weak safety net. Needless to say, the neighborhood structure no longer expressed community

Figure 9. Ben Yehuda Street Pedestrian Mall, Jerusalem, serving as the theme photo of the Facebook group Renewing Urbanity in Israel. Source: Yoninah (2011).

values. Moreover, whereas at the beginning of the privatization process, the state did give way to small-scale bottom-up civilian initiatives that diversified the desirable public space, things changed: Entire neighborhood public spaces were abandoned to the interests of huge private entrepreneurs who built or "renewed" them. These spaces lacked the diversity sought by state planners back in the 1990s, and are little more than gigantic "housing containers," with little in the way of added community value (Figure 10).

Figure 10. Public spaces of a new neighborhood in Rosh HaAyin. An example for a street without interest and uses other than housing.

4. Conclusion: "Us" Plans

As mentioned in the beginning, the housing fabrics developed around the turn of the 20th century were motivated by the desire to minimize the impact of the epidemic outbreaks typical of the European industrial city. These fabrics, most of which were rich in green areas, some of which were even anti-urban, are gaining in popularity these days following the Covid-19 pandemic, given the well-documented fact that the dense urban construction and free and random encounters offered by any vibrant city serve to spread the virus. I argue, however, that this is only part of the story, as the Israeli experience clearly shows that additional "players" make those fabrics more suitable for dealing with pandemics and with crises in general. These players are the state and major public entities, and the community ideology embedded in their planning.

Dekel's (2021) book is an adapted diary of his life under siege in the Chinese city where the Covid-19 pandemic broke out. It emphasizes two issues relevant to our purposes. The first is the need for a warm and neighborly community: "You realize that now, wherever we live, it would be within a warm community, and not in a lonely building without neighbors" (p. 86). Indeed, a recent study highlighted the positive relationship between a cohesive community and successful coping with Covid-19 (Baqer et al., 2021). The second issue is the need for immediate contact with the community by looking out the window: "What helps us keep sane in a nearly two-month quarantine is the immediate contact with the outside world. One of the ways to remain up to speed is simply look out the window….I do it a lot" (Dekel, 2021, p. 133).

The history of state planning in Israel indicates that the value of community is associated with sparsely constructed and anti-urban fabrics. Although this value was part of the historical dealing with the massive and alienated city—as in Perry's neighborhood unit (1929/1974)—refining the architectural expression to the point of imposing community could not have taken place without the state's decisive power. The architects' collaboration with the state produced neighborhoods with little in the way of individual freedom and urbanity. This is particularly true of the inner courtyard-based neighborhoods of the 1970s. In these neighborhoods, state architectures sought to produce spaces of the community, instead of that "intimate anonymity" representative of the urban experience, according to Schocken (2000).

With regard specifically to architecture, when we see the neighbors' balconies all facing the same green garden (Figures 3 and 4, and particularly 5 and 6), the sense of togetherness is empowered, and tenants can draw comfort from a green, live landscape. With regard specifically to the Covid-19 crisis, when states lock people in and deny them the freedom to wander and choose, which is essential to good urbanity (Freudendal-Pedersen & Kesselring, 2020; Zecca et al., 2020), and particularly when civilians cooperate out of internal identification, fabrics that from the very beginning have relied on the value of the community rather than on urban experience, freedom of choice, and individual mobility are preferable. These spaces are perfect for crises because whatever form the crisis takes, be it pandemic, war, or natural disaster, the individuals with their self-centered needs and daily wars make way for the power of the community and mutual responsibility.

Recent studies about coping with Covid-19 indicate that this was the finest hour of states and international organizations (Anttiroiko, 2021). Municipalities were able to act within the boundaries charted by the government, and the effectiveness of large public

movements was demonstrated by their ability to influence the government (Mendes, 2020). The management of national transportation lines, the delivery of knowledge, medical examinations, and healthcare (Lak et al., 2020), as well as the decision to defer mortgage or rental payments to prevent the evacuation of the unemployed (Mendes, 2020) were government decisions taken and implemented together with additional civic and international bodies (Ito & Pongeluppe, 2020). In other words, coping with large-scale crises requires significant state actions. The long arm of the private market, which dominates our routine, is not long enough.

To return to the urban fabrics, it is no coincidence that in Israel it was the state that planned the community fabrics, nor is it a coincident that these fabrics, where the community is seen through the window, are more suitable for handling crises. The public interest and ideology that favor togetherness have produced these fabrics. This is also the answer to the research question regarding the additional, ideological element in urban construction suitable for coping with crises: (1) Community fabrics are better suited for coping with crises, and (2) community fabrics are planned by planners working for the public or its representatives.

A word about the future. The values central to this article—attachment to the land and community—have not disappeared, nor are they expected to. They are part of our human needs. Community gardening, sustainable planning, and spatially active social networks are no more than the contemporary translation of those needs, which are met by the free market and civil society in isolated sites in physical and virtual space in the neoliberal age. In times of emergency lockdown, when vibrant urban spaces have been locked down by command, and with the restriction of mobility to neighborhood spaces, these were found lacking. It was revealed that occasional or virtual encounters cannot replace a sound community planning basis. That, marginalized by free choice that justifies "good urbanity" are large populations whose reduced mobility does not enable them to enjoy all that the city has to offer (Sepe, 2021), and that the older and poorer are sicker and otherwise disproportionately weakened in times of lockdown and crisis (Ito & Pongeluppe, 2020; Mendes, 2020). Worst of all, the new and supposedly "urban" public spaces abandoned to entrepreneurial interest were exposed in their inappropriateness. Therefore, there is no choice but to have the attentive government or significant public entities representative of community needs reassume the role of designing public spaces. This need not do so as omniscient and omnipotent entities, but as another player in the arena. A player that can take responsibility for the weak and embody the value of community in space.

Acknowledgments

I thank architect Kobi Haina for helping me hone the message of this article.

Conflict of Interests

The author declares no conflict of interests.

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About the Author

Hadas Shadar (PhD) is an architect and researcher of public housing and Brutalist architecture in Israel. She is a senior lecturer in the NB Haifa School of Design and in the Technion. Dr. Shadar is also a conservation adviser of master plans and a curator of exhibitions dealing with her areas of expertise. In 2013, she co-founded an association and website to promote the study of Israeli brutalism (https://www.brutalist-/architecture.org).

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 150–163
https://doi.org/10.17645/up.v6i4.4446

Article

Real vs. Virtual City: Planning Issues in a Discontinuous Urban Area in Budapest's Inner City

Melinda Benkő [1,*], Bence Bene [1], Ádám Pirity [1], Árpád Szabó [1] and Tamás Egedy [2,3]

[1] Department of Urban Planning and Design, Faculty of Architecture, Budapest University of Technology and Economics, Hungary; E-Mails: benko@urb.bme.hu (M.B.), bene.bence@edu.bme.hu (B.B.), adampirity@edu.bme.hu (Á.P.), szabo.arpad@urb.bme.hu (Á.S.)
[2] Budapest Business School, Faculty of Commerce, Hospitality and Tourism, University of Applied Sciences, Hungary; E-Mail: egedy.tamas@uni-bge.hu
[3] Geographical Institute of the Research Centre for Astronomy and Earth Sciences, Hungary

* Corresponding author

Submitted: 29 April 2021 | Accepted: 20 June 2021 | Published: 17 November 2021

Abstract
The 21st century has brought fundamental changes in the development of cities, with the spread of ICT and the rise of digitalization. The new technologies are increasingly making their mark on urban planning and policy as well. The question of how contemporary urban planning is adapting to new challenges is particularly relevant as neighborhoods built in previous centuries and decades by traditional planning methods are now increasingly confronted with new public and environmental demands. Despite the bad reputation of Budapest's 8th district, Józsefváros, based on the socio-economic and urban problems it has continuously faced in the past, the neighborhood has become one of the most dynamically developing urban areas in the last decade. From a planning point of view, an exciting area of the district is Szigony Street and its wider surroundings due to the strongly fragmented, heterogeneous urban fabric. Nevertheless, the only high-rise mass housing estate built in Budapest's historic inner city in the 1960s and 1970s is located there. Our research used a complex methodology (document, content and database analysis, fieldwork, surveys with professionals, and interviews) to explore the planning history of the area's development. Ultimately, the aim was to identify the most important outcomes and consequences of traditional and contemporary planning and design and whether modern digital planning can make a meaningful contribution to the development of the neighborhood. Our results show that urban planning and development in Budapest are still essentially based on traditional top-down approaches. Digitalization has a role to play primarily in visualization and contextualization but digitalizing of planning alone will not solve problems and past planning mistakes that affect the urban fabric of a neighborhood.

Keywords
Budapest; digitalization; ICT; Józsefváros; mass housing; real city; Szigony Street; urban development; urban planning; virtual city

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

Over the last decade, we have witnessed the rapidly growing role of ICT and digitalization in urban development and the appearance of new concepts, like digital city (Ishida & Isbister, 2000), intelligent city (Komninos, 2002), and smart city (Hollands, 2008) that nowadays dominate professional debates. The concepts of digital city and intelligent city are mainly concentrated on the digital representations and manifestations of cities (Nam

& Pardo, 2011), whereas the smart city concept is a comprehensive, strategic approach in which infocommunication technology is used as a tool for urban management (Washburn et al., 2009). These concepts clearly point to the growing intertwining of physical (real) and digital (virtual) spaces. In this article we deal with the relationship between the real and the virtual city from an urban planning perspective. The real city is obviously made up of physical and both built and natural components. Developers and designers try to construct this world precisely, but representations also play their role, because a city is much more than its stable materiality: It is a permanently changing assemblage (McFarlane, 2011) that is experienced by users differently. This duality of the real and the representational is a basic phenomenon that is described as actuality and potentiality, objectivity, and subjectivity, hyperreality, or real and virtual (Champion, 2019). Nevertheless, "almost real" is the original definition of the word virtual that became a commonly used word in the digital era. However, the new meaning of virtual is referring to anything "created by computer technology and appearing to exist but not existing in the physical world" (Virtual, n.d.).

Computerization and digitalization of cities accelerated significantly in the 2000s and these processes created a new urban knowledge infrastructure. Digital infrastructures and platforms have allowed for the emergence of new work structures that redefine sectoral boundaries, and shape local and regional economies, as well as urban planning issues (Malone, 2018). Digitalization has also compelled governments and public institutions to rethink laws, regulations, and policies related to urban development (Zysman & Kenney, 2018). It is no coincidence that new questions about how ICT and digitalization will affect urban development, how they will impact the transformation of neighborhoods, and how they will change the way the local economy works have become the focus of urban development debates. Digitalization is often perceived as a functional concept, an unproblematic key to future development. The increasing digitalization of the world lead to a situation where digital technologies and digital constructs are profoundly embedded in our daily lives and work (Dufva & Dufva, 2019).

From an urbanistic and planning point of view, it may be particularly interesting to examine the relationship between traditional and new methods of urban development, and whether urbanism and contemporary architecture based on modern techniques can carry on, transform or, if necessary, correct the achievements, consequences, and possible mistakes of previous decades and centuries. To explore this process, we have chosen a specific and highly complex area of Budapest's inner city, which has been a testing ground for urban development efforts and experiments for many decades. The research focuses on the 750-meter long Szigony Street and its surrounding urban blocks because it is a special site in terms of planning for two main reasons: First, this is the only part of Budapest's homogenous historic inner city where a modern regeneration project with demolition and replacement by a prefabricated housing estate was realized in the 1960s and 1970s; second, this is the only part of the inner city where a contemporary large-scale renewal transformed the inherited urban fabric using the modern method of demolition and replacement. Evidently, in the past, planners and architects worked with traditional methods and tools, but their planning process has recently been facilitated by digital techniques.

The article addresses questions on the main features and achievements of the traditional planning period in the development of the case study area. We investigate how 21st century digitalization has affected the transformation of the physical environment of the area and what changes digitalization has brought to the planning process and work. The results presented in the article are based on secondary and primary sources. Secondary methods include the review of international and national literature, analyses of different statistical databases, and content analysis. The content analysis was mainly based on the study of development documents, policies and strategies on the city, the district, and the case study area, as well as on the analysis of digital photos, maps, and design documents. The main aim of the secondary research was to explore and understand the long-term processes of urban development. In the primary research both quantitative and qualitative methods were used. In 2020 and 2021, we carried out several field trips, including mapping and photo documentation in order to get an overview of the actual situation and to compare the reality (e.g., building stock and state of the physical environment) with the virtual information (e.g., open access data and GIS maps). The qualitative research involved written and online in-depth interviews with seven professional actors (planners and architects), who worked in the area in the last two decades and played a key role in its development.

2. ICT, Digitalization, and the City

2.1. The Role of ICT in Urban Development

The development of ICT and especially the emerging knowledge-intensive industries opened a new chapter in urban development. In the post-industrial age, the transformation of urban networks, urban regions, and cities was fundamentally influenced by the rapid spread of ICT, which has not only changed the physical environment of cities but has also affected changes in the social and economic context (Portugali et al., 2012).

Sassen (2001) pointed out that ICT transforms the spatial organization of society, as well as economy and consumption patterns. In recent years, however, several studies have highlighted the contradictory effects of ICT on urban development. It is still unclear how ICT affects the transformation of urban space (Audirac,

2005), as telecommunication technologies are changing very rapidly (Graham & Marvin, 1999) and we might not even be able to recognize the spatial effects of ICT (Firmino et al., 2006). At the same time, it is a fact that ICT can contribute to improving services and quality of life and achieving sustainability goals (Bifulco et al., 2016). It is no coincidence that the use of ICT in the development of innovative, sustainable, and smart cities has led to the spread of new urban planning models (Yeh, 2017).

Tranos (2013) draws attention to the fact that the internet and telecommunications continue to be a primarily urban phenomenon. Material and electronic spaces are becoming more and more intertwined and are working together. Economic performance continues to depend on stationary, material spaces, which in turn are increasingly permeated by the internet and the cyber network. However, the correlation between the use of ICT and the city is not negative, since virtual and physical spaces do not replace but complement each other (Tranos & Nijkamp, 2013).

2.2. Digitalization of Urban Development

Perry (2008) and Yigitcanlar (2011) brought a new perspective to the field by expanding the concept of knowledge-based urban development. The concept considers socio-economic development, sustainability, and governance, emphasizing the role of knowledge-intensive industries, ICT, and digitalization in urban development and planning. It aims to create a city that provides a perfect environment for business, people, spaces/places, and administration, and puts a strong emphasis on the balanced development of these systems; thus, it is based on a holistic approach (Carrillo et al., 2014).

Knowledge-intensive industries and high-tech technologies are playing an increasingly important role in urban development and respond to the challenges of the urban environment today. Therefore, complex urban development strategies increasingly include measures to facilitate the establishment and participation of high-tech enterprises in urban development, as well as to formulate economic and sustainability goals (Katz & Krueger, 2016; Pancholi et al., 2015). Thanks to these processes, the use of modern technologies and various big data databases in planning and development is also playing an increasingly important role in the development of cities.

Hancke et al. (2013) and Townsend (2013) pointed out that connecting, integrating, and analyzing the information and big datasets produced by pervasive and ubiquitous computing and digitally instrumented devices built into the urban fabric can be used to model and predict urban processes and to simulate future urban developments (Batty et al., 2012; Schaffers et al., 2011). Kitchin (2014) emphasized that many city governments now use real-time analytics to manage aspects of how a city functions and is regulated. More recently, there have been attempts to draw all these kinds of surveillance and analytics into a single hub, supplemented by broader public and open data analytics (e.g., Rio de Janeiro, Dublin, Santander, or London). These efforts allow cities to become a real-time laboratory where the use of big data sets provides the basis for a more efficient, sustainable, competitive, open, and transparent city. Big data is certainly enriching our experiences of how cities function, and it is offering many new opportunities for planning and more informed decision-making (Batty, 2013).

2.3. Digitization and Digitalization in Urban Planning

In the context of urban planning, international results suggest that digital technologies and digitization in general promote openness, affordances, and generativity (Nambisan et al., 2019). Openness of urban planning and technological architecture can support joint decision making and governance (Wareham et al., 2014). The digital dimension may thus lead urban planning to many different directions. According to Douay (2018), the following trends can be identified in urban planning based on the use of ICT: (1) algorithmic planning implying the return of experts and technocrats, (2) uberized planning as a reflection of urbanism and urban capitalism, (3) wiki planning based on urbanism looking for crowdsourced planning, and (4) open-source planning relying on the renewal of the practices of the democratic institutions of urban governance. Anttiroiko (2021) draws attention to the role of platformization in contemporary planning. His results suggest that digital co-production platforms represent a paradigmatic case of urban platform, where representatives of local public authorities—politicians, public managers, and urban planners—and citizens meet and collaborate in pursuit of improving the use of each other's resources and achieving better outcomes. Contemporary planning requires new skills such as data analytics, data optimization, and data visualization, and new professions appeared that are currently dominated by experts who apply technical skills. Power has slowly shifted from traditional public actors and governments towards a variety of companies who provide much of the infrastructure for the digitally instrumented city (McQuire, 2021).

3. Twists and Turns in the Development and Planning of the "Real" City

In Budapest, three periods have significantly reshaped the development of the "real" city. The Hungarian capital city was founded in 1873 through the unification of three historic towns: Buda, Pest, and Óbuda. Thanks to the unification and the subsequent dynamic population growth, Budapest became one of the biggest cities in Europe. This golden age of the city lasted until the First World War. In this period, the architecturally homogeneous central urban fabric of the city was built up and composed of approximately 400 urban enclosed blocks of beaux-arts

and art nouveau buildings. The General Development Plan in 1994 designated this part of the city as the inner zone, where most of the housing stock dates back to the so-called founder period (Gründerzeit) in the late 19th and early 20th centuries (see Figure 1).

After the Second World War, between 1949 and 1989, Hungary became a state-socialist country. The new political ideology brought with it the spread of industrial and mass housing developments (Molnár, 2013). The urban fabric gradually changed after 1950, when Greater Budapest was created by annexing 23 formerly independent settlements of the suburban zone to the core city. The inherited historic city center and the inner city became relatively small and neglected parts of the city, at the same time industrial areas developed just around the center and high-rise housing estates were erected in the outskirts. In the urban fringe, the so-called reconstruction often resulted in the demolition and rebuilding of former city centers based on the principles of modern architecture (Egedy et al., 2017; Losonczy et al., 2020). This period could be characterized by a profound functional and spatial division.

The political and economic change in 1990 opened the door to market-based development and urban regeneration. Since the late 1990s, neoliberal urban development has resulted in the emergence of new residential and commercial buildings in the inner city. Global capital and local private investors discovered the inner city and well-located areas were renewed building by building. EU funds later facilitated this process by several complex urban renewal programs introduced after 2007. In the third period, the urban fabric started to become more and more fragmented.

The case study area is located in one of the poorest and most stigmatized parts of the historic inner city. Demolition and replacement were and still are used to provoke large scale urban changes in the neighborhood. During the socialist period, the only housing estate in the historic core of the city was built here, and the only megaproject, the Corvin Promenade (originally called

Figure 1. Map of Greater Budapest indicating different developments in the historical periods. Legend: Budapest between 1873 and 1950 (dark grey); suburban zone until 1950 (light grey); historic inner zone (blue); large housing estates with more than 6,000 dwelling units (black); Józsefváros, Budapest's 8th district (green); Szigony Street, the case study area (red).

Corvin–Szigony Project) is underway, developed by contemporary neoliberal urban development concepts.

The area of Szigony Street represents a location in which a diverse range of urban concepts and experiences have been realized. It is not a typical part of the historic city center of Budapest where plot division, densification, and intensification characterized the changes. Here, the urbanization had always been dramatic, brand new, unknown, and large-scale intervention appeared based on contemporary objectives. Thus, Szigony Street is an ideal case to analyze and to understand theories and methods used by planners and check how their digital tools affect reality. Szigony Street itself is a short urban sequence that is squeezed between two main radial historic axes of Budapest, the Baross and the Üllői roads. Along this 750-meter-long street there are large-scale urban interventions with various building programs (housing estates, clinics, business district) and architectural styles (historic, modern, high-tech, etc.; see Figure 2).

Three periods can be distinguished in the planning and development of the Szigony Street area:

1. Traditional planning: The period from the mid-18th century to the Second World War, when the primary road network and building structure of the area were established and the essential components of the urban fabric were formed. The period was characterized by investor-led planning where planning and development were in alignment. Between 1870 and the First World War, the Council of Public Works played a decisive role in the development of the area alongside investors;
2. Modern planning: The second period coincided with the communist period. Between 1949 and 1990, with the rise of modern architectural ideology in Central and Eastern Europe, the construction of high-rise housing estates began. Political ideology was also present in the construction of these large urban housing estates, so this period can be called a period of ideology-led planning from both an urban planning and an urban policy perspective. During this period, the area became a highly disrupted territory;
3. Contemporary planning: The third period started in the 1990s after the change of regime with the return of the market economy and investor-led planning. In this period, ICT and digitalization gave a boost to urban development and the use of digital tools in planning opened new possibilities.

3.1. Traditional Planning: Atypical Historic Urban Fabric

The urbanization of the site begun in the 1730s with the construction of the first buildings. This eastern outskirt area of Pest City received the name József (Josephinum) after the son of Maria Theresa, the Habsburg sovereign of Hungary, in 1777. The first plan defined the main roads and large urban gardens. After the unification of

Figure 2. Budapest's Szigony Street.

Pest, Buda, and Óbuda in 1873, Józsefváros became the 8th district of the Hungarian capital. Besides the typical development pattern of single, two, or three story-high simple courtyard residential buildings with small workshops, the former urban gardens of the area gave opportunity for large scale interventions as well. After completing its first medical faculty campus in inner-Józsefváros, the Royal Hungarian University of Science, in Budapest, developed a second one, the clinics on Szigony Street between 1898 and 1910. These clinics located in villas within a fenced green garden form the southern gate of the area. The catholic church owned another garden and a housing estate for the middle classes was built there between 1910 and 1912 (Papházak). This six-story high building complex forms a special historic urban island on the street.

3.2. Modern Planning: Clearance and Replacement in Budapest's Inner City

Following the urbanization of the interwar period, the consequences of Second World War, and the 1956 revolution, Middle-Józsefváros had one of the most neglected physical and social contexts in Budapest. During the state socialist period (1949–1989), mass-housing policy based on the Soviet model was initiated using large prefabricated concrete panels, and today, one third of Budapest's housing stock is located in modern neighborhoods of this kind. The first 15-year housing plan (1960–1975) focused on the efficient urbanization of green field areas, but, at the same time, it also identified some historic urban fabrics for clearance and replacement by slabs and towers. Most of them were former city centers somewhere in the outskirts of Budapest (e.g., Óbuda, Újpest, Csepel), but Middle-Józsefváros, as a problematic area, became the only area in which such interventions took place within the historic urban core. Since 1962, several masterplans have been prepared with similar foundations: preservation of the historic buildings along the main roads (József, Üllői, Baross) and the large-scale historic building complex (Corvin, Clinics, Papházak), but total demolition of the inner parts, blocks, and buildings with more than 5,800 dwelling units. Although the urban form of the replacement concepts using towers and slabs were planned in different versions, Szigony Street and the perpendicular Práter Street were always the main axes of the composition. This project was developed as Budapest's pilot model to find efficient modern solutions to demolish and replace the historic urban fabric. Finally, they transformed a 12-ha large part of Józsefváros only, where six 16-story high residential towers were built in 1970, and some 10–13-story high slabs with more than 2,000 dwelling units by 1975. In the mass housing estate, Szigony Street changed dimension and from a narrow street became a 70-meter-long grey valley providing space for a possible new main road planned across the historic urban fabric (see Figures 3 and 5).

3.3. Contemporary Planning: Real vs. Virtual City

Budapest, after the change of political and economic regime, introduced a non-hierarchical, dual-municipal structure in 1990 and Józsefváros became

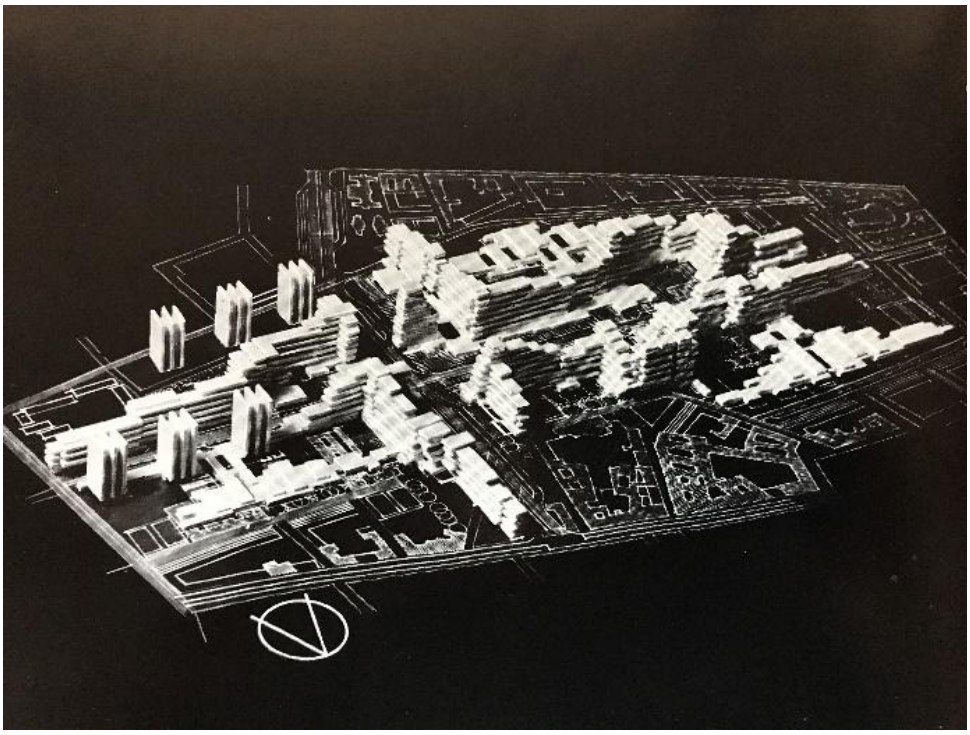

Figure 3. One of the proposals for the urban regeneration of Middle-Józsefváros in the 1960s. Source: Preisich (1973, p. 42).

one autonomous administrative unit, the 8th of the 23 districts of the Hungarian capital. In 1997, the local government of Budapest and the 8th district's local government created the Rév8 Plc., a public company responsible for urban renewal. In 2000, the council of Józsefváros abandoned its former rehabilitation plan and decided to identify urban quarters based on physical and social data and introduce a quarter-based development and management approach. In 2005, the municipality approved the new spatial division and each of the eleven quarters became a local unit with different problems and potential. The quarters of Józsefváros started to develop differently in the 21st century (Alföldi et al., 2019). One of the 11 quarters, the Corvin Quarter, was prepared for total privatization giving the opportunity for a 22-ha large contemporary private development within Budapest's historic urban core (Kiss, 2019). At first, the name of the area was Corvin-Szigony, reflecting the western and eastern limits of the land; later it became the more international and real estate-friendly Corvin Promenade. The development started in 2005 and by 2018 reached Szigony Street, where it continues today with the Innovation Campus. This whole project is promoted as the largest Central European urban renewal within a historic city center. However, the concept, just like the earlier modern one, is based on tabula rasa, displacement of the residents, scale, and functional transformation (see Figure 4).

Szigony Street is partly situated in the Losonci Quarter and creates the borderline between the Losonci and the Corvin Quarters. These are the two quarters where the municipality does not use context-sensitive rehabilitation (Perczel, 1992) but has been managing a traditional top-down planning process since 2000. To facilitate the re-evaluation of the Corvin investment area, the Rév8 Plc initiated some other private projects in the neighborhood. As a result, the Pázmány Péter Catholic University built one of its new buildings in the middle of the planned modern urban axis (Szigony Street) in 2008, and an apartment building was constructed behind the Papházak. In addition, here the modern high-rise housing estate of Szigony Street serves as a reference for contemporary urban development: total demolition of the past and replacement by dense, 30-meter high, urban-block sized residential or office buildings. Although this article focuses on the physical impacts of the urban renewal on the built environment, it is evident that this process has resulted in subsequent changes in the district's socio-spatial context (Czirfusz et al., 2015; Horváth, 2019).

4. Space and Data: Digital Tools in Contemporary Planning and Design of the "Virtual" City

The use of ICT and digitalization has opened new perspectives for urban planning and development worldwide. In the following section, we review the contemporary planning shaping the physical and social context of the Szigony Street area based on fieldwork and surveys undertaken with planning and design professionals in 2021.

Figure 4. Urban diversity of the Szigony area: New residential buildings, prefabricated modern slabs, and historic tenements in the background.

4.1. Spatial Units

Based on historic and contemporary development, the area can be divided into different morphological units, but they do not reflect any special characteristics based on ICT. It is easy to recognize them by their spatial segregation that exists not only in the urban form, but also in the social context of the urban blocks. In recent years, the density and the intensity of the areas increased and most of the public spaces—the undermanaged Szigony Street and the perpendicular overmanaged (Carmona, 2010) Corvin Promenade—created a place for urban diversity: Digital nomads, youngsters, and students use the same public areas as residents of the prefab slab buildings and towers or neglected historic tenement buildings (Czirfusz et al., 2015; see Figure 5).

4.2. Planning and Design Units

Following the historic inner city development where different private owners developed similar urban plots, the effective transformation started in the 1960s. Typical tenement houses were demolished to modernize the area, to change not only the physical but also the social context. This process was interrupted and, after decades of neglect, contemporary large-scale development started in the 21st century (see Figure 6). The first intervention was undertaken by the new Faculty of Pázmány Catholic University specialized in digital technology and robotics, but its building, like an enclosed fortress, occupied a part of the parking area of the housing estate in Szigony Street. Four-story high, stand alone, independent buildings organized around inner courtyards in the middle of the panel urban jungle in 2008 (see Figure 7). Then, after the global economic crisis, the Corvin Promenade was constructed in the Szigony Street area and large-scale office buildings provided a new facade to its central part in the last few years. These 9/10-story high, dense, controlled private developments for white-collar workers communicate intensively with the new Promenade, but on the narrow Szigony Street they have elevated levels and transparent glass walls without any public entrances. The Corvin Promenade Project is the only one of its kind and dimension in Budapest's inner city and it has changed the image and socio-economic status of the area completely.

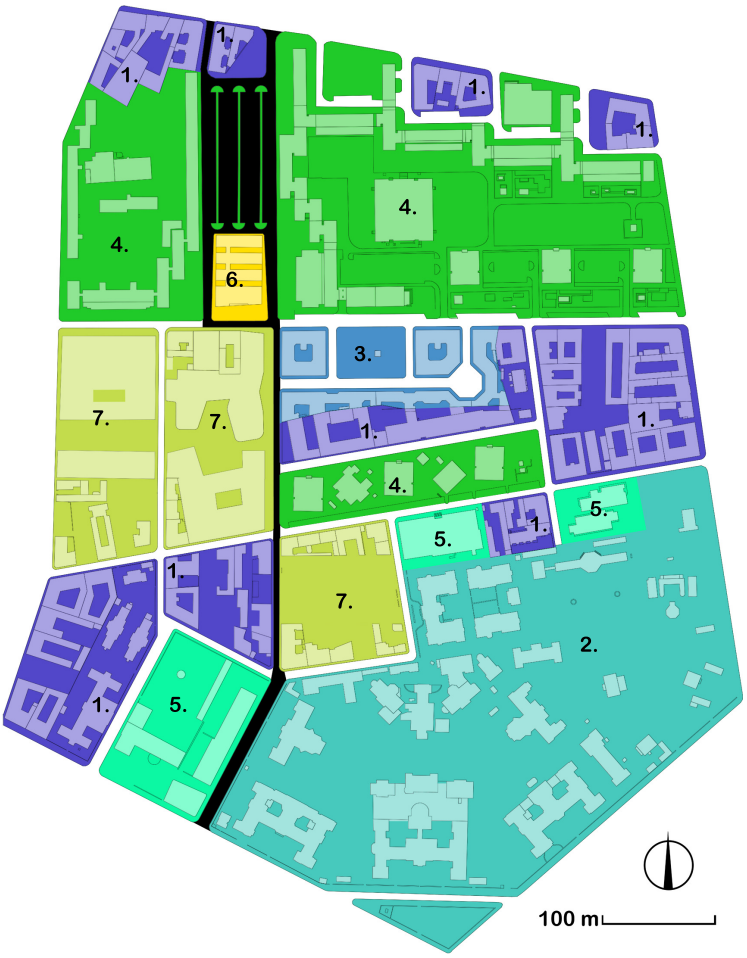

Figure 5. Contemporary urban fabric composed of different morphological units reflects disrupted developments. Legend: Corvin Street (black), (1) historic tenement buildings, (2) Clinics, (3) historic housing estate, (4) modern mass housing, (5) modern public buildings, (6) university building, and (7) Corvin Promenade.

Figure 6. Contemporary large-scale development and design units. Legend: Corvin Street (blue), (1) Pázmány University building, (2) housing complex with more than 1,000 dwelling units, (3) Corvin Offices, (4) residential building, (5) Innovation Campus, (6) Clinics, and (7) Clinics Metro Station.

Figure 7. Szigony Street view from a panel building: The contemporary brick university building occupies a part of the planned urban highway between modern slab buildings without any communication with its surroundings.

Densification, intensification, gentrification, and youngification characterize the Szigony Street area. New services and users appeared along the street and, in addition the southern gate of the area, the Clinics Metro Station will also be renewed soon. Investors continue to search for land to develop, for example the Innovation Campus will occupy a piece of land that belonged to former historic tenement buildings. It will be the first large scale building in the area, which will be connected to the street by a publicly used square and facilities on the ground floor. This design proposal demonstrates a metamorphosis of Szigony Street's image in the next 15 years.

4.3. Digital Tools Used by Planning and Design Professionals

In 2021 we carried out seven in-depth-interviews with planners and architects who were involved in the transformation of the Szigony Street area between 2002 and 2021. The questions were organized around different topics related to the planning and design process: methods and tools used during the data collection, methods and tools used during the realization and communication of the project, personal relationship to the site, and opinion about the current status of Szigony Street. It is important to recognize that most of them used traditional data collection methods based on fieldwork, so photo documentation, mapping, and offline meetings were still the basic tools for data collection. All interviewees used historic and statistical data, checked previous planning and design documents, and followed official EU and national regulations. CAD and GIS programs gave the professional background; however, digital tools providing participatory methods (Benkő et al., 2018), social media, or innovative visualization techniques to communicate the future were not introduced. In 2002, the original development concept was value-driven, focusing on economic and social potential and on this basis, the Corvin and Losonci Quarters of the 8th district became an inner city urban laboratory. There, the physical context reflects the changing policy, market, and interests. To explain the dimension and method of this radical contemporary intervention, reference was made to the modern urbanism of the mass housing neighborhood: clearing of the remaining historic area, replacement by large-scale projects, using traditional top-down planning and design resulting in densification and intensification. Projects were created using digital tools; however, ICT and digitalization had no direct impacts on the urban fabric.

4.4. Open-Source Urban Data

Data collection has always been and is still fundamental for every context-sensitive urban research, planning, and design process. Besides the official and sometimes highly prized data available in a native language, validated open-source and community-produced data are available remotely. Surveys show that in the case of Szigony Street, professionals did not use them neither for analysis nor for facilitating data-driven participation (Tenney & Sieber, 2016). If planners are interested in users' opinion, social interfaces and applications could be useful for gaining information and creating surveys. In the Szigony Street area, several public and small private virtual social-media groups exist, but, according to local sources, they are still not well-organized.

The historic research was accompanied by several open-access databases. In Hungary, Fortepan (2010), a Hungarian-developed community-based copyright-free platform gives the opportunity to share archive photos of citizens and institutions. In 2021, almost 150,000 images are available, and several hundreds were taken in the Szigony Street area (see Figure 8).

Figure 8. Modern mass housing estate on Szigony Street. Source: Fortepan (2010).

In Hungary, the digitalization of the different public collections started in 2006. For example, Mapire (the historical map portal) is a geo-referenced interface presenting historical maps by GIS technology. The collection is based on the military surveys of the Habsburg Empire, country- and city-level, and thematic maps. Concerning any site in Budapest, urban changes can be easily traced from the middle of the 18th century to the middle of the 20th century. However, more and more collection of written resources is also attainable on the web. Hungaricana (Hungarian cultural heritage portal), the most relevant local portal with documents of various public collections (libraries, archives, museums, state institutions, etc.) shows 2,181 documents in which Szigony Street is mentioned. In 2021, global, national, and local digital data exist; sometimes they are open-access (see Figure 9) and are geo-referenced, but for most of them a fee is required, and the spatial composition and distribution of statistical data are not relevant enough for the space of a planning or design project (Németh, 2020).

5. Discussion and Conclusions

Traditional planning is related to power and the urban fabric is shaped by political will and economic interest (Brenner, 2011; Fuller & West, 2017). However, contemporary ICT and digitalization of the city seem to play several roles, and, among them, democratization of the planning process and governance are important ones (Hennen et al., 2020). Based on the analysis of the planning history of Szigony Street area in Budapest's inner city, three different phases are differentiated. The first is the traditional world with a planning framework given by the city (urban network, public facilities, regulation, etc.), where local private developers and investors construct the city plot by plot. The second is the modern urban regeneration in which demolition, modernization, scale transformation, and efficiency are basic concepts. In addition, this process in socialist cities was facilitated by the nationalization of land and buildings, central planning, and common soviet norms (Tosics, 2013). The planning methods and tools remained traditional but reflected the theory of modern urbanism about the future city. In the third phase, at the end of the 20th century, the world entered the digital age. However, for Budapest, and for other Central and Eastern European cities, it was the beginning of post-socialist capitalism, with mass privatization, globalization, economic value-driven development, and digitalization (Sýkora & Bouzarovski, 2012). Traditional top-down planning and design methods continue to play a dominant role in urban development, with the role of ICT and digitalization mainly limited to database management and attractive visualization related to real estate industry requirements. In the case study area, the development of the modern mass housing neighborhood is characterized by demolition and replacement, top-down planning without participation and scale transformation continues with the help of digital methods and tools. As a result, real and virtual cities coexist. The hard, physical, and soft social components of the contemporary city develop in a different manner.

The case study area of Szigony Street in Budapest reflects these three planning phases perfectly. Some island-like historic tenement buildings co-exist with the inherited prefabricated modern housing estate and contemporary new large-scale developments. Diversity characterizes everything: urban form, functions, and users.

Figure 9. A public webcam took photos during the construction of a large-scale office building at the end of the Corvin Promenade and Szigony Street.

At the same time, the real and virtual cities are increasingly overlapping and intertwined. The range and volume of data provided by sensors, digital networks, and statistical databases on the physical space are rapidly increasing. Locals know more and more about each other (by social network), about the history of the area (by open-access digital resources) and about the actual and future transformations (by digital written and visual communication tools).

In line with the previous findings of Bibri and Krogstie (2017) and Lim et al. (2018), we stress that the importance of digitalization in urban planning is expected to increase in the near future. This is basically due to two processes. First, in urban planning, many of the urban renewal programs currently underway were launched in the 2000s (e.g., the Corvin project was developed in 1999–2004 and implementation started in 2005), when the degree of digitalization in Hungary and in urban planning was much less advanced. On the other hand, in recent years, we have witnessed an acceleration of digitalization. The degree and quality of digitalization of local society are constantly increasing thanks to socio-economic development, which has been reinforced by the impact of the Covid-19 pandemic of recent years (home office working significantly changed working methods and processes, new lifestyles, and attitudes; Sardar et al., 2021). Budapest's municipalities today introduce digital participatory methods about public space renewal projects, small interventions, and tactical urbanism. However, the actual and drastic transformations of major urban areas, construction of large-scale landmark buildings, change of the regulations, etc., take place using a conventional top-down approach supported by digital, intelligent, and smart methods and objectives.

The Szigony Street area changed significantly in the two last decades. Contemporary planners of the urban development projects, or designers of a large-scale building describe their concept as cooperative, generous, open-minded, innovative, but they think that the Szigony Street in 2021 is still dreary, contradictory, disproportionate, and incomplete. Can we really say that projects in the digital age are innovative? Did ICT and digitalization really change the traditional planning and design methods in practice? The reality is that although planned and well-promoted virtual cities already exist and new digital tools are shaping our daily life, the physical urban fabric is still planned and designed in a traditional way.

Acknowledgments

The research was funded by the COST Action 18137 MCMH-EU project and the National Research, Development, and Innovation Office of Hungary (Grant agreement No. K128717).

Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

Melinda Benkő (PhD and habilitation in architecture) is an associate professor at the Budapest University of Technology and Economics Department of Urban Planning and Design. She earned a Campus France, MTA Bolyai, and Fulbright Grants, and is currently the chair of the "Facing Post-Socialist Urban Heritage" doctoral conference series and member of the Committee on Architecture at the Hungarian Academy of Sciences. Benkő's research, academic, and professional activities focus on contemporary urban design theory and practice related to urban form and space usage.

Bence Bene is a PhD student of the Department of Urban Planning and Design at Budapest University of Technology and Economics. He has published on the mobility of homeless people in Budapest and informal urbanism in Tirana. Bence is working as an architect in an NGO called "From Streets to Home Association," helping to solve the issues of homelessness and other types of housing crises in Budapest. Recently, he has researched the spontaneous urban patches of Hungarian post-socialist mass housing estates.

Ádám Pirity graduated with an MSc degree from the Faculty of Architecture of the Budapest University of Technology and Economics. In the fall of 2020, he was admitted to the university's Pál Csonka Doctoral School. The main topic of his doctoral research is to explore the history and operation of a design company operating in the period of state socialism in northern Hungary. Collecting and organizing various data has become an important part of his research activities.

Árpád Szabó (DLA) is an architect and urban designer. He obtained his diploma at the Budapest University of Technology and Economics' Faculty of Architecture in 1999 and finished his DLA studies at the Doctoral School of Architecture in 2007. Since 2003, he has been teaching at the Department of Urban Planning and Design and since 2019 he has been the head of the department. He works mainly on urban design projects at his own studio (Czirjak Szabo).

Tamás Egedy (PhD) is an urban geographer. He is senior research fellow at the Geographical Institute of the Research Centre for Astronomy and Earth Sciences and associate professor at the Budapest Business School. His research activities are in the field of urban regeneration, housing estates, and creative economy in Hungary. He is editor of the leading Hungarian geography journals *Hungarian Geographical Bulletin* and *Geographical Review*.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 164–171
https://doi.org/10.17645/up.v6i4.4464

Article

Integrating Digital Twin Technology Into Large Panel System Estates Retrofit Projects

Paulina Duch-Zebrowska * and Katarzyna Zielonko-Jung

Department of Environmental Design, Faculty of Architecture, Gdańsk University of Technology, Poland;
E-Mails: paulina.zebrowska@pg.edu.pl (P.D.-Z.), katarzyna.zielonko-jung@pg.edu.pl (K.Z.-J.)

* Corresponding author

Submitted: 30 April 2021 | Accepted: 24 July 2021 | Published: 17 November 2021

Abstract
As sustainability is now a standard for the proposed developments, the focus ought to be shifted towards the existing buildings and, among them, the worldwide stock of large panel system (LPS) buildings. Major upgrades and retrofits were done to some of the LPS estates in Germany and France, but a leading sustainable way must still be developed for LPS buildings in Eastern European countries, where apartments in those half-a-century-old estates are privately owned. Both sustainability and ownership issues make the demolition option redundant, and therefore the method for deep thermal retrofit and urban intervention is being developed with the use of BIM simulation tools. Digital twin (DT) technology allows for calibration to intertwine with the Internet of Things applications that reward the inhabitants for sustainable behaviour while feeding the relevant data back to the DT. Thanks to this, smart technology can be used to raise the level of social participation in the projects and thus help educate the end-users, which is paramount in establishing and maintaining good ecological habits, and as such, also for the efficacy and viability of the final endeavour. This article proposes a procedure of creating a 3D model typology repository for facilitating DT technology to provide a good analytical tool for community consultation and enable virtual testing of technical and urban solutions before implementation. It aims to determine the method for virtual technology to give deteriorating estates a new lease of life and improve their perception in the wider community while being a conduit for the adaptation of CEE to the digital revolution.

Keywords
3D model repository; BIM simulation tools; digital twin technology; end-user education; large panel system; modular design; participation projects; smart technology; sustainable refurbishment; thermal upgrade

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

This article is the first output of a project that aims to find a new lease on life for the existing modular estates built widely across post-WWII Europe. This article assesses the possibility of using modern design techniques in thermal retrofit projects for such buildings to inform and advise policymakers, and provide a clear path forward to reduce the buildings' operational carbon footprint.

The technology that prevails in modern design is building information modelling (BIM), which has gained recognition in the construction industry since its implementation as it enables early clash detection and therefore reduces the construction cost. The next step taken by the construction industry was the integration of the buildings' predicted and actual performance, which has been achieved by building performance simulation (BPS) tools (Hopfe et al., 2017) widely used in the preparation of building management systems (BMS). Nowadays, the use of BIM and BPS does not stop with the completion of the construction works—the BMS and the Internet of Things provide a steady data flow to the simulation

software, creating a constantly growing virtual twin of the actual building. This article provides an overview of the possibilities of using the above methods in the retrofit projects of existing buildings, particularly in large panel system (LPS) buildings.

As described in the *Statistical Review of World Energy* by BP (2020), primary energy consumption continues to grow every year and, as such, each action in this regard requires a substantial reduction in energy consumption. Since buildings are responsible for 36% of CO_2 emissions in the EU, as shown by Lorenzo-Sáez et al. (2020), reducing their energy consumption should be a priority. LPS buildings constitute a high percentage of all residential buildings in Eastern Europe. Due to comparable technologies, one solution may affect a significant number of buildings by similar initiatives; therefore, finding an answer for the most cost-effective thermal retrofit of LPS buildings may significantly reduce CO_2 emissions considering the scale effect. Based on this, as well as on the climate change and our response to it being our collective responsibility, LPS buildings were chosen for the research.

The first part of this article describes the LPS and identifies its general strengths and weaknesses. The second part explores the software that may be used to create new opportunities for LPS estates. This is followed by section 3, which considers the impact new technologies have on end-user education and the way it affects estate sustainability. The conclusion summarizes the results of the analysis and provides a roadmap for the next steps of the project.

2. Main Considerations of the Research

2.1. Principles of the Large Panel System

LPS is a construction system used since the late 1950s that allowed for swift assembly of the building from prefabricated modules. Due to the centralized design and management of the construction process at the government level, a closed typology of solutions was utilized. However, the possibility to provide big quantities of habitable units in a short time through the erection of prefabricated LPS buildings was part of the proposed solution to the main hindrance of the quick-paced progression of the second Industrial Revolution post-WWII, which was the insufficient workforce influx due to the lack of housing for labour workers willing to migrate into cities in search of a better life (Korzeniewski, 1981, p. 9). This approach, described also by Dekker and Van Kempen (2005), was widely adopted in many countries, with more than 50 million LPS type apartments created in 1956–1991 (Eurostat, 2018); such solutions remained popular until as late as the 1980s, primarily in countries under the influence of the former USSR, where the central government established the housing market strategy and policy. While some LPS buildings were erected in Western Europe as well, the free-market laws of the Western economies allowed for the diversity of the systems adopted, and the idea of a typical LPS was swiftly abandoned due to the lack of design diversity. Currently, prefabricated concrete elements are still widely used in the construction industry however, since they do not fulfil the typology criteria, they are not covered by this research article.

The LPS systems varied between countries and received local names, which demonstrates the local societies' connection to them: Germany–Planttenbau, Russia–Panelnye-doma, Poland–Wielka plyta, Romania–Bloc or Systematization, Czechia and Slovakia–Panelák or Sidlisko, and Hungary–Panelház.

LPS buildings have become a familiar part of the urban landscape. Due to the common denominator—the closed typology of solutions in prefabricated reinforced concrete elements, enabling effective building construction by using modules—the local varieties were omitted in this article and are all referred to as "LPS" for ease of comprehension.

2.2. Strengths and Weaknesses

LPS estates were typically built-in rural areas adjacent to the existing towns. It was an extensive urban design undertaking—the new areas of the city developed on pristine sites. Up until that time, Europe's urban system development was predominantly a slow-paced and long-term endeavour (Bosker et al., 2008). It was the first time in history with so many extensive developments happening at once. The urban planners were experimenting with various designs in terms of road layout, as well as locations of service outlets and amenities, all of which were designed from scratch. Since then, LPS estates have become part of the city with broad transport and connections, but the original urban design remained part of the estates. The centralized policy at the early stages of the rapidly increasing urbanization of East European cities post-WWII enforced the universal use of the urban design standard. The standard, as described by Korzeniewski (1981, pp. 64–67), consisted in setting up basic amenities like estate-level services and a primary school within walking distance—no more than 800 meters away from the furthest residential building entrance. Incidentally, this approach has now resurged due to the publication of Jeff Speck's book *Walkable City Rules* (2018).

The main idea of LPS estates was based on the uniform needs of the citizen, as described by the centralized standard, which resulted in the lack of individualism and poor aesthetics—a weak point indicated by residents in all media and internet relations (see, for example, "Wady i zalety bloków z wielkiej płyty," 2020), and also described by Gribat and Huxley (2015, Chapter 8, p. 165). However, the national design standard provided an outline of the space required to fulfil the social and active recreation needs of the community members as understood by policymakers. As the land was obtained by expropriation of farmers for the greater

good of society, the estates were designed lavishly, with free space between the buildings often exceeding 60 meters.

As further described by Korzeniewski (1981, pp. 61–63), the central urban guidelines included the requirements for natural air corridors, sunlight, and overshadowing, as well as the distance between buildings. This is because such estates were intended for people moving in from rural areas, who were used to having fences to guard them against their neighbours' prying eyes. The spaces between the buildings allowed for greenery, private and public garden areas adjacent to the buildings, wide pavements, and playgrounds surrounded by trees that provided shade for playing children while also being far enough from the buildings not to cause any issues due to root overgrowth or overshadowing of apartment windows. LPS estates feature various green areas suitable for various uses, ranging from neighbourhood fairs, through outdoor sports, to enabling everyday activities for the elderly and young children. Modern residential developments use the space available more sparingly as they need to increase the revenue gained from the site. The distances between buildings and the green areas on the estates are two of the most often raised advantages of LPS estates over their 21st century counterparts, as described in many online articles providing information for potential buyers in Poland, like the law firm Pewny Lokal (2020). Nonetheless, at the time the LPS estates were built, vehicle use was not as prevalent as it is nowadays. Therefore, the lack of sufficient parking spaces is the primary disadvantage always indicated by LPS estate inhabitants, as is the deteriorating condition of open spaces—an opinion often shared on social media and online message boards for inhabitants, among many others, on the online forum of Gazeta.pl (2018).

The LPS estates were erected on the pristine sites that had been used as agricultural land only a few years before, and as such, had no proper roads or amenities; however, these quickly followed once the estates became populated. Nowadays, the proximity to local amenities was shown to be advantageous for inhabitants in several studies, although the deterioration of local services under pressure from bigger shopping centres was also described as a growing tendency, with only 37% of respondents to public opinion polls using local shops to satisfy most of their shopping needs (Frendler-Bielicka, 2013).

Low workmanship standards are another issue commonly raised in the debate on LPS buildings' future, as described in energy analyses (Ostańska, 2009). The connections between the panels allowed for higher levels of infiltration and raised concerns regarding the safety of welded connections due to their exposure to elements (Tofiluk, 2017). Therefore, each project shall be preceded by a structural assessment, as per industry standards. However, airtightness tests performed as part of past thermal retrofit projects have shown a nearly 20% improvement, as evidenced by Dębowski et al. (2014), with such projects reducing the exposure of welded connections and further deterioration.

The next factor to consider during works on LPS buildings is the issue of ownership. In Germany, where most radical refurbishments have been performed, including Märkisches Viertel in Berlin by Gesobau (Lössl, 2016), which became the world's largest low carbon fully accessible estate, many LPS buildings have been abandoned and the apartments are mainly tenured, making any refurbishment works easier. Following the system transformation of the early 1990s, the inhabitants of LPS buildings in most Eastern European countries had the opportunity to acquire apartments at a fraction of their value. The move was welcomed by the residents but at the same time shrewd by the governments due to the transfer of responsibility for the technical state of the buildings that were becoming increasingly deteriorated every year. The buildings' technical decline was accompanied by a decline in the condition of the internal services, like pipework and electricity, which impacts the general efficiency of building systems.

As mentioned above, the lack of individualism caused by the design typology lowers the attractiveness of LPS estates to the public. However, the examples of thermal modernization projects that brought the LPS buildings to a higher aesthetic standard, like Märkischen Viertel or Grand Parc Bordeaux (Miesarch, 2019), are inducing new ways of thinking for all other estates.

2.3. Main Considerations

Originally, the average design life for LPS buildings was supposed to be 50–60 years, with the shortest design life of 25 years envisaged for the Russian Khrushchyovka designed to resolve a temporary housing shortage (Absimetov & Solovev, 2020). Once that time elapsed, there were numerous suggestions, mainly in France, Germany, and the UK, to demolish LPS buildings and make space for new developments. While it might have been a tempting option, as estates originally built on pristine sites with no infrastructure are nowadays located in urbanized areas and benefit from such local amenities as schools, shops, and public transport networks, considering the growing problem of sand shortage on the world construction market, as described by Beiser (2018), as well as the amount of embodied carbon in the concrete panels (Anderson & Moncaster, 2020), demolition cannot be deemed a sustainable option for site recovery. Additionally, technical and structural analyses have been performed in many countries, e.g., in Poland in 2019 (Instytut Techniki Budowlanej, 2019), which established that the buildings are structurally sound. With the embodied carbon remaining constant, the main consideration of this research project is how to reduce the impact on the environment during the use of buildings and make the estates more attractive for occupiers.

3. Digital Twin Technology Use in Large Panel System Retrofit Projects

The analysis of the geometry and correlation between systems of the designed building before the commencement of construction work is the main benefit of using the BIM system, as it allows for early intervention in case any discrepancies occur. As such, the BIM tool helps the design team to increase productivity, plan the expenditure, and manage the acceptable risk of development by bringing a high level of information to the decision-making process. This is the reason for BIM becoming entrenched in the new development design, as commercial practices and developers are constantly increasing revenue while reducing investment project risk. For any successful project, five key aspects of the strategic approach are needed before implementation: assessment, plan, finance, decision, and risk management (Ruggeri et al., 2020). Effectively used BIM tools help with three initial ones—assessment, plan, and finance—while also providing data for decision making and, due to the level of information collected, help with risk management. Meanwhile, BPS tools provide a quick analysis of the estimated energy consumption and how it gets affected by changes and tweaks in the planned projects. Similar to new development projects, the above key aspects determine the success of refurbishment projects as well. Due to the multi-layered challenges facing LPS refurbishment, ranging from electrical wiring to urban planning, the use of BIM and BPS tools in retrofit projects helps plan works with the largest energy efficiency at the lowest expenditure achievable.

The most time-consuming element of work is the creation of library of materials and products that match the original LPS buildings as the standard software library of BIM materials does not match the physical attributes of 50-year-old concrete. The external walls, slabs, windows, doors, and roof build-up all need to be re-created in the software to allow for flexibility in the model's energy performance settings. The thermal properties of the elements are subsequently imported to the simulation engine via the energy model.

The two types of software initially analysed are Revit with the simulation tool Insight, as well as IES VE with IES ISCAN; they were initially chosen from a list of software most commonly used in the architectural education system prepared by Hopfe et al. (2017). The authors' consideration in choosing the software for initial analysis was to consider the systems that are widely used to ensure the efficacy of the unabridged project. They both work at a different level of information—Revit, which is mainly a tool for the construction industry, requires a higher level of detail, making it more time-consuming. However, due to the wide use of typology in the construction of LPS buildings, the creation of 3D model templates is a straightforward solution in this regard. There is a closed catalogue of products/panels that were used during construction and products that can be implemented into predefined libraries, whereas 3D models of building types might be collected in open-source repositories. A 3D model of the given building type could then be downloaded from the repository and easily modified to match the specific technical and local conditions. We propose to create families of all systems and panels used for one type of LPS, similarly to what had been done 50 years ago. This would enable each model to be "erected" in a virtual environment using panels that it had originally been built from. If there are any commonly used LPS types, the entire buildings can be modelled as templates and then adjusted to specific locations for individual building model creation.

The process of using digital twin (DT) technology for LPS building retrofit projects proposed by the authors is shown in Figure 1 and consists of steps outlined below. The 3D models from the original project data are created per type of building and a repository of template 3D models is created; as described in the paragraph above, the most time-consuming element of work—preparation of an individual model for a specific building—is significantly simplified, reducing the 3D model creation timeframe. Secondly, all previous modernization works need to be included in such an individual model. The next step is the incorporation of the accurate representation of reality, which makes the BIM model a virtual twin of the building—this requires a link between the model and the constant input of usage data—the more data the better the twin. Therefore, the next stage involves the input of usage data (e.g., using the IES iSCAN software). In the beginning, only the available meter readings from the main meter can be imported. However, once smart meters are available, the flow of information to the software becomes constant and the model starts to recognize patterns. From that point onwards, the software algorithm can suggest energy-saving measures and the level of interference it causes (shallow/deep retrofit) or the planned retrofit works can be included in the simulations for swift estimation of costs, energy savings, public consultation use, and risk assessment before the final decision is made.

The DT process may be used for single buildings but also whole estates or districts. Considering the urban projects, the data input is simply at a different level—the data from building smart meters are accompanied by data regarding vehicular and pedestrian traffic, the grid and utility locations, and car charging station locations. Accordingly, the DTT can be used to analyse the energy usage across the grid and point to the appropriate location for a photovoltaic panel energy-storing facility or new subterranean parking, which can first be checked virtually for any potential clashes or impact on the area's traffic.

The biggest challenge for LPS renovation—both at the building—and urban-level and second only to the substantial cost of such works—is the decision-making process with many owners and occupiers involved. The graphics and data outcome of DT technology used

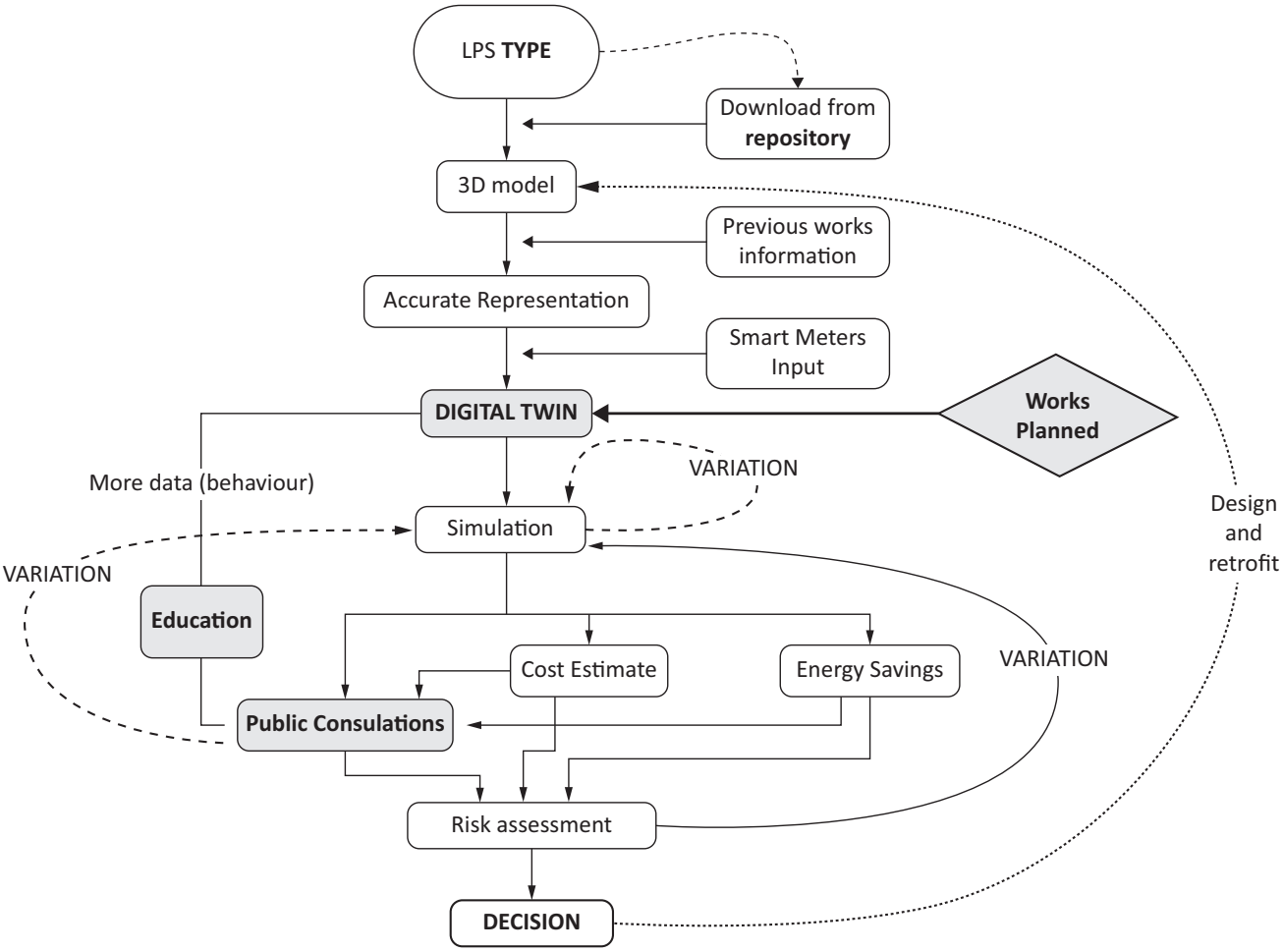

Figure 1. The DT process for LPS retrofit projects showing the directions of the information feed.

for wide consultation and information of all stakeholders allows for better decisions with lesser risks involved. Public consultation to demonstrate the advantages and disadvantages of each refurbishment option can be held as interactive workshops utilizing virtual reality simulation solutions. The added benefit of public participation is that it may help to generate trust and build up a reputation, as discussed by Baer-Pásztory and Bergmülle (2013), values which are at a lower level in CEE countries compared to Western Europe.

A big proportion of LPS buildings still require extensive modernization, as described by the Polish Building Research Institute (2019), including the upgrade of electrical and water systems, as well as ventilation systems—the process from Figure 1 consists in the following: The housing association decides to make the necessary upgrades to the system and orders an individualized building model from the template repository to plan all works using it and check for clashes and possible conflicts with occupiers, as well as the need for consultations, the ratio of works that are intrusive for inhabitants, and the potential risks. Thanks to this, all stakeholders are prepared for all consecutive works from the start and all potential conflicts can be resolved in virtual reality, reducing the duration and cost of works. Once the individualized model is created, it forms the base for the subsequent refurbishment projects. The model with the latest changes can be imported into the DT software and populated with data from smart meters, making it a virtual twin that always remains up to date. However, the refurbishment decision is a good trigger for the model's creation; it can be commenced at any stage of a building's life in anticipation of future modernization works.

We can predict that one of the next steps in the sustainability simulation might be the reduction in water consumption and the benefits of rainwater tanks for the building's water usage. Capable of assessing the amount of water saved by analysing weather report data from the previous years, a DT can precisely estimate the water savings, effectively helping future-proof entire estates.

There are many benefits of using the virtual twin technology. For example, an apartment owner who plans refurbishment can use a DT to track all implications of the works that may affect the building systems and structure. Changes in apartments may soon be done first on a virtual building, with subsequent simulations run on a DT educated by smart metering to advise on the appropriate timing of works to avoid disruptions to other users thanks to real-time electricity, elevator, and parking zone usage patterns. As dubious as it may seem,

similar technology is already used in the UK—constant analysis of the loads from smart meters readings provides information and makes it possible to adjust the power supply to car charging stations.

The considerable challenge for the countries of CEE is to reach the digital revolution threshold that has been crossed by Western economies in the last decade. As stated in *The Rise of Digital Challengers* (Novak et al., 2018, p. 6), "the digital economy of CEE countries accounts for 6.5 percent of GDP… but well behind Digital Frontrunners such as Sweden (9.0 percent)." In the same report (p. 12), digitalization is named "the next major growth driver" for CEE. In western economies—like the UK—50% of households will have a smart meter installed by the end of 2021 (Holder, 2020); similarly, the EPC (Energy Performance Certificate) is a requirement for all rental agreements since 2008 (Department for Levelling Up, Housing and Communities, 2007)—it creates a vast public database from which DTs can be fed data at the building-, estate-, or district-level. By comparison, in CEE these standards are falling behind due to the slow-paced voluntary action and a limited amount of information about the potential benefits of replacing standard meters with smart ones. Considering that there are areas in Eastern Europe where children do not have broadband sufficient for remote learning/home-schooling during the Covid-2019 pandemic, the CEE requires more time to close the digital revolution gap. However, this time should be used for the creation of template models in preparation for a future data influx, and secondly, the big factual and educational campaign prepared for familiar estates can be the key to a widespread digital revolution, following the logic of behavioural replication—if old panel system buildings receive smart meters, the newer developments will follow swiftly.

End-user education is yet another critical element of DT technology that has been identified during this investigation. There are two reasons behind it. Firstly, with knowledge comes an understanding of why digital technologies (like smart metering) are beneficial and should be implemented as widely as possible. Smart meters are not merely used for the convenience of the energy company but for the actual management of the energy usage and adjustment of behaviour to become more energy efficient. But data can only be managed if it is known—this is why constant updates on energy usage provided by a smart meter inside one's apartment, as well as a monthly bill, is a better incentive for behavioural changes than the bill alone.

The second aspect of education is even more critical than the first. This is to assure that the maximum energy saving is achieved for all thermal retrofit works—one that matches the estimates, at the very least. As described in extensive research by Galvin and Sunikka-Blank (2013), the less thermally efficient a building is, the better the user behaviour—the lack of thermal insulation is largely offset by users' everyday energy saving habits. However, the cited study revealed that once all thermal upgrades have been installed, the residents' energy-saving habits have deteriorated—the actual energy savings were 30% lower than the estimates due to detrimental changes in user behaviour. DT technology can help with reinforcing energy-saving habits as the technology enables the installation of interactive displays (large ones for a few buildings or smaller ones for each building's reception) on the estate premises to show a constant flow of energy to the given apartment and compare it to others in the building. Each inhabitant can also use a mobile app for that purpose. After the implementation of such solutions, constant feedback becomes an incentive to save more energy. Furthermore, policymakers would be limited only by their imagination in this area, e.g., they may organize wide range of contests for occupiers that might become a district tournament to constantly reinforce the residents' energy savings behaviours.

4. Conclusion

Thanks to the extensive use of typologies in LPS, the implementation of a 3D model-based DT technology, while initially time-consuming, is relatively uncomplicated, as 3D model templates can be widely applied. Meanwhile, the DT provides feedback on LPS retrofit at every stage, from design to operation, from cost estimations via public consultations to decisions, results, and future challenges, from energy performance and CO_2 reduction goals to utility grid planning and urban improvements. The longer the DT exists and the more data it receives, the more accurate the simulations become; as such, the sooner the technology is implemented, the better for any type of LPS building retrofit project.

As the DT constantly grows with the data collected, the technology itself develops further as well. Looking ahead, the implementation of DT technology prepares the LPS estates for future challenges like noise and light pollution and any others that might occur in the rapidly urbanizing areas in the future. New requirements will simply become additional attributes applied into the digital environment with the software providing calculations of simulated outcomes.

The retrofit measures, resident education, and installation of photovoltaic panels in places with the most sun exposure (such locations to be suggested by the BIM and DT simulation) give LPS buildings the potential to become energy-positive structures, which would help enormously with the climate change and air pollution that Eastern Europe currently struggles with.

Our study provides the foundation for a new way of thinking that helps with managing the change in digitalization in CEE. Since people are often afraid of the unknown, the familiar can lead the change—the digital revolution. But once the commonplace *panelák* ("panel building") becomes a smart and digital building, it may be easier to convince society to follow in its footsteps.

Additionally, it ought to help with the most important aspect of the sustainable future—the conscious user—as only through responsible decisions at every level will it be possible to resolve the issue of pollution plaguing our planet.

This analysis is the first output of a wider project researching the means of giving LPS estates a new lease of life and making them sustainable even by 21st century standards while helping with the digitalization of CEE's mid-life housing stock and its inhabitants. The next step is a pilot case study including the creation of a single building model to check all potential issues with derelict material characteristics, access to data, and potential issues with the simulations. That will be followed by a planned case study modelling a whole estate to review the possibilities and challenges of using the template library. Once these challenges are identified, the plan is to test the model during public consultations—the participation project which will clearly define the most pressing areas for improvement for the inhabitants. The final step, and the authors' aim, is the creation of a repository of model types and materials that would be an open-access tool used by teams from other countries working on separate systems with the exchange of experiences from specific lessons learned.

Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

Paulina Duch-Zebrowska is a researcher at the Faculty of Architecture, Gdańsk University of Technology. She applies extensive experience gained in her previous career in commercial architecture in her research projects aimed at bringing existing buildings to the current sustainability standard, as well as her scientific interest is in passive design and energy-positive buildings.

Katarzyna Zielonko-Jung is an assistant professor at the Faculty of Architecture, Gdańsk University of Technology. Her scientific interests focus primarily on issues connected to ecological architecture and urban solutions, and on the correlation between the shape of building development and microclimatic phenomena that occur within urban spaces, especially in terms of aerodynamic phenomena. She is the author and co-author of numerous publications, including the following monographs: *Combining Advanced and Traditional Technologies Within Ecological Architecture* (2012), *Contemporary Ecological Architecture* (2012), and *Shaping of Ecological Architecture in Urban Structure* (2013).

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 172–188
https://doi.org/10.17645/up.v6i4.4405

Article

Multiparametric Analysis of Urban Environmental Quality for Estimating Neighborhood Renewal Alternatives

Dalit Shach-Pinsly [1,*], Stefan Bindreiter [2], Idan Porat [1], Shai Sussman [1], Julia Forster [2] and Michael Rinnerthaler [2]

[1] Faculty of Architecture and Town Planning, Technion—Israel Institute of Technology, Israel;
E-Mails: dalitsp@technion.ac.il (D.S.-P.), idanpo@technion.ac.il (I.P.), shaisu@technion.ac.il (S.S.)
[2] Institute of Spatial Planning, Technical University of Vienna, Austria; E-Mails: stefan.bindreiter@tuwien.ac.at (S.B.), julia.forster@tuwien.ac.at (J.F.), michael.rinnerthaler@tuwien.ac.at (M.R.)

* Corresponding author

Submitted: 26 April 2021 | Accepted: 21 July 2021 | Published: 17 November 2021

Abstract
The neighborhood renewal process is an important opportunity to update the built environment; however, major changes to the built environment might decrease spatial performance and environmental quality. In these processes, there is a need to evaluate urban renewal alternatives, especially the quality of the environment, to understand the performance of the newly designed built environment. The quality of the built environment depends on a variety of aspects (such as walkability, energy level, security, open spaces, water permeability, etc.), several of which can be assessed using diverse measurements and evaluation models. Current new technological developments, based on GIS, enable the evaluation of diverse aspects of environmental quality and promote urban renewal decision-making processes. Urban renewal needs to harness these models in the decision-making approaches to improve assessment processes of urban renewal alternative estimations that consider future performance and quality of the built environment. In this article, we present a 3D-GIS multiparametric scenario analysis for neighborhood renewal alternatives estimation to evaluate the performance and quality of the built environment as part of the decision-making process. The multiparametric approach will include an evaluation analysis of several aspects of environmental quality, including walkability, accessibility, sense of security, energy, shade, water infiltration, visibility, and more. The analysis results will indicate the level of performance for each aspect as indices for environmental quality. The multiparametric scenario analysis for neighborhood renewal will be conducted on three renewal alternatives for one neighborhood in the city of Hatzor HaGlilit, Israel.

Keywords
3D-GIS; design alternative evaluation; Hatzor HaGlilit; neighborhood renewal; parametric analysis; urban environmental quality

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

Neighborhood regeneration processes are often difficult to promote in peripheral areas due to diverse aspects such as populations having a low socioeconomic status, economic factors (contractors' and entrepreneurial profits), low density, and more (Healey, 1995). However, many towns and cities located in peripheral areas experience population growth and aspire for urban regeneration of old city neighborhoods to be improved and updated. Therefore, there is a need to develop high-quality urban regeneration processes; moreover, there is a need to evaluate the performance and environmental quality of the newly developed neighborhood alternatives.

Over the last few decades, the quality and performance of the environment have become fundamental in urban planning and design (Carmona & Sieh, 2004; Cicerchia, 1996; Shach-Pinsly, 2010), aiming to evaluate and measure diverse aspects of environmental quality, such as security (Shach-Pinsly, 2019), visibility (Ortner et al., 2016), walkability (Leslie et al., 2007), and energy (Forster, 2016). Therefore, urban renewal decision-making processes must consider the environmental quality of the renewal area according to a variety of quality aspects and develop a multiparametric scenario analysis approach to understand the quality of the neighborhood to be built. In peripheral areas, it is particularly valuable to understand the urban performance of renewed areas, which is influenced by diverse environmental qualities. Therefore, in this research, we use a parametric analysis approach of multiple environmental qualities for understanding the outcome performance of the renewed urban environment.

Perry's "neighborhood unit" theory (Mumford, 1954; Perry, 2007) presented an important concept for the design of districts/neighborhoods within a city. The concept was an early diagrammatic planning model for organizing new residential communities as functional, self-contained neighborhoods in the early 20th century in industrializing cities. Questions relating to environmental quality were laid out as a fundamental basis; however, they were related more to safety and usage separation to provide better air quality for the residents.

1.1. Multiparametric Analysis, Decision-Making Processes, and Urban Renewal

Recent planning discourse has been characterized by concepts and approaches that emphasize aspects of sustainability, resilience, and compatibility. Often, these concepts build on previous ideas (e.g., Howard's garden city) and turn away from outdated principles (e.g., car-friendly city). Current concepts focus on a high building density and mixed land use so as to avoid urban sprawl and long distances for the provision of public services (e.g., education, work, shopping), as well as to ensure more efficient use of (energy) resources. Newer concepts additionally address other sustainability aspects, such as local material and energy flows, nature conservation, mobility reduction through mixed-use, and qualified densities to provide inhabitants with a better quality of life (Bibri et al., 2020; Cervero & Kockelman, 1997; Gaffron et al., 2005).

The scenario technique is a proven method for mapping and describing possible future developments against the background of different planning cases, trends, and framework conditions. This technique is well known in spatial planning; for example, scenarios have been used in urban and spatial planning in the fields of land development (Waddel, 2002), sustainable urban development, mobility research (Mitteregger et al., 2019), and technology impact assessment (Duinker & Greig, 2007). They are considered an established means of identifying development horizons (sometimes participatory) for cities and regions (e.g., scenario processes in Munich, Hamburg, Zurich, or Vienna in recent years). However, the innovation is the performance evaluation process. Although the planning scenarios aim to understand the spatial layout of the urban renewal outcomes, the performance and quality of the environment are hidden and invisible through this process. This usually occurs due to several reasons: lack of models and tools for measuring the quality of the environment, lack of understanding regarding which parameters influence diverse aspects of the quality of the built environment that affect the urban performance, and lack of models for integrating the performance analysis results into the urban regeneration process.

This research aimed to create a planning and decision-making process for neighborhood renewal based on multiparametric analysis that considers the environment quality and performance of the renewed area. The main objective was to determine parameters for evaluation based on (a) known parameters that influence the quality and performance of the environment, (b) available data, and (c) previous knowledge of analysis methods and tools. We reviewed diverse parameters and selected parameters that met these criteria, including parameters that relate to basic indicators such as building footprint, roof area, and green space, as well as performance indicators such as energy consumption, public transport, shaded area, solar potential, sense of security, walkability, and visibility.

This article will focus on the "boot" neighborhood in Hatzor HaGlilit and present three urban renewal alternatives for this neighborhood. Hatzor HaGlilit is located in the northern part of Israel. The town was founded in 1952 and housed immigrants mainly from North Africa. The "boot" neighborhood is characterized by middle-class mass housing, built in the 1950s and 1960s. In 2019, Hatzor HaGlilit had a population of 9,300, mainly religious-traditional Jewish.

2. Literature Review

Current urban regeneration strategies relate mainly to improving buildings, infilling new buildings within existing urban construction, demolishing old buildings, constructing new buildings, and integrating diverse communities into deteriorated locations (Carmon, 2001; Kleinhans, 2004). Different strategies for physical urban regeneration developed around the world show a diversity of models. For example, in the US, most urban renewal focuses on demolishing large-scale mass housing projects and transforming them into small-scale housing projects for mixed-income residents (Goetz, 2010). An urban renewal policy in England, the New Deal Communities, aims to renovate and improve existing public residences. Austria developed mixed-use areas with affordable housing known as "soft urban renewal"

(Huber, 2011). Porat and Shach-Pinsly (2019) aimed to improve urban renewal processes based on identifying post-World War II mass housing suitable for urban renewal. This model assists in improving top-down urban renewal processes with a wide view of the potential for mass housing stock to be renewed.

Middle-class mass housing projects were developed around the world and in Israel to settle refugee residents after World War II (Shadar, 2009). Currently, a large portion of these housing buildings are old (50–70 years old) and do not meet current construction requirements (such as building materials, small apartment sizes, infrastructure systems, etc.); thus, many of these neighborhoods need to go through a process of urban renewal to provide higher quality for residents (Carmon, 1998). Physical urban regeneration is one of the main aspirations of city regeneration (Jeffry & Pounder, 2016); however, there is a lack of knowledge regarding the quality and performance of the renewed area (Carmona, 2019).

Most middle-class mass housing in Israel is developed based on the "international style," with similar methods and tools to those used for development in Europe (Shadar et al., 2011). The "international style" building typology includes block housing with clear, straight geometrical lines and flat roofs, as developed in Hatzor HaGlilit. Because of low budgets, the buildings' quality was reduced, resulting in poor physical condition of apartments for residents from low socioeconomic situations (Shadar et al., 2011).

Current urban regeneration in Israel focuses on three main strategies: (a) condensation by adding single-bedroom apartments to buildings to increase land efficiency, (b) demolishing and redeveloping construction by increasing building rights, and (c) strengthening buildings against earthquakes using the newly developed General Master Plan No. 38 (Planning Director, 2005) by adding two to three apartment floors to existing buildings or by demolishing and redeveloping new buildings with increased building rights.

Much of the urban renewal research on mass housing is based on sociological analysis to identify specific urban sites (Apparicio et al., 2008). The urban regeneration strategy relates mainly to individual buildings at a site and to social aspects and does not consider the performance of the developed site. Currently, there is a shift toward new challenges of mass housing regeneration for policymakers and decision-makers, as well as growing involvement of the public sector for large-scale neighborhood urban renewal projects (Cunningham & Sawyer, 2005; Porat & Shach-Pinsly, 2019). Methods and tools for evaluating neighborhoods' environmental quality have been further developed and spread since the beginning of the 21st century. There is a need to understand the quality of the built environment due to its influence on the deterioration of public space (Carmona & Sieh, 2004); however, currently, there is no comprehensive evaluation process for the physical master plans (Waldner, 2004). Carmona and Sieh (2004) and Carmona and Magalhães (2007) developed a multi-quality analysis tool—positive-local-qualities—which summarizes a wide range of environmental dimensions that influence the quality of the environment, including the amount of planted green areas and foliage, security, accessibility, economic vitality, and more. Furthermore, Carmona (2019) measured the quality in public open spaces and the value of the built environment in relation to health, society, economy, and environment, using the "place quality" tool, aiming to expose the role of design in influencing the quality of the environment. Talen (1996) showed that the planning program and its implications are used in relation to a particular dimension, such as the functionality system that influences the planning appendices or planning instructions, etc. Forster (2016) defined visualizations as important tools in planning, as well as in estimating "impacts of planning measures before their realization" (Talen, 1996, p. 73). Shach-Pinsly and Porat (2016) evaluated the planning of master plans based on a place-based identity versus iterative top-down and bottom-up approaches. Walkability measures the ease of walking in a defined area. In addition, diverse researchers connect walkability with better health, and environmental and economic benefits (Florida, 2014). Several factors influence walkability, including quality of walking routes (sidewalks and footpaths), pedestrian rights-of-way such as good crosswalks, land use patterns, sense of safety, and security (Bain, et al., 2012). Furthermore, it is important for developing sustainable urban planning and design and improves quality of life (Shelton, 2008). Several models aimed at evaluating walkability, including that of Frank et al. (2010), who developed the walkability index for understanding quality of life. Leslie et al. (2007) developed a model for discovering environmental attributes relevant to the walkability of local communities. Shach-Pinsly (2019) developed the "security rating index" (SRI) for analyzing secure and unsecured urban areas to integrate these outcomes in the planning process. The concept of performance-based energy (or building) codes (Cruz & Abreu, 2017; Foliente, 2000; Hui, 2002), or safety codes (Tavares, 2009) attempt to provide clear guidelines (e.g., energy or fire safety codes) for building development that takes into consideration the complexity of the building designs. In this sense, there is difficulty in understanding the complexity of the urban environment design. Furthermore, Shach-Pinsly and Capeluto (2020) introduced the concept of "performance-based codes" for understanding the role of performance in the planning process and how it can be integrated into the planning and design process. In this research, we introduce a new approach that associates the performance-based codes concept with evaluating different alternatives for the urban renewal process.

Over the last few decades, evaluation tools have been developed and mainly used to evaluate whether diverse buildings and neighborhoods have been successful as sustainable development goals (Sharifi &

Murayama, 2013). For example, LEED-ND promotes green neighborhoods that reduce vehicle miles, increase public transport, and include green building infrastructure by developing a rating system for design, construction, operation, and maintenance (Szibbo, 2015). BREEAM (UK) is a system for rating and evaluating a range of environmental issues such as ecology, health and well-being, and waste, among others, based on sustainability metrics and indices; it also focuses on neighborhood development (Sharifi & Murayama, 2013). Neighborhood 360° is a rating system tool that aims to promote quality, healthy, and livable development and design for better and more prosperous neighborhoods based on points given for the entire project (The Israeli Green Building Council, n.d.). The city resilience index (Fitzgibbons & Mitchell, 2019) assesses cities to monitor and measure factors contributing to city resilience. However, these models are mainly rating-based methods and not planning-based ones. The analysis is performed on a large scale and does not go into the planning and program details. The overall score is characterized by categories so that the overall quality of the plan can be understood, but spatial/visual analysis of the quality of the environment is lacking.

Such complex issues are among the most important challenges in spatial planning. Schönwandt (1999) and Selle (1997) described the need for cooperative processes in which visualization and planning support tools are used. They serve as important communication tools to be able to prepare data for different target groups in a comprehensible way and to depict different professional perspectives on complex problems. Socially and gender-relevant aspects can also be considered, as D'Ignazio and Klein (2020) showed. Digital methods help to structure such complex problems, as well as their sub-aspects.

3. Methodology

3.1. Methodology Framework

The research aim was to develop a comprehensive evaluation process for urban regeneration decision-making based on quality and performance analysis of the developed area. The methodology is based on the integration of analysis knowledge for evaluating the quality and performance of the built environment developed by an international team from the GIS Lab, Technion—Israel Institute of Technology, and the Simlab (Spatial Simulation Lab of Vienna University of Technology). The researchers aimed to demonstrate a comprehensive performance assessment of the "boot" neighborhood in Hatzor HaGlilit, Israel. The project area selection was based on former studies and research developed at a planning studio (Ulpan 2, 2019), which showed the need for further research and involved the proposal of explicit development paths and concrete instructions for action.

Three urban renewal alternatives were developed for the "boot" neighborhood: (a) preserving the current spatial design, (b) promoting the real-estate level of the neighborhood, and (c) promoting social and community performance. The alternatives analysis aimed to understand the quality and performance of each alternative by assessing 15 environmental quality parameters, including basic indicators—e.g., roof area (potential area for photovoltaic [PV]), green areas, and paved (public) roads—and performance indicators—e.g., public transport, shaded areas, walkability, and sense of security. The basic research assessed key aspects of the area—e.g., current spatial and landscape features, cultural value, environmental and economic conditions, sociodemographic context, and regional/local policies for development of the area—followed by a quality and performance analysis of the urban regeneration alternatives for the area.

The flow of the research was as follows (see Figure 1):

a. Develop three urban renewal alternatives for the "boot" neighborhood;
b. Analyze each alternative according to the 15 environmental quality/performance criteria;
c. Obtain results of each quality/performance criterion for all three alternatives;
d. Urban regeneration decision-making based on multiparametric alternatives analysis;
e. This current research relates to the design of the urban environment from the point of view of the planner and the scale of a master plan, and not from the architectural scale. The main importance was to understand the possibility of adding layers of evaluation to the process of urban renewal for a better development decision-making process for a neighborhood. Therefore, the selection of indicators is adjusted to the neighborhood scale.

3.2. The "Boot" Neighborhood in Hatzor HaGlilit

Perry's "neighborhood unit" concept (Mumford, 1954; Perry, 2007) employs a variety of social and physical design principles, among them separation of vehicular and pedestrian traffic, arterial boundaries defining the inward neighborhood cell, neighborhood radius of a one-quarter mile, sizing the neighborhood to sufficiently support a school, and including between 5,000 to 9,000 residents.

The "boot" neighborhood is located in the southeastern part of Hatzor HaGlilit and is shaped like a boot, hence its name (see Figure 2). The area of the neighborhood is about 13 ha and is relatively flat and walkable. The housing density is six to 10 housing units per 1,000 m². The city bus stops are located on the main axis of the neighborhood.

This is one of the first neighborhoods built in the city in the 1950s and includes residential buildings of a variety of types: private and semidetached houses adjacent to each other with relatively wide-open spaces between

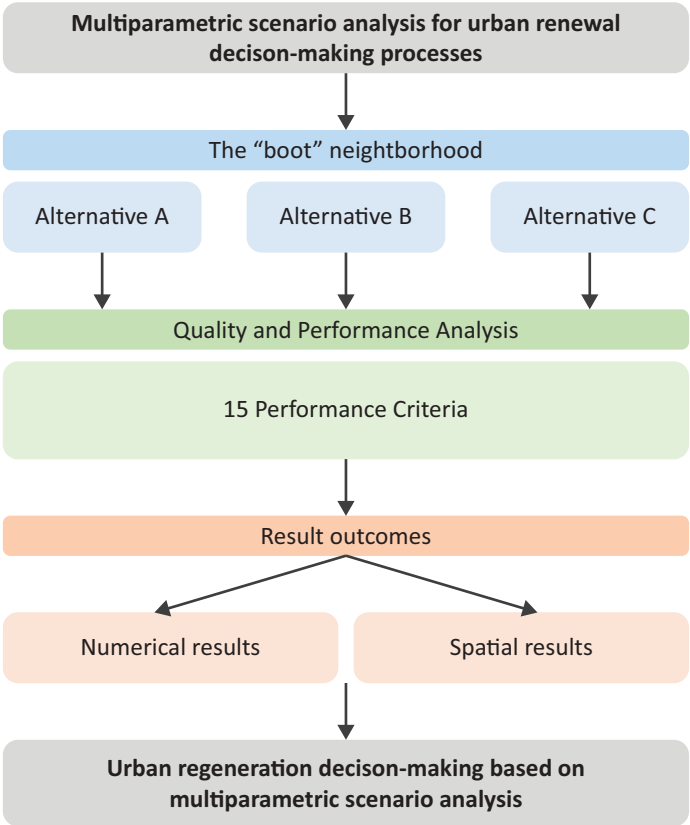


Figure 1. The research's flow.

them, three to four stories high public housing arranged in diverse layouts with wide patios between the buildings, H-shaped buildings, and parking lots for some of the buildings. The distribution layouts of the building create the sense of a low-density area with vast open areas. The neighborhood contains a number of commercial and public buildings distributed in various locations and includes health care, a community center, community

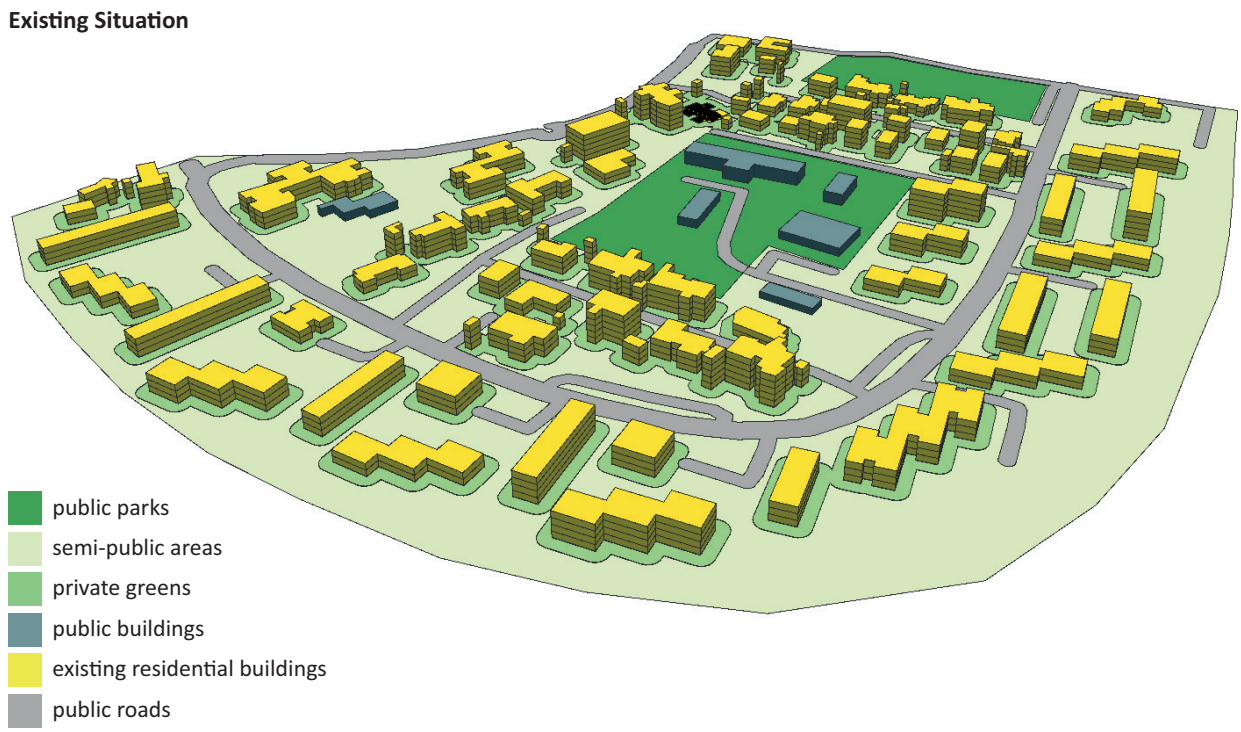


Figure 2. Current status of the "boot" neighborhood in Hatzor HaGlilit.

police, a synagogue, a kindergarten and nursery, an elementary school, and a high school.

The neighborhood's population consists of immigrants from North Africa and Romania, mainly traditional-religious, who immigrated to the country in the 1950s and 1960s, as well as residents who immigrated from the Soviet Union during the 1990s. Today, the neighborhood has around 2,800 residents. The entire population lives in about 900 housing units (around 3.1 persons per household). Hatzor HaGlilit belongs to cluster four (out of 10) of the socioeconomic index. The unemployment rate is 6.8%. The average wage is 23% lower than the state average and is around 8,000 ILS.

3.3. Scenario Alternatives Development

To understand the influence of urban renewal on a defined area, different themes/directions of urban renewal need to be developed. Therefore, we are introducing three urban renewal alternatives that represent the different themes/directions: (1) "the economic alternative," that strengthens real estate aspects based on defined compact and a repetitive urban typology for efficient land use development; (2) "a community alternative," an urban morphology that promotes community relations based on common public areas between buildings; and (3) "business as usual," preserving the existing structure with infill construction and the construction of additional floors. The differences between the urban alternatives are regarding the residential buildings' layout and types; none of the alternatives involves changes in the commercial/service/amenities buildings and main streets in the area.

3.3.1. The Economic Alternative

This alternative was developed based on superblock buildings, of between two and five floors, along the main road of the neighborhood. In the main area, there are single residential buildings, seven floors high, located around the public buildings and open spaces (see Figure 3).

3.3.2. The Community Alternative

Alternative 2, which promotes social and community performance, is structured by 21 compounds of residential buildings, each with two buildings: an L-shaped-four-to-five-floor building around a single seven-story building. These compounds lay on both sides of the main road and surround the commercial/service buildings and wide-open space in the central area of the neighborhood (see Figure 4). The article does not deal with the population; however, some studies show that physical characteristics contribute to community performance (Ewing & Clemente, 2013; Papas et al., 2007). Therefore, we emphasize social performance based on measuring parameters that influence social and community performance, as internal visibility (eyes on the street for personal security), sense of security, walkability, and shade (very important for the community's performance in Israel's hot climate). These urban parameters are significant for social and community relations.

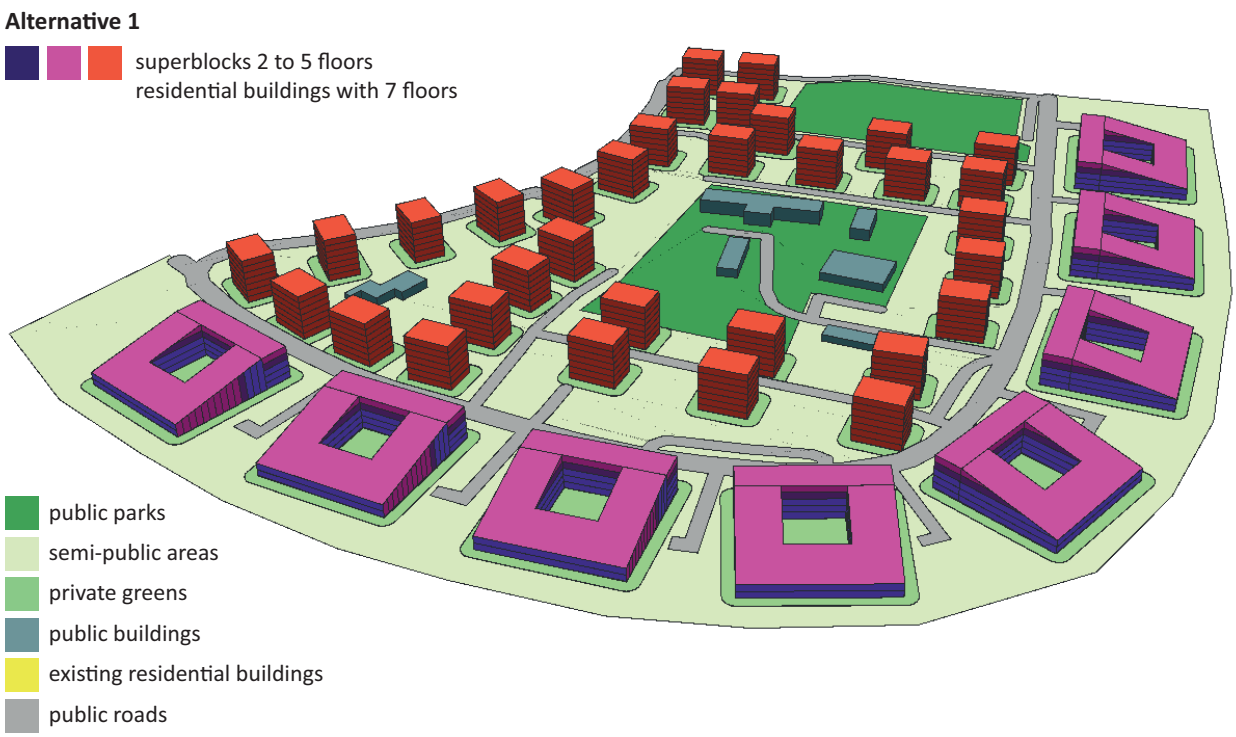


Figure 3. Alternative 1: "Economic alternative," promoting the real-estate level of the neighborhood.

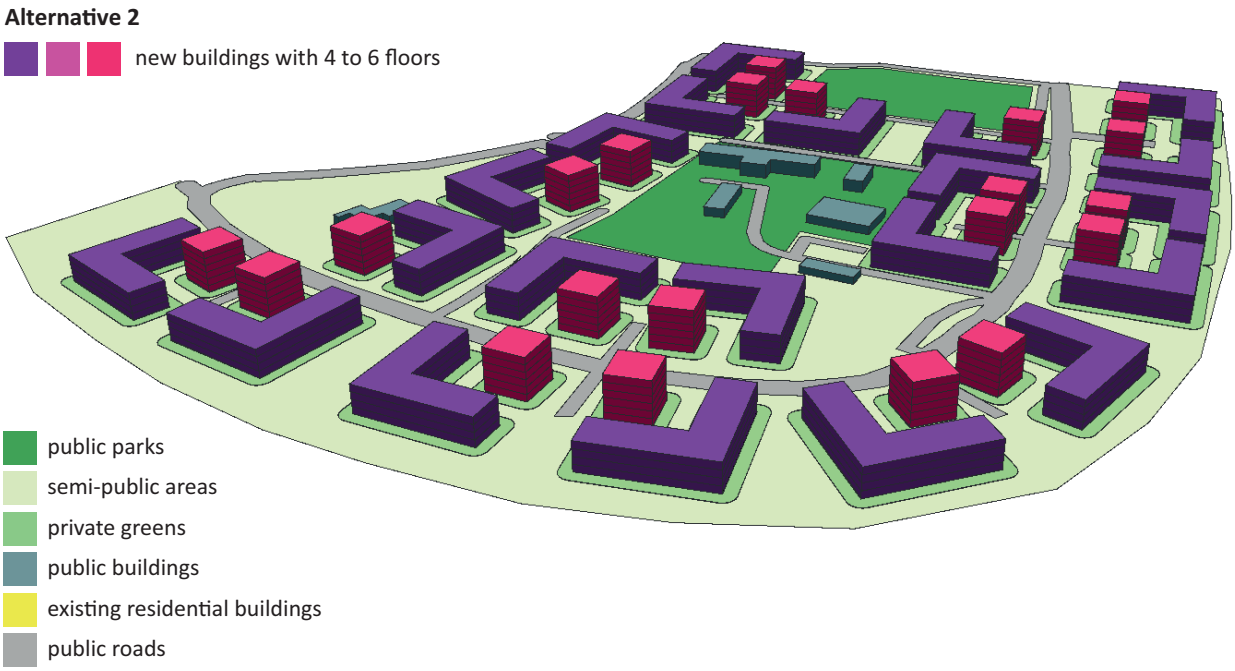


Figure 4. Alternative 2: "Community alternative," promoting social and community performance.

3.3.3. Business as Usual: Preservation of the Previous Design

This alternative aims to keep the main layout of the neighborhood as is; however, in this alternative, new buildings are incorporated into the open spaces using the infill practice, including increasing each building's height by two to four floors, keeping the buildings' floor shapes/sizes, and reducing and redefining the open public spaces between them. The height development is gradual: lower towards the outer parts, higher next to the street and on the other side of the street, and lower next to the public buildings (see Figure 5).

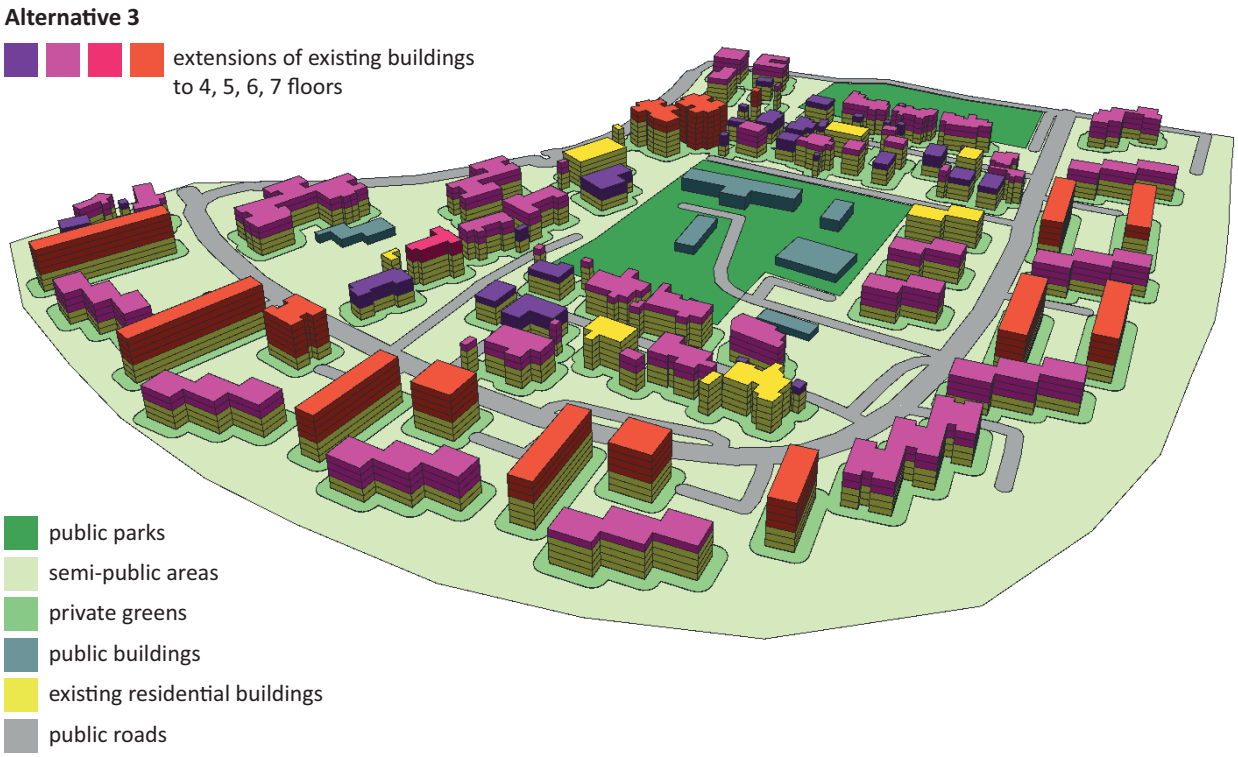


Figure 5. Alternative 3: "Business as usual" (preservation of previous design with additional floors).

3.4. Indicators

To evaluate the quality and performance of these alternatives, we determined 15 measurable criteria, defined based on available data and evidence-based models, and tools for measuring the criteria. They are divided into two groups: basic indicators (Table 1, essential characteristics and key figures of the urban design) and performance indicators (Table 2, evaluating qualities of the design with regard to the ecological sustainability and quality of the environment criteria).

The analysis was developed in a small peripheral neighborhood of low-medium socioeconomic status. Most residents mainly travel within the neighborhood, using public facilities (schools, kindergartens, local commerce, etc.), carrying out errands mostly on foot. Designing the renewal of a neighborhood requires an understanding of how to measure several indicators: (a) Community resilience indices: green open areas, use of local energy, public transportation, surface runoff, and flood prevention, shade (vital for the hot Israeli climate); (b) walking through the neighborhood (walking paths) and walkability (independence from private vehicles); (c) personal sense of security; and (d) internal visibility (eyes on the street within the neighborhood) which contributes to security and a sense of community in the neighborhood. In this sense, walkability and walking quality within the neighborhood are important. However, walking out of the neighborhood towards the city remains the same for all alternatives; therefore,

Table 1. Basic indicators.

#	Quantitative Parameters and Indicators	Description
1	Total Project area (in m²) 1.1. Building plot area (in m²)	Total area including building plots, public roads, and public parks Building Plot Area (1.1) = Total project area (1) − Roads (5) − Public green spaces (4.3.)
2	Building Footprints (in m²)	Residential and public buildings footprint, housing units, gross-floor-area (GFA), and gross-floor-area ratio (GFAR, gross-floor-area/size of building plots).
3	Roof Area (in m²) 3.1. Potential area for PV	Roof area is equated with the building footprint. Roofs can be used for green roofs and/or PV modules. We assumed that 70% of roof area can be used for these purposes.
4	Green Areas (in m²; potentially unsealed) 4.1. Private greens 4.2. Semi-public greens 4.3. Public greens	Green Areas = Total area (1) − roads (5) − building footprints (2) − parking (6) Private greens (4.1.) = Courtyards + 5 m buffer around residential buildings Semi-public greens (4.2.) = Building plots (1.1) − building footprints (2) − private greens (4.1) − parking (6.) Public greens (4.3.) = Area of existing parks in m²
5	Paved (public) Roads (in m²; potentially sealed area)	Street areas, not including private access roads and paths on building lots.
6	Parking (in m²; potentially sealed area)	Resident parking: One lot (25 m² according to Neufert & Neufert, 1992/2009, p. 403, Table 12) per residential unit on building lots. Public parking: 0.5 lot/residential unit spreading along public roads.
7	Sealed Area (in m²)	Sealed areas = Building footprints (2) + Roads (5) + Parking spaces (6)
8	8.1. Expected power demand (in kWh) 8.2. Compactness measure of building forms	Expected Power demand (8.1.) = GFA (2.4) × average annual power demand/sqm: 93.5 kWh according to Hassid (2019, p. 42, Figure 3A). Reducing the surface area of a building envelope can help reduce energy consumption in the building and reduce the materials (and connected environmental impacts) used in the envelope's construction. The shape factor $\gamma = \frac{S}{S_{min}}$ shows the surface-to-volume ratio of the buildings based on the concept of a compactness measure of sustainable building forms by D'Amico and Pomponi (2019). A value of 1 shows the "optimum" ratio of volume to surface. The GFA-weighted average of γ of the design is shown.

Note: General description and key values of urban designs.

Table 2. Performance indicators.

#	Performance Indicator	Attribute Value Range to Points				
		5	4	3	2	1
9	Public transport: Quality of service The assessmentis based on the Austrian adaption (Schwillinsky et al., 2018) ofthe Swiss evaluation system of public transport quality (ARE, 2011). Attribute values of analysis method range from A (good) to G (nonexistent public transport system), intervals, and timetables (Nateev Express, n.d.).	A	B	C	D	E, F, G
10	Infiltration potential (IP) IP is determined via the rainwater drainage and the respective runoff coefficients (DIN 1986–100:2016-12) ofthe surfaces using an adapted formula from German/European Standards DIN EN 12056–3 and DIN 1986–100, respectively Austrian Standard Ö-NORM B2501:2015. The indicator shows the extentto which a scenario achieves the optimal IP (complete unobstructed and unsealed surface) in the project area.	>90	>80	>60	>40	≤40
11	PV potential (on roofs) is calculated from solar radiation data provided by the Photovoltaic Geographical Information System (European Commission, 2019a, 2019b) and shown in percentage of energy consumption of expected inhabitants; it depends on the efficiency of PV modules (e.g., ENF Solar, n.d.; Photovoltaik.org, 2020) and available roof area.	>90	>80	>60	>40	≤40
12	Shaded areas Shaded areas are measured at noon hours ofthe average hottest days (15th July and 15th August at 11 am and 4 pm) ofthe year. The size ofthe shaded areas is compared to the size ofthe project area minus the building footprints.	>60	>53	>46	>39	≤39
13	Walkability The walkability index is measured by analyzing and integrating four parameters: building density, entropy index, mixed-use, and junction density, based on Feng et al. (2010) and Frank et al. (2010). The rates range from one (very low walkability) to five (very high walkability). The integrated walkability index is the percentage of cells/pixels with a high or very high walkability index.	>40	>35	>30	>25	>20
12 + 13	The shade parameter will be added to the walkability index to understand the "quality walk" spatially and numerically.	>60	>53	>46	>39	≤39
14	Sense of security The sense of security is measured using the SRI (Shach-Pinsly, 2019), a GIS-based model to identify secure and unsecured urban areas in a city. The system is based on measurements of urban elements that influence the sense of security in the built environment: mixed usage, building proximity, streetlights, the distance between junctions, and the number of intersections. The rates range from one (unsecured areas) to five (secured areas). The SRI is the percentage of cells/pixels with a high or very high secured index.	>40	>35	>30	>25	>20
15	Visibility (eyes on the street, internal visibility) Internal visibility is measured by calculating all sightlines from each floor level toward the neighborhood open space, public and private, based on Shach-Pinsly, (2010), where the darker areas mark the most visible areas (5) and the lighter areas mark the less visible areas (1). The integrated internal visibility index is the percentage of cells/pixels with a high or very high internal visibility index.	>40	>35	>30	>25	>20

it was not included in the calculations. The methods and tools used for measuring the quality indicators (e.g., security, visibility) were based on validated tools.

In this research, we only measured internal visibility. We based the analysis on Shach-Pinsly (2010), where the internal visibility of a compound building area was measured. For the internal visibility analysis, we simulated windows in the three-dimensional façades (streetscape) facing the inner open spaces of the neighborhood. The outcome of this analysis shows that the public open areas are most visible from the building façades, and there is the possibility of "eyes on the street" in the neighborhood. Walking paths relate to the walking routes used by pedestrians to access different areas of the neighborhood. Walking paths enable better walking accessibility for pedestrians to diverse areas and usages in the neighborhood. In such residential neighborhoods, people mainly prefer to use the shortest walking path, and, in a hot climate such as Israel's, people prefer to walk on the shaded side of the walking paths/streets; both aspects are mainly influenced by the urban morphology, trees, etc.

The morphological typology of an area highly affects the performance and quality of the urban environment metrics. Therefore, the analysis was based on physical metrics for understanding the existing and renewed performance of the measured neighborhood for current and future residents. There are additional metrics that relate to residents' preferences in a neighborhood, usually drawn from questionnaires. However, the urban renewal alternatives intend to triple the neighborhood's population; thus, there are unknown residents whose opinions cannot yet be determined.

The tools for analyzing quality and performance aspects were validated in previous research: The sense of security analysis is based on the SRI tool that was developed and demonstrated in Shach-Pinsly (2019) and Shach-Pinsly and Ganor (2021) and was validated on the case studies of Tel-Aviv (Israel), Portland (US), and the Hadar neighborhood, Haifa, Israel. Furthermore, walkability analysis and validation were based on Feng et al. (2010) and Frank et al. (2010). Shade analysis is a widespread method for understanding the amount of shade in a particular place/area, as is shown in Rafiee et al. (2014) and in ESRI analysis tools. In order to estimate the energy consumption for the different designs, Granadeiro et al. (2013) and Depecker et al. (2001) have developed concepts that can be calculated using simulation software such as the US Department of Energy's EnergyPlus (US Department of Energy, 2021). In the work of Hassid (2019), the annual energy consumption per square meter. was determined for a reference building in the study region, which forms the simple basis for the extrapolation in our work. Currently, there are diverse visibility analysis methods and tools used for visibility evaluation. For this research, we based the internal visibility analysis on Shach-Pinsly (2010) since this study measures the internal visibility of a building compound or neighborhood.

4. Results

In the following section, Tables 3 and 4 show the respective indicators and key figures for the concrete variants described. The tables are followed by explanations of the selected indicators.

Further explanations and discussion on the results for Tables 3 and 4 follow:

Indicators 8 and 8.1: The estimated energy consumption is determined from average values and does not consider the structural implementation of the designs, household sizes, and user structure. The basis for calculating the expected energy consumption are the average values of the two simulations (ISO 13790, EnergyPlus) for the energy consumption for cooling and heating in kWh/m² of a reference building for the region around Hatzor HaGlilit carried out by Hassid (2019, p. 42, Figure 3A). However, the geometric analysis of the indicator 8.2—surface-to-volume ratio—provides a simple marker of the inherited efficiency of the design and indicates that the expected power demand will be higher, as calculated in 8.1. The reference building has got a $\gamma = 1.03$, which is close to the optimum of 1.

Indicator 9: Quality of service of the designs does not vary much as designs do not change the location and available services (modes of transport, intervals, local and regional connections) at public transport stops.

Indicator 10: Whereas all design scenarios using the BAU variant 10a (water impermeable standard materials for roofs and parking) show poor performance, the more water-sensitive urban design variants (10b, c, and d) using grass pavers, green roofs, or both, reach up to 81% of the theoretical optimum ($Q_{[umin]}$ runoff 859 l/s) as illustrated in Figure 6a. The influence of green roofs on the balance of sealed and unsealed surfaces can be seen with the naked eye in Figures 6b and 6c.

Indicator 11: The PV potential includes only the roof areas, as no investigations were carried out in the course of the study regarding the radiation of façades, materials, and the surroundings. Due to the low level of detail of the designs, potential areas for further PV installations (shading elements, façades) could not be considered in the calculations.

Regardless of the individual design, some indicators and characteristics have proven essential for high urban and ecological demands: Parking spaces account for a very high proportion of space in all variants, almost a quarter (21%) of the total project area. The design of these areas offers considerable potential regarding avoidance of heat islands and improving IP. Parking garages should be implemented in the designs to reduce sealed areas as

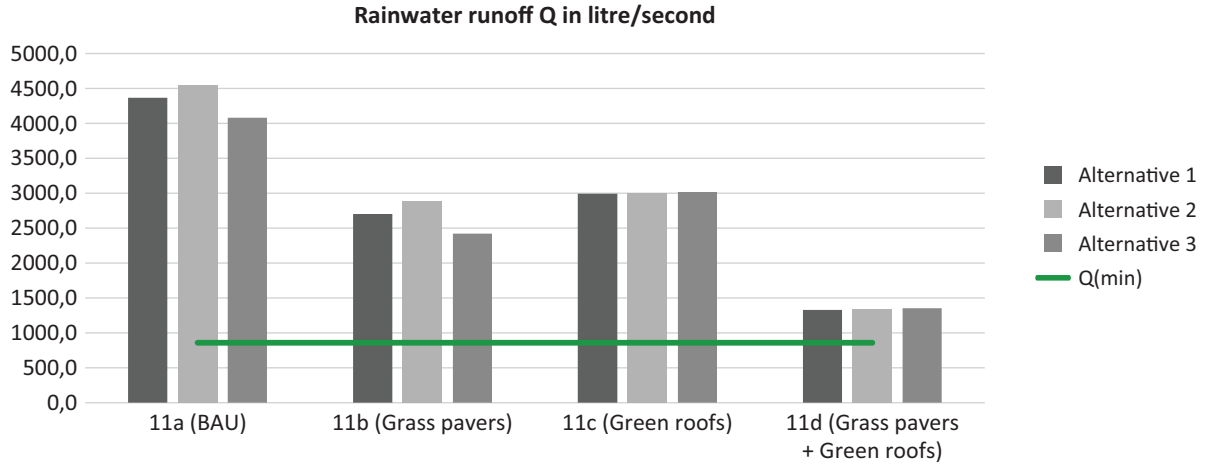
Table 3. Results: Basic indicators.

#	Basic Indicator	Existing Situation	Alternative 1	Alternative 2	Alternative 3
1	Total Project Area (in m²)	168,415	168,415	168,415	168,415
	1.1. Building plot area (in m²)	129,494	126,417	129,114	129,494
2	Building Footprints (in m²)	25,313	31,861	35,644	25,313
	2.1. Residential buildings footprint	22,886	29,434	33,217	22,886
	2.2. Housing units	900	1,425	1,425	1,425
	2.3. Public buildings footprint	2,427	2,427	2,427	2,427
	2.4. GFA	73,755	141,588	187,013	129,522
	2.5. GFAR	0.49	1.12	1.45	1.00
3	Roof Area (in m²)	22,886	29,434	33,217	22,886
	3.1. Potential area for PV	16,020	20,604	23,252	16,020
4	Green Areas (in m²; unsealed area)	86,335	79,742	78,490	86,335
	4.1. Private greens	34,858	27,539	30,065	34,858
	4.2. Semi-public greens	46,823	31,391	27,780	33,698
	4.3. Public greens	17,779	20,811	20,644	17,779
5	Paved (public) roads (in m²; sealed area)	21,179	21,224	18,693	21,179
6	Parking (in m²; sealed area)	22,500	35,625	35,625	35,625
7	Sealed area (in m²)	68,992	88,710	89,962	82,117
8	8.1. Expected power demand (in kWh)	6,896,093	12,485,055	16,732,269	11,356,842
	8.2. Compactness measure γ	1.247	1.249	1.202	1.304

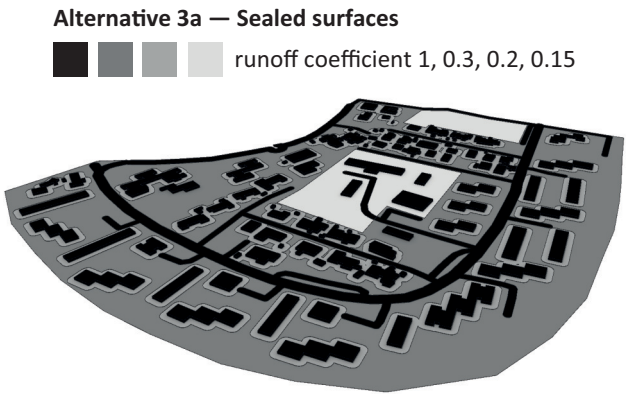
Note: Differences between the building plot area sizes in the scenarios arise from the fact that the properties are connected differently by public roads.

Table 4. Results: Performance indicators of design alternatives.

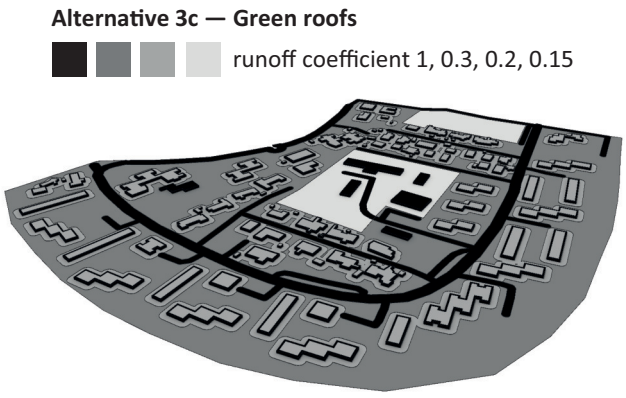
#	Performance Indicator	Existing Situation	Alternative 1	Alternative 2	Alternative 3
9	Public transport: Quality of service	D	D	D	D
10 a	IP business as usual (BAU): Rain runoff/ drainage (Q) in liters/second (l/s) on the project area (% of optimum)	3,777 l/s (58%)	4,366 l/s (50%)	4,551 l/s (47%)	4,083 l/s (54%)
b	Q Parking: Grass pavers with frequent traffic loads (e.g., parking lots; % of optimum)	2,727 l/s (73%)	2,703 l/s (74%)	2,889 l/s (71%)	2,421 l/s (78%)
c	Q Green Roofs: Extensive greening, from 10 cm build-up thickness (≤ 5°; % of optimum)	2,709 l/s (74%)	2,992 l/s (70%)	3,001 l/s (69%)	3,015 l/s (69%)
d	Q Parking and Green Roofs: Parking and Green Roof variants combined (% of optimum)	1,659 l/s (89%)	1,330 l/s (93%)	1,339 l/s (93%)	1,353 l/s (93%)
11	PV potential (in kWh; % of assumed total energy consumption in 8.1.)	4,994,377 (72%)	6,422,501 (51%)	7,248,136 (43%)	4,994,377 (44%)
12	Shaded area (m²) Shaded area (%)	31,533 19%	70,634 42%	76,200 46%	56,787 34%
13	Area of walking paths (m²) Area of walking paths (%) Relative walkability score (based on Feng et al., 2010; Frank et al., 2010)	65,916 39% 0.69	58,572 35% 0.7	49,392 29% −1.39	65,916 39% 0.69
12 + 13	Area of shaded walking paths (%)	13%	25%	32%	14%
14	Sense of security	46%	22%	29%	46%
15	Visibility (internal visibility, eyes on the street)	11%	48%	44%	39%



(a) Total rainwater runoff Q for design scenarios and variants in project area.



(b) Alternative 3a (BAU).



(c) Alternative 3c (Green Roofs).

Figure 6. Total rainwater runoff for design scenarios and variants in project area (a) and exemplary graphic display of IP of sealed and unsealed areas of Alternative 3 as BAU (b) or with green roofs (c).

it has a great influence on water-sensitive urban design (performance indicator 11; see comparison of variants 11a to 11d). Figure 7 demonstrates the spatial analysis for indicators 12 (shadow), 14 (sense of security), and 15 (internal visibility, eyes on the street) for all alternatives.

The spatial analysis in Figure 7 shows the different layouts of the indicator outcomes over the alternatives. The analysis shows similarities between several hot spots of the internal visibility and the security analysis. For example, in Alternative 1, at the eastern-lower part and the eastern-northern part of the plan, there are safer areas with relatively easily walkable areas and a walking path with shadows (see Table 4). In this research, we measured shade from the buildings; however, additional vegetation should be added and has the potential to increase the shaded area for walking and as a whole.

5. Conclusions

The neighborhood renewal process is an opportunity to increase the performance and quality of the urban environment for its present and future residents and for urban functionality. The neighborhood renewal process can also threaten the neighborhood's quality, gentrification, social separation, and community segregation. There is much to gain and much to lose in the process of neighborhood renewal. To increase opportunities and decrease threats, planners and decision-makers need to act and design according to values, available data, and indicators. They should understand the quality of the environment, the existing or developed neighborhood, and its influence on urban performance for the benefit of the community.

The performance-based codes (Shach-Pinsly & Capeluto, 2020) aim to integrate performance analysis into the planning and design process. In this research, we demonstrated this line of analysis in one neighborhood based on several selected indicators. We analyzed the spatial performance of an existing neighborhood, as well as three urban renewal alternatives. Our analysis focused on the performance measures, walkability, public transportation, IP, solar potential, sense of security, shade, and internal visibility. This range of spatial quality performance indicators could assist planners and decision-makers in assessing and estimating neighborhood renewal alternatives.

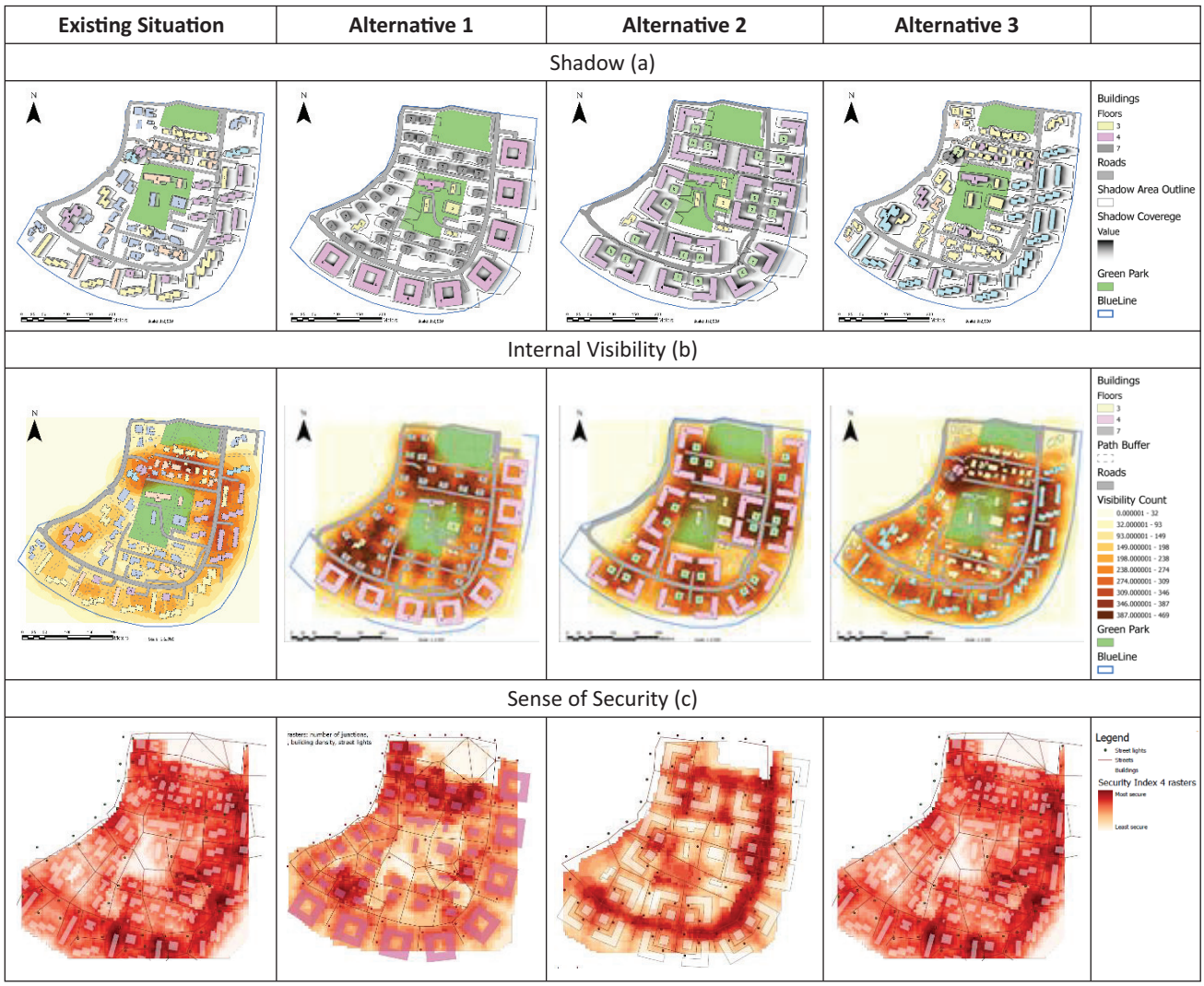


Figure 7. Noon hours of the average hottest days (15th July and 15th August, 11 am and 4 pm): (a) shadow analysis, (b) Internal visibility (eyes on the street); and (c) sense of security based on the SRI (Shach-Pinsly, 2019).

Through the analysis in this article, we calculated and showed the spatial quality differences in a range of neighborhood design alternatives. Results, focused mainly on inner open public residential areas, show that the area of shaded walking paths increased by 19% and internal visibility by 37%. Although the most secured areas relatively decreased by 24% and remained the same as Alternative 3, these areas were more focused in inner residential areas, and large areas of the renewed alternatives show medium levels of sense of security. The IP decreased down to minus 11% but can be optimized (up to more 40%) in all designs by choosing water-permeable surfaces. The higher energy demand of more housing units reduces the relative PV potential (down to minus 29%). Other indices remain with no significant change. The differences between alternatives and the original state may be considered as differences in the quality of the scenarios.

Since the applied tools have been validated in previous research, we can rely on these validations. Based on this authentication, we developed the comparative evaluation for establishing the decision-making/evaluation process. Interestingly, we found a correlation, for example, between visibility analysis and security analysis. Currently, the planning system in general, and urban characteristics in particular, lack tools for evaluating quality and performance parameters; therefore, here lies the importance of this research and the need to develop a performance analysis framework as a basis for decision-making. Based on the analysis results, inherent weaknesses and strengths of the urban renewal designs can be identified and addressed at an early planning stage and serve as basic data for planning decision making when estimating future neighborhood regeneration performance and its effect on the society and community. It is important to note that there is no "perfect" or "optimal" neighborhood design; rather, there are different alternatives with a range of qualities to estimate.

The method used is suitable for the rapid assessment and comparative evaluation of design alternatives. The multiparametric analysis allows one to understand the relationship between the different qualities and

better understand the performance of the built environment. Currently, many evaluation models offer a numerical index without a spatial layout. Integrating numerical indexes and spatial indexes allows one to better suit the morphology design of the neighborhood, resulting in higher levels of quality and performance. For example, designing shaded and secured walkways located in diverse neighborhood locations based on multiparametric analysis allows residents to enjoy quality walkability while enabling better solar potential and green roofs by changing the morphology design.

Overall, the presented method shows the potential of spatial design-based knowledge analysis and decision support, as it can be used to investigate essential aspects (such as walkability, soil sealing and water-sensitive urban design, shading, energy potential, etc.), independent of the design variant. If these aspects are considered at an early stage in a design, they can be set as criteria in tendering procedures and competitions, thus ensuring that all design variants achieve higher quality.

Acknowledgments

We would like to thank the COST Action CA18137—MCMH EU—European-Middle-Class-Mass-Housing, supported by COST (European Cooperation in Science and Technology), that enabled the creation of this article.

Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

Dalit Shach-Pinsly, PhD, is an architect and urban designer. She is currently a researcher and senior lecturer at the Technion–IIT. She was a partner investigator in the H2020-MG-9.2-2014 MIND-SETS—Mobility Innovations for a New Dawn in Sustainable Transport Systems. She was a senior researcher of FP7-DESURBS-EU-Designing Safer Urban Spaces. Formerly she joined the College of Built Environments at the University of Washington as a post-doctoral fellow sponsored by the competitive Marie Curie EU IOF Fellowship (2008–2011).

Stefan Bindreiter is a spatial planner and software developer and holds an MSc in Spatial Planning from the Vienna University of Technology and an MSc in Digital Media from the University of Applied Sciences in Hagenberg. He is a PhD student and project researcher at Vienna University of Technology's Spatial Simulation Lab with a research focus on algorithm-based analysis tools for spatial planning. He addresses the concrete application of these methodologies in the creation and implementation of macro-regional planning strategies.

Idan Porat, PhD, holds a BA in Environmental Studies, an MSc, and a PhD (with excellence) in Urban And Regional Planning from the Technion—Israel Institute of Technology. He is an associate teaching fellow and senior researcher at the Technion—Israel Institute of Technology. He is one of the founders of the Spatial Capital Lab and the Spatial Planning & Design Lab at the Center for Urban and Regional Studies and the leading researcher of the "Israel 100" national strategic plan.

Shai Sussman is a civil engineer in Geoinformation and has recently completed a Master's in Urban Planning at the Technion—Israel Institute of Technology under the supervision of Dr. Meirav Aharon Gutman. As part of his thesis, he was involved in a joint venture between Cornell-Tech and the Technion, where he developed a time-based spatial-microsimulation platform to simulate demographic behavior in an urban renewal context.

Julia Forster, PhD, is a senior scientist and head of the Spatial Simulation Lab (Simlab) at the Vienna University of Technology. She is a trained architect and holds a PhD in Spatial Planning, for which she was awarded the Ressel Prize of Vienna University of Technology. She is concerned with strategic visualization of energy and mobility data in settlement areas as a tool to support planning and decision-making. Her research focuses on digital spatial visualization for holistic system views and agile collaboration among domain experts.

Michael Rinnerthaler is a spatial planner and holds a BSc and an MSc in Spatial Planning from Vienna University of Technology. He was a project researcher at Vienna University of Technology's Spatial Simulation Lab.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 189–201
https://doi.org/10.17645/up.v6i4.4425

Article

Spatial Accessibility in Urban Regeneration Areas: A Population-Weighted Method Assessing the Social Amenity Provision

Robin Gutting [1,2,*], Maria Gerhold [3] and Stefanie Rößler [1]

[1] Leibniz Institute of Ecological Urban and Regional Development, Germany; E-Mails: r.gutting@ioer.de (R.G.), s.roessler@ioer.de (S.R.)
[2] Department of Geography and Environmental Studies, Stellenbosch University, South Africa
[3] Faculty of Spatial Information, University of Applied Sciences Dresden, Germany;
E-Mail: maria.gerhold2@htw-dresden.de

* Corresponding author

Submitted: 28 April 2021 | Accepted: 31 May 2021 | Published: 17 November 2021

Abstract
Principles of social sustainability serve to guide urban regeneration programmes around the world. Increasingly, the upholding of these principles is subject to qualified evaluation and monitoring. One of the cornerstones of social sustainability is access to basic services. This is also a strategic and operational objective in urban regeneration measures. While indicator-based evaluations of accessibility do exist, hitherto they have tended to apply descriptive statistics or density parameters only. Therefore, there is a need for small-scale, regularly updated information on accessibility, such as the nearest facility based on street networks and population density. This deficit can often be attributed to the complex methodological requirements. To meet this need, our article presents a method for determining the spatial accessibility of basic services with low data requirements. Accessibility is measured in walking time and linked to the local population distribution. More specifically, GIS tools in connection with land survey data are used to estimate the number of inhabitants per building; the walking time needed to reach four types of social amenity along the street network is then determined for each building; finally, a population-weighted accessibility index is derived and mapped in a 50-m grid. To test this method, we investigated four urban regeneration areas in Dresden, Germany. The results show that with freely available geodata, it is possible to identify neighbourhoods and buildings with both high population densities and poor accessibility to basic services. Corresponding maps can be used to monitor urban regeneration measures or form a basis for further action.

Keywords
accessibility; population mapping; social amenities; socially integrative urban development; spatial network analysis; urban renewal

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

In view of current disparities between prosperous, economically thriving neighbourhoods and those which are socially disadvantaged, urban regeneration "is increasingly seen as being anchored within the sustainable development agenda and should tackle physical, social, economic and environmental issues together" (Colantonio & Dixon, 2009, p. 19). The various definitions of social sustainability proposed by scholars of urban regeneration all share the principle of the long-term, fair participation, and use of urban resources by all population groups (Colantonio & Dixon, 2009). At a more operational level, collaborative urban planning, pleasant urban environments and well-balanced local economies and labour markets are regarded as just as important

in securing socially sustainable urban regeneration as socio-cultural factors and adequate institutional development (Müller et al., 2019; Nyseth et al., 2019). In practice, these principles are represented by various measures in individual regeneration approaches all across Europe and worldwide aimed at improving large, deprived monofunctional areas built after the Second World War or working-class neighbourhoods erected at the end of the 19th century (Jensen & Munk, 2007; Wassenberg & van Dijken, 2011).

In order to evaluate the success of measures intended to foster social sustainability, complex digital technologies and monitoring approaches are increasingly accompanying the regeneration process. A wide variety of qualitative and quantitative methods is employed, supplemented by GIS-approaches to derive spatially differentiated information. Zheng et al. (2014) provide a comprehensive overview of studies on urban regeneration and the evaluation of sustainability. A great deal of research has also been done on providing theoretical frameworks for measuring the level of (social) sustainability of urban regeneration approaches at neighbourhood scale. Key indicators have been proposed, which can be applied before, during and after regeneration projects, given that data requirements are met (Huang et al., 2020; Korkmaz & Balaban, 2020). Some studies have considered individual aspects of sustainable urban regeneration, focusing on human health or on the perception of streetscapes and the urban fabric, which forms the basis for developing an identity and sense of place within the neighbourhood (del Aguila et al., 2019; Doğan et al., 2020; Ma et al., 2021). In practice, the comprehensive assessment of urban regeneration measures and their success is often demanded by public funding bodies (European Commission, 2021). Depending on the objective of the evaluation, most assessment techniques rely on quantitative or qualitative surveys, document analysis, workshops, case-study analysis, or the calculation of a comprehensive set of indicators (Bundesinstitut für Bau-, Stadt- und Raumforschung & Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, 2016; European Commission, 2021; Stadt Heidelberg, 2019; Thüringer Ministerium für Infrastruktur und Landwirtschaft, 2020).

The principle of reasonable access to municipal services for all population groups, both spatially and socially, is one of the cornerstones of social sustainability (Müller et al., 2019). It can also be found as a strategic and operational objective in urban regeneration approaches and corresponding legislation (e.g., German Building Code, Chapter 2, 2017; UK Housing and Regeneration Act, Chapter 1, 2008; The Planning Act in Denmark, Part 2, 2007). Accessibility is usually understood as the potential for spatial opportunities that can be reached with the help of a transport system (Büttner et al., 2018). Geurs and van Wee (2004) theoretically describe four components of accessibility: (1) land-use component; (2) transportation component; (3) temporal component; and (4) the individual component. The land-use component reflects the land-use system comprising the amount and quality of spatial opportunities (e.g., job or health and social facilities, etc.) as well as the demand for these opportunities at origin locations. Transportation entails the transport system and the effort, which is necessary to reach facilities along the transportation network (e.g., time, money, etc.). The temporal component describes temporal constraints like the time available for participating in certain activities (e.g., work, recreation) and the individual component reflects the specific features of the demanding population, e.g., their needs, abilities, and opportunities depending on people's income, age, and physical condition. Especially those socio-demographic aspects play an important role: Despite good spatial connections, economic- or health-related hurdles may still prevent people from taking advantage of spatial opportunities (Gargiulo et al., 2018; Gharebaghi et al., 2018). Location-based measures are frequently used in accessibility analysis and, among others, evaluate accessibility through the modelling of origin-destination (demand and supply) pairs and the effort to cover the distance between them at different spatial scales ("distance measures"). The shortest way to different facilities by foot, bicycle, public transport, or car is assessed based on different costs, e.g., minutes, money, or volume of CO_2 emission (Arellana et al., 2021; Bundesinstitut für Bau-, Stadt- und Raumforschung, 2021; Handy & Clifton, 2001; Hull et al., 2012; Klaus et al., 2020; Metropolregion Hamburg, 2021; Rossetti et al., 2020). When investigating the supply side, isochrone maps can be constructed, e.g., to depict the accessibility of the surrounding neighbourhood to urban green spaces within a certain timeframe (Kolcsár & Szilassi, 2017). Infrastructure-based measures focus on the transport system itself, which is often modelled as multi modal street grid covering public transport, private car, or pedestrian accessibility (Geurs & van Wee, 2004). Structural parameters are calculated, e.g., by applying indexes, graph-based connectivity measures, or space syntax (Hull et al., 2012; Ignaccolo et al., 2020; Smith, 2018).

But research shows that the understanding and use of those concepts and approaches is often limited in practice and fails due to more complex methodological requirements (Boisjoly & El-Geneidy, 2017; Silva et al., 2019). Some studies that have assessed spatial accessibility in the context of (socially) sustainable urban regeneration measures have adopted fairly simple analytical approaches, i.e., involving surveys and descriptive statistics or datasets such as the number of facilities within a certain buffer area (Shirazi et al., 2020; Zheng et al., 2017). In practice, evaluations have tended to deal only with parameters of spatial density such as square metres of green space per inhabitant or the number of doctors within a municipality (Stadt Dresden, 2017; Stadt Heidelberg, 2019).

Against this background, our aim is to show how the spatial accessibility of social amenities in urban

regeneration areas in terms of pedestrian accessibility can be precisely assessed using a comprehensive approach that is also easy to apply. In our method, population mapping and spatial network analyses are conducted on the basis of building footprint and road network geodata as well as local data from statistical offices and surveys in order to identify population concentrations where there is an urgent need for more accessible social amenities. Specifically, we analyse the spatial accessibility of four types of basic service by applying a 50-m grid under consideration of the following main influencing factors: (1) the urban street grid; (2) population density; and (3) distribution of social amenities. The focus of the analysis is to create a population-weighted accessibility index based on minimal data inputs, which is a composite of population density and accessibility in minutes (for another example of composite accessibility measures see Pilot et al., 2006).

Following, in Section 2, the case study neighbourhoods and the regeneration framework, the indicators used, and the assessment techniques are described. In Section 3, the results are presented in relation to the four case study neighbourhoods. These results are discussed in Section 4, according to the applied methods. The article finishes with concluding remarks in Section 5.

2. Material and Methods

2.1. Case Study Neighbourhoods

Our research focuses on four neighbourhoods representing regeneration areas within the city of Dresden (DD), Germany: DD-Pieschen, DD-Neustadt, DD-Friedrichstadt, and DD-Löbtau. As the capital of the state of Saxony, Dresden currently has a population of around 560,000 (see Figures 3 to 7 for the city's location within Germany and Europe). These four historical neighbourhoods with mixed functions were established at the end of 19th century during a period of massive industrialisation and urban growth. Due to poor maintenance of the building stock during the communist era, the buildings and flats in these neighbourhoods were somewhat dilapidated at the time of Germany's reunification in 1990. For DD-Löbtau, for example, around 15% of the buildings were ruinous and showed severe damage leading to a vacancy rate of more than 30% in 1990. With no playgrounds at hand and brownfields used for wild parking and illegal waste dumping, attractive public space was limited (Stadt Dresden, 2021a). In addition, the socio-economic make-up of DD-Friedrichstadt was difficult. Characterised by mostly low-income and socially disadvantaged households, the population showed (and still shows) an above-average proportion of recipients of state transfer payments, which corresponds to a population share of 18.5% compared to the city-wide average of 11.2% in 2014 (Stadt Dresden, 2021b). However, public regeneration policies and programmes over the last three decades have resulted in widespread urban renewal: Since the 1970s, municipalities (initially in West Germany) have received finance from the national urban development support programme Städtebauförderung ("German National Framework of Urban Development Assistance Programmes for Sustainable Urban Development Structures"), which aims to strengthen cities and towns both economically and socially by removing obstacles to their development. Municipalities can apply for funding to address various urban development problems such as: (1) the loss of functions in inner cities and town centres; (2) housing vacancies and derelict sites; and (3) social deprivation and environmental challenges (Bundesministerium des Innern, für Bau und Heimat, 2020; Rößler et al., 2020). One of the first components in this programme were the so-called "urban renewal and development measures," which for over 20 years have also been implemented at our four case study neighbourhoods. These primarily address weakness in the physical fabric (refurbishment of the housing stock) as well as functionality (maintenance and new establishment of functions).

2.2. Indicators for Spatial Accessibility of Social Amenities

As discussed above, a central objective of regeneration activities is to improve access to social amenities by foot. At the same time, spatial accessibility is also an appropriate indicator to measure the progress and success of such activities. Acknowledging the main categories of social amenities as facilities for daily need, health care, recreation, and education, we chose the following amenities as suitable for developing and testing the assessment techniques (Marshall, 2005; Sheffield Hallam University, 2005; Stadt Dresden, 2017): (1) facilities for daily need (e.g., supermarkets); (2) general practitioners' surgeries; (3) green spaces; and (4) nursery schools. The practical relevance of these amenities for our study is confirmed by the direct and indirect renewal activities in the regeneration areas to improve accessibility of these four types of facility in the last 20 years, e.g., by establishing new parks or funding the refurbishment of retail outlets and medical practices in core areas of the neighbourhoods. Moreover, we can safely assume that these amenities are relevant to most regeneration areas and that the necessary input datasets used in the following assessment techniques are widely available.

2.3. Assessment Techniques

2.3.1. Population Mapping

Our population maps were created using the technique of spatial disaggregation, an established approach for small-scale population mapping, here implemented in an automated five-step workflow (Figure 1; Biljecki et al., 2016; Hecht et al., 2019).

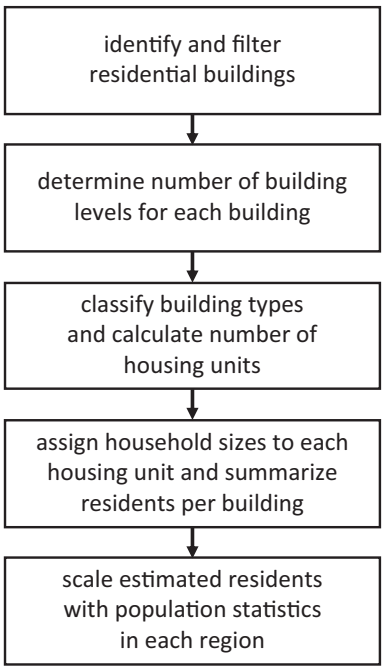

Figure 1. Workflow to estimate the number of people in residential buildings.

Firstly, building footprints from the German land survey register (Authoritative Real Estate Cadastre Information System, 2020) were used to identify and filter residential buildings. This dataset, which is supplied as open data by the Saxon State Office for Geoinformation and Surveying (GeoSN), includes an attribute describing the function of each building, e.g., residential, or industrial use. In addition, geo-referenced point data from GeoSN comprising building addresses were applied to exclude all buildings without an address, since all residential buildings are assigned a house number and street name (GeoSN, 2020b). This ensured, for example, that small auxiliary non-residential buildings were filtered out. Plausibility checks were conducted using residential building data from OpenStreetMap (https://www.openstreetmap.org). Secondly, most of the information on building levels could be derived from an existing attribute in the 3D city model provided by GeoSN. Verification and plausibility checks were realised by calculating building heights from the digital terrain and surface models from GeoSN and by estimating the number of building levels from this height data and an average figure for storey height (GeoSN, 2020a).

Thirdly, the buildings were classified as single-family houses or apartment buildings with the help of German census data from 2011, which is based on a 100-m grid (Zensus 2011, 2020). Each grid cell specifies the number of buildings contained within it classified by type. The classification was straightforward in the case of cells featuring only one building type by assigning the building type information to the building points falling within the boundary of the respective grid cell. For grid cells with mixed building types, information from OpenStreetMap data was used for classification. Buildings, which could not be classified due to missing information in OpenStreetMap, were compared with already classified edifices in the surrounding area to assign a building type based on similar properties, such as size and structure levels. We assumed one housing unit per building for single family houses and two housing units per level for apartment buildings (Meinel et al., 2009). Plausibility was checked by dividing the number of apartment units in one grid cell indicated by the census data by the summed number of estimated levels in the same grid cell to obtain an average number of housing units per level. While our assumption of two units per level for apartment buildings proved to be reasonable for most buildings, we also found levels with more than two housing units. We used this refined data for further calculations. The total number of housing units per apartment building was determined by multiplying the number of levels with the number of housing units per level.

In a fourth step, household sizes were assigned to each housing unit using another 100-m grid-based census dataset which specifies the relative shares (%) of different classes of household size (Zensus 2011, 2020). Using these statistics, each housing unit was randomly assigned a household size of one to six people according to the percentages of each class within each 100-m grid cell. The estimated number of members of every household per building was summed to give an estimated total number of residents per building. Finally, the numbers of residents in a building were scaled, based on the real population statistics from 2018 for each city district of Dresden (Meinel et al., 2009). The final results represent a dataset of building polygons with an estimated population attribute for each residential building. The automated workflow was implemented in FME Workbench.

2.3.2. Accessibility

The building polygons were converted to point data to clearly select buildings within the boundary of the individual regeneration area (Figure 2). By applying the "1.5 interquartile rule method," buildings with unusually high numbers of residents were excluded as outliers (Khan Academy, 2021). In addition, a 50-m grid was generated for the same spatial extent featuring only those cells which contained at least one residential building point. A resolution of 50 m is a compromise between the highest possible (small-scale) information and methodological feasibility. At higher resolutions of less than 50 m, grid cells often only contain parts of a single building. Coarser resolutions no longer permit small-scale statements regarding pedestrian accessibility.

To delineate the street and footpath network of Dresden, we opted for open data from the German land survey register for the year 2019 (GeoSN, 2020c) instead of using Open Street Map data. Data from the German land survey register are regularly modeled across Germany according to uniform criteria and are

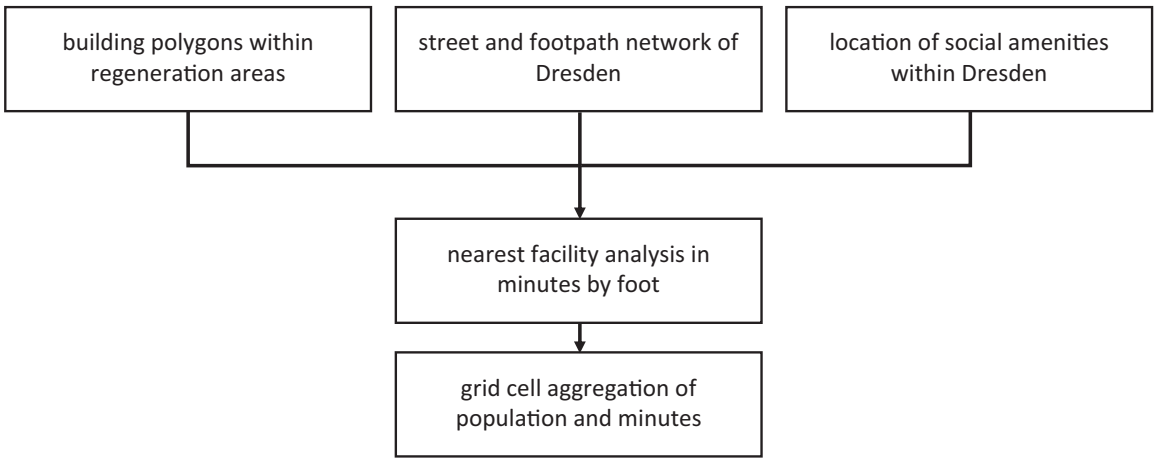

Figure 2. Workflow to estimate the accessibility of social amenities.

therefore available area-wide and in greater topicality as well as completeness. Motorways were deleted from the dataset as they cannot be used by foot. The resulting geometries of streets and footpath were merged and checked for any topology errors. Geodata in the form of point data referring to the above-mentioned four social amenities was taken from the open data portal of the city of Dresden for the year 2020 (Stadt Dresden, 2020). To capture facilities for daily need, we identified grocery stores of all sizes. Access to health care was analysed by identifying the surgeries of general practitioners while ignoring specialists (e.g., paediatricians), dental surgeries, and hospitals. To capture green spaces, we identified public parks and urban forests with a minimum size of one hectare as this was considered sufficient for most recreational activities (e.g., ball games) and the construction of basic facilities. In terms of nursery schools, we opted for private and public facilities.

Using the small-scale population distribution, the street/footpath network, and the location of the social amenities, it was possible to apply the ArcGIS Extension Network Analyst to determine the nearest facilities inside and outside the regeneration areas at a walking speed of 5 km/hr, which represents the average walking speed of an adult without physical disabilities (Mohler et al., 2007). As a result, four new attributes were obtained for each building within the investigated area indicating the shortest distance in minutes to the nearest social amenity.

To aggregate the population estimations and derive the average walking distance in minutes within the 50-m grid cells it was necessary to multiply the number of people in each building point by the calculated distance to the nearest facility. Then a spatial join was made between the buildings and the grid cells. The resulting building point data obtained the grid cell tile ID, which made it possible to apply a summary statistics operation for the population and the multiplied overall minutes of the four accessibility attributes according to the tile ID. Finally, a division of the summed-up minutes by the total number of people led to an average accessibility per person in minutes in every grid cell. The five aggregated attributes can be found in Figures 3 to 6 in the layers "Population per grid cell" and "Accessibility per person in minutes."

2.3.3. Population-Weighted Accessibility

To take account of population density in the assessment of accessibility, these two parameters were combined in one dimensionless index. For this purpose, the parameters were normalized to a value of between zero and one. The basis of the normalisation was the value range of the population density of the grid cells within the four regeneration areas as well as the value range for walking times to each of the four social amenities. For example, grid cells with the highest population per grid cell (194 people) were assigned the value one and grid cells with the lowest number of people the value zero. In the case of the social amenity "General practitioner" (Figure 4), the longest walking time in the regeneration areas was around 13 min per person, which was assigned a grid cell value of one; grid cells with an accessibility of less than one minute per person were given the value zero. Then we weighted the normalized accessibility with the corresponding normalised population density in each grid cell by multiplying these values. For easier representation in the maps, the index was then converted into the value range 0 to 10. Grid cells with index values of 5 to 10 indicate areas and buildings which have comparatively poor accessibility due to longer walking distances *and* higher population densities, i.e., a greater number of people are affected by the poor accessibility (Figure 7).

3. Results

By applying the method presented above, we were able to create two thematic layers in a raster map. The population density layer depicts the number of estimated people in a 50-m grid cell, i.e., number of people per 2,500 m^2, and is shown in all figures (Figures 3 to 7). The second layer indicates the accessibility of the four

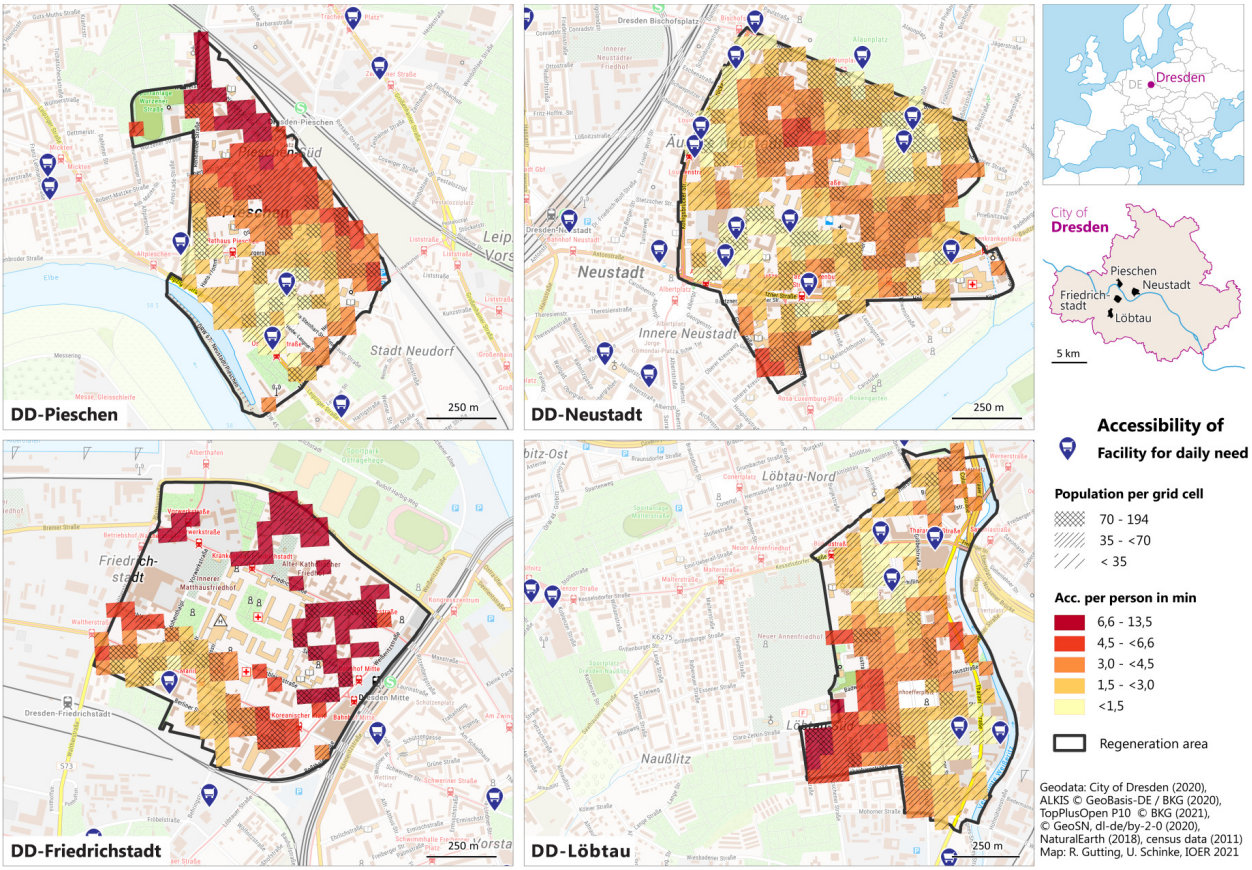

Figure 3. Grid cells showing population density and walking distance in minutes to nearest facility for daily need.

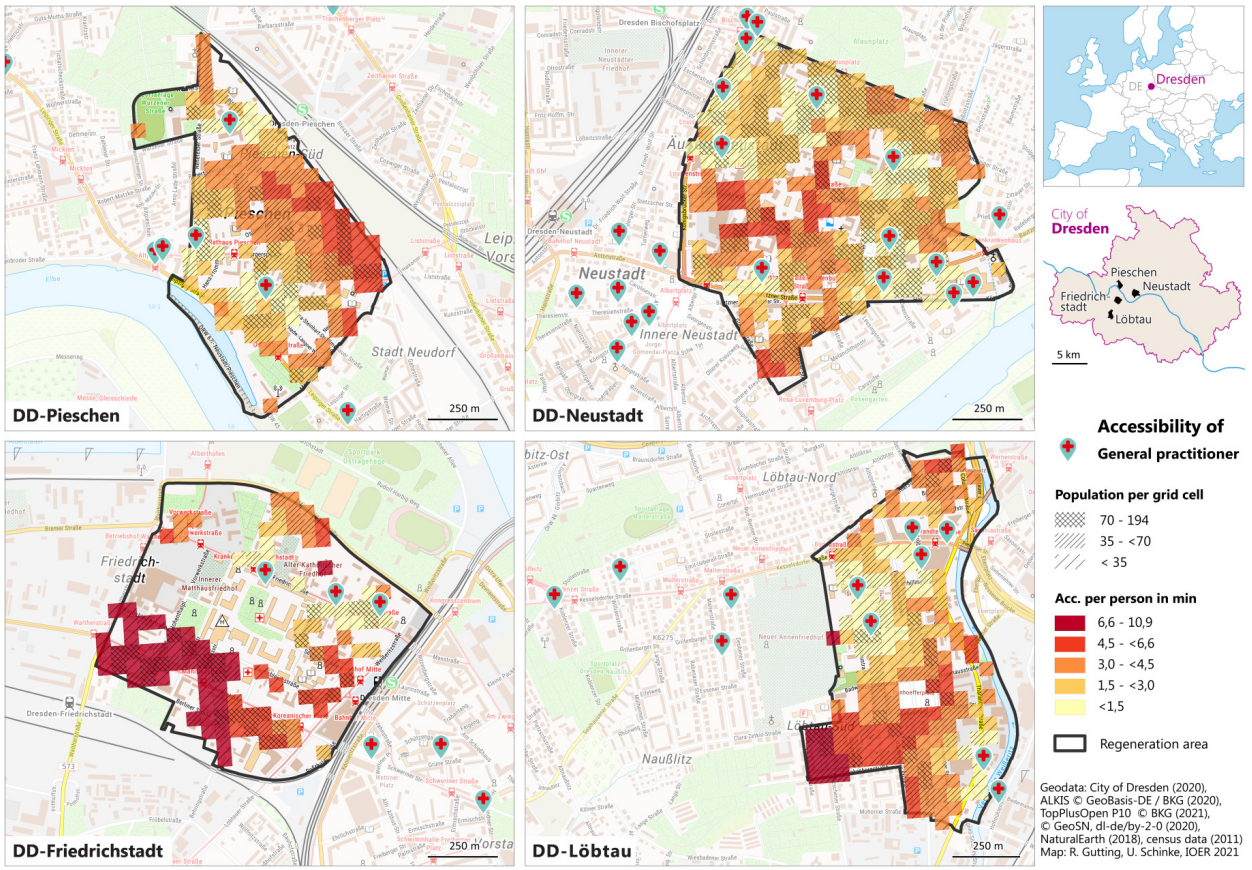

Figure 4. Grid cells showing population density and walking distance in minutes to nearest general practitioner.

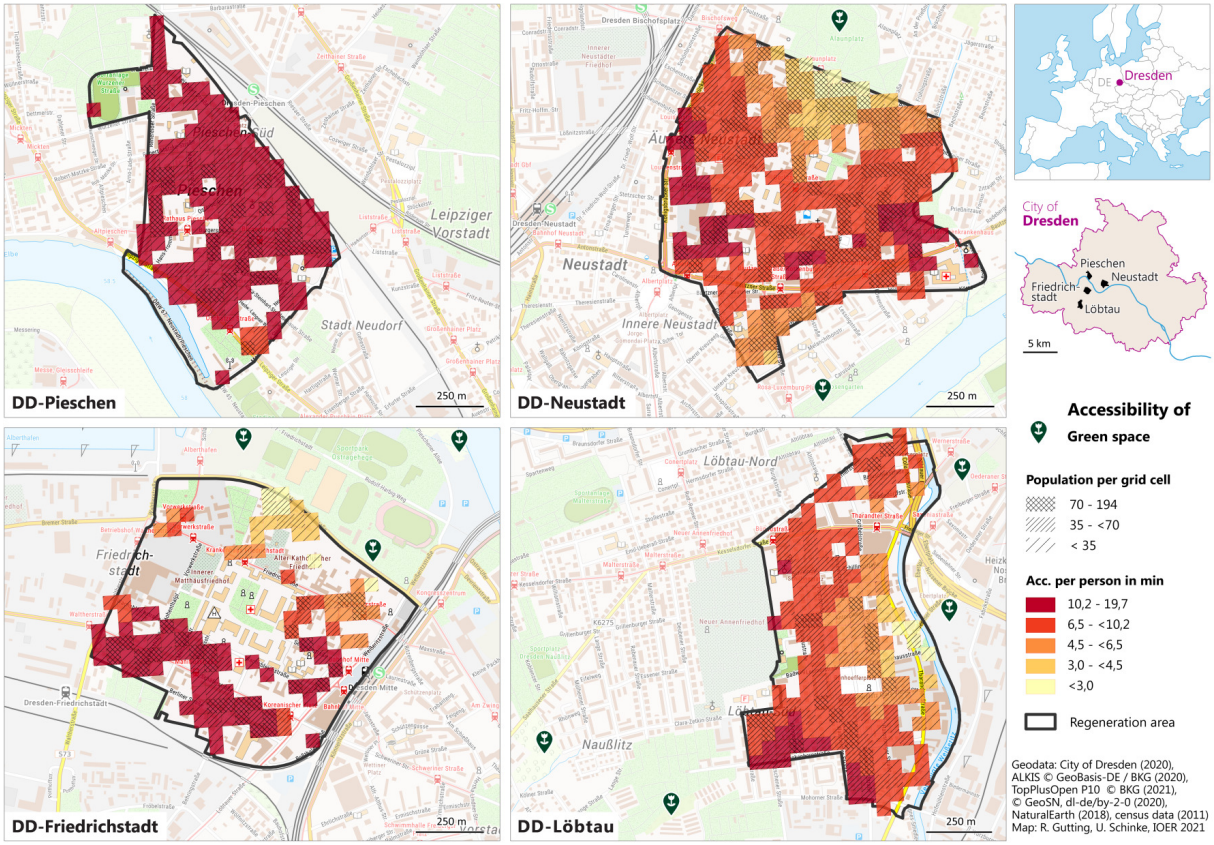

Figure 5. Grid cells showing population density and walking distance in minutes to nearest green space.

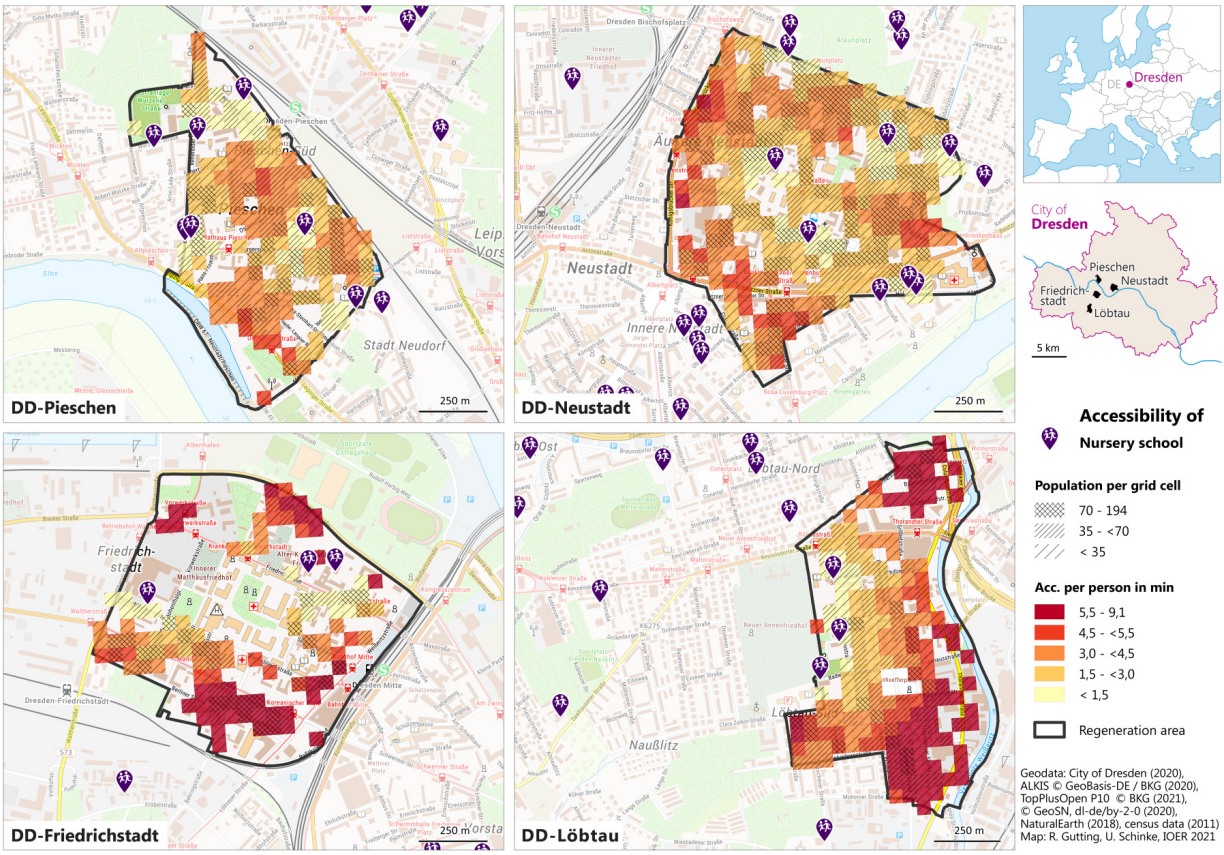

Figure 6. Grid cells showing population density and walking distance in minutes to nearest nursery school.

social amenities (Figures 3 to 6), representing the average number of minutes that each person within a 50-m grid cell must walk to reach the nearest amenity. By superimposing these layers, it is possible to pinpoint areas within the regeneration areas which show poorer accessibility as well as high population densities. The population-weighted accessibility index is shown in Figure 7.

We also calculated the city-wide accessibility, i.e., average walking distance (in minutes) per person for each of the four amenities, to serve as a benchmark for the neighbourhood results below. In general, we can say that all four basic amenities can be reached in less than 11 min from each residential building. Due to the prevalence of facilities for daily need (supermarkets) and general practitioners, these are associated with rather short walking times averaging 6.6 min per person. Nursery schools can also be reached in only 5.5 min. In comparison, an average walk of 10.2 min is required to reach the nearest park or forest.

At sub-neighbourhood level, our small-scale analysis enables a precise localisation of high population densities affected by poor accessibility (Figures 3 to 6). Grid cells with walking distances above city-wide average are marked in dark red. The socially disadvantaged neighbourhood of DD-Friedrichstadt, for example, shows areas with average walking distances of over 6.6 minutes to facilities for daily need clustered in the north and east which comprise 38% of the neighbourhood population (Figure 3). High population densities of up to 190 people per grid cell and poorer accessibility can be found especially in the eastern parts of this regeneration area. Regarding access to general practitioners, areas with above-average walking distances of more than 6.6 minutes per person and high population densities (42% of the neighbourhood population) are seen in the south and west (Figure 4). The proportion of such areas in the other three neighbourhoods is significantly lower. Due to the high density of facilities in DD-Neustadt, for example, there are no grid cells with walking distances above the city-wide average either for facilities of daily needs or general practitioners.

Our small-scale analysis also identified above-average walking distances to green spaces (Figure 5). Here DD-Pieschen particularly stands out: Residents in almost all grid cells (covering 97% of the population) need more than 10.2 min to walk to the nearest park or forest. Large parts of the southern regeneration area of DD-Friedrichstadt also show above-average walking distances (70% of inhabitants) associated with high population densities. In the other two neighbourhoods, DD-Neustadt and DD-Löbtau, only a small share of the population has to walk longer than 10.2 min to reach green spaces. Nevertheless, individual grid cells

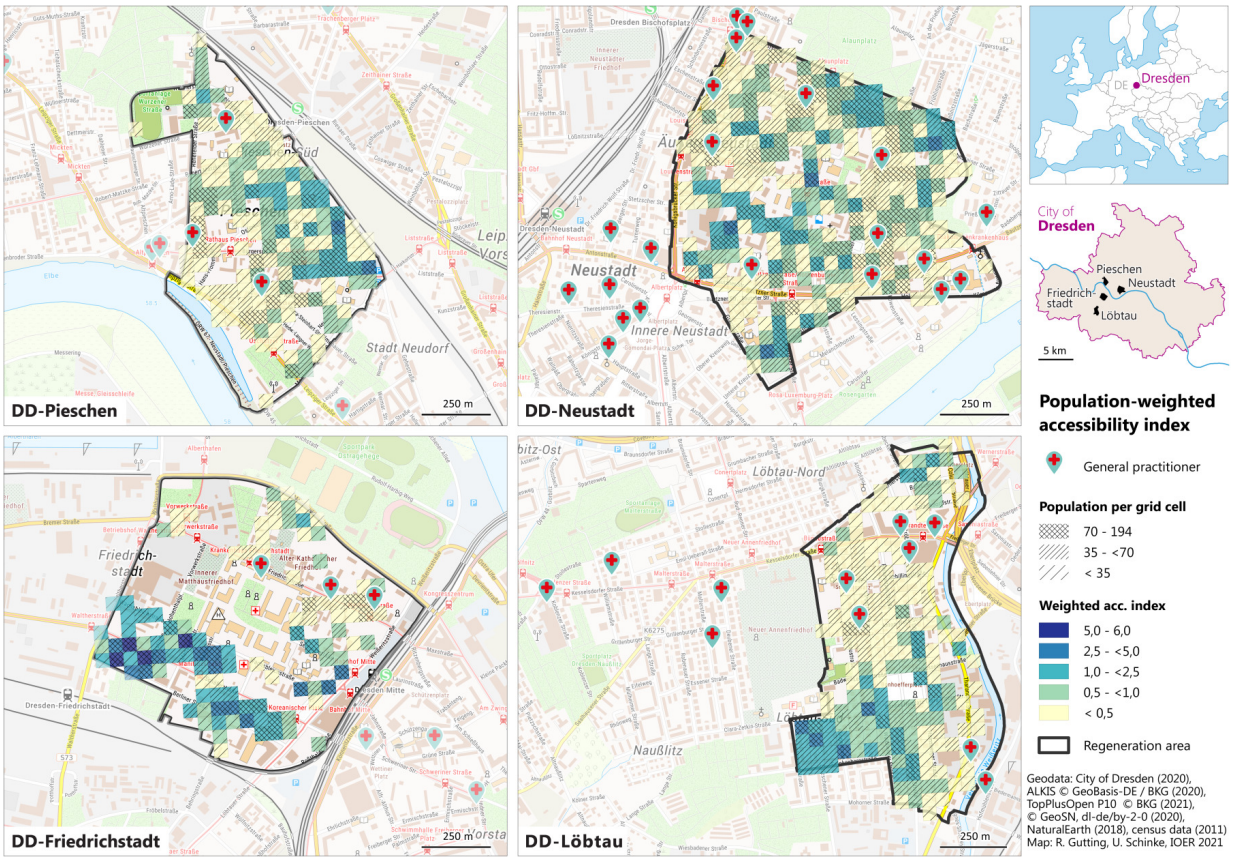

Figure 7. Grid cells showing population density and population-weighted accessibility index regarding access to general practitioners.

with high population densities and poor accessibility can also be found in the west and east as well as in the south-west of these neighbourhoods. Regarding nursery schools (Figure 6), grid cells indicating longer distances than the city-wide average of 5.5 min per person can be identified in the northern and southern residential areas of DD-Friedrichstadt and DD-Löbtau. These comprise around 30% of the local populations with some high densities of up to 190 people per grid cell, especially in southern parts of DD-Friedrichstadt.

As described above, the two information layers can be linked for easier interpretation by means of the indicator "population-weighted accessibility index." Figure 7 shows the results for this indicator regarding access to general practitioners. Only in DD-Friedrichstadt do we see any grid cells with a value above five. In this case, the four cells encompass around 500 residents, who thus live in high-density locations with poorer accessibility due to longer walking distances. However, it should be noted that the highest value, namely six, is still considerably under the maximum value of 10. No problematic areas can be identified in the other three neighbourhoods, where over 90% of the grid cells show values less than 2.5.

4. Discussion

4.1. Mapping Results

The presented method is able to correctly estimate populations at the level of the city districts with an accuracy of up to around 90%. In combination with network analysis tools and geo-referenced data, we determined spatial accessibility for four types of social amenities in urban regeneration areas within the city of Dresden, expressed as average walking distance (in minutes) or by means of a population-weighted accessibility index for a small-scale 50-m grid. The applied methods and the exemplary results show that the presented technique allows status quo analysis, the monitoring of any changes, the assessment of comparable or different neighbourhood settings, or the comparative assessment related on a city-wide scale.

The practical value of any accessibility analysis is limited without a suitable benchmark. In our case, we took the overall city-wide average as our benchmark, measured in average minutes per person, and compared this with the value in each grid cell to determine the share of the population above or below this value. Comparisons with former points of time are also possible and are often used in planning practice for indicator-based monitoring (Stadt Dresden, 2017; Stadt Heidelberg, 2019). Legal requirements and guidelines may also specify benchmarks as distances measured in kilometres or in minutes (on foot or by car). Guidelines in Germany, Austria, or the Netherlands, for instance, state that 90–99% of local residents must be able to reach a general practitioner within 10 minutes by car (Klaus et al., 2020; Sundmacher et al., 2018). In Hamburg, Germany, nursery schools have to be reached within 20 min on foot or 10 min by car (Klaus et al., 2020). Applying these stipulations, we find that the neighbourhoods analysed here have a sufficient level of accessibility to general practitioners and nursery schools. In fact, the nearest facility can be reached in less than eleven minutes (general practitioner) resp. in about nine minutes (nursery schools) on foot. Only the accessibility of facilities for daily need is inadequate in parts of the neighbourhoods with more than 13 min' walk to the next facility compared to the minimum requirements of 10 min' walk to the next shop specified in the literature (Kuhlicke et al., 2005). Such legal requirements or guidelines can certainly replace city-wide average values in small-scale analyses of accessibility.

For our population-weighted index, however, it was not possible to carry out a benchmark analysis due to the lack of a suitable comparative dataset. However, the index can be used to present an overall picture of the accessibility for a broader social topic. To do this, the index must be calculated for all important amenities within a specific social area. It is then possible to weight the individual indexes and combine them into an overall index. This is useful, for example, to show the overall accessibility of the health sector by combining the individual indexes for general practitioners, hospitals, and other specialist clinics into one index.

4.2. Methodological Approach

The population-weighted accessibility index is most useful when comparing smaller neighbourhoods that have similar structural characteristics. Analyses that incorporate both rural outskirts and urban centres should be avoided as the indicator values can then hide underlying disparities. For example, index values can be low in the centre *and* in the outskirts but for different reasons: (1) shorter distances and higher population densities in the centre; or (2) longer distances and lower population densities in the rural surroundings. Furthermore, the indicator is more suitable for identifying densely populated neighbourhoods with accessibility deficits because our methodology is designed to calculate higher values in such cases, trending towards the maximum value of 10. It should also be noted that, for the purposes of balanced spatial planning, areas showing low population densities and accessibility deficits should still be given due consideration in upgrading programmes.

Another point to be considered is that spatial proximity is not the only factor governing people's use of social amenities. Insufficient capacity along with the reputation/quality of a nursery school or general practitioner, for example, can determine the level of use. The presented approach also ignores the specific needs of vulnerable groups such as refugees, the disabled or the socially disadvantaged. Regarding the disabled, for example, it would be necessary to set different parameters for the speed of travel between the home and the facilities

in order to correctly calculate the average accessibility in minutes per person for a single residential building. The same applies to infrastructure related to various age classes. We also dealt with this question in our study by analysing the demand for nursery schools, which is a type of age-dependent infrastructure. In further studies, the demand for age-related accessibility could be determined for the residents of a residential building using demand-specific parameters for walking or driving speed.

5. Conclusions

The approach successfully shows how freely available (open source) geodata and official statistics can be used to estimate and map the population at the scale of residential buildings. In connection with spatial accessibility analysis, the presented approach can support municipal regeneration activities by: (1) showing the degree of accessibility of different types of facility in defined neighbourhoods; (2) comparing various neighbourhoods in relation to one another and to the whole city; and (3) monitoring the upgrading or degradation of areas. The notion of social sustainability as investigated by scholars can be methodologically substantiated to show spatial and thematic disparities in accessibility within small neighbourhoods and clearly illustrate these in maps. The overlaying of information on accessibility with population density within a grid cell can pinpoint residential buildings with poor access and thus help spatial planners design solution-oriented upgrading programmes that build on the achievements of previous measures towards sustainable urban regeneration.

Depending on data availability, our approach can be expanded to more social amenities. Accessibility to education and subsequently to job opportunities for example contributes to socially integrative urban regeneration in the same way as the analysed amenities and can be assessed with our approach. In addition, our workflow can be applied to other settings in urban regeneration areas worldwide. Open data on urban street networks is offered by OpenStreetMap or third-party providers such as DIVA GIS. The locations of social amenities are often already mapped as simple point geodata in publicly accessible online databases of the corresponding municipalities. By means of manual mapping, data gaps can be closed for some amenities such as supermarkets, parks, or schools. The small-scale mapping of the population, however, can prove challenging. Global databases are available that map population distributions at various resolutions (Global Human Settlement Layer, 2021; WorldPop, 2021). Our approach provides very small-scale results and is thus more useful for some applications than databases at lower resolutions. If basic data cannot be obtained, the individual calculation steps in the presented method can be simplified. For example, it is possible to make a reasonable assumption regarding the particular number of housing units per building level or to differentiate between the types of residential buildings on the basis of aerial photographs. By making use of freely available surface models (e.g., SRTM data), the number of building levels can be derived from an estimated height of individual levels. Further, if no data on household sizes is to hand, the number of people in a building can be estimated by assuming average household sizes depending on the building type.

Acknowledgments

This article has been elaborated within the project TRANS-URBAN-EU-CHINA ("Transition towards urban sustainability through socially integrative cities in the EU and in China"), funded by the EU's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 770141. We thank our colleagues Ulrike Schinke for technical support and Robert Hecht for critical review. We also would like to thank Prof. Frank Schwarzbach for helpful input and support and the two reviewers for the critical review of our article, which helped us to improve it.

Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

Robin Gutting (Dipl. Geographer) recently worked as a research associate at the Leibniz Institute of Ecological Urban and Regional Development (IOER, Dresden/Germany) and is now doing a Master's in Urban and Regional Science at Stellenbosch University, South Africa. As a consultant, his research interests are aimed at the development of models for small-scale forecasting of housing demand of certain household types. See also: https://www.prognose-und-planung.de/wer-wir-sind.html

Maria Gerhold (B.Sc. Cartography/Geoinformatics) is a Master's student of geoinformatics at the University of Applied Sciences Dresden, Germany. She received her Bachelor's degree in cartography/geoinformatics in 2019. Her research interest is focussed on GIS technologies for analyzing, transforming, combining, and updating large-scale geodata using automated workflows.

Stefanie Rößler (Dr.-Ing.) is a senior researcher at the Leibniz Institute of Ecological Urban and Regional Development (IOER, Dresden/Germany). She holds a diploma in landscape architecture and got her doctorate at Technische Universität Dresden in 2009. Her research interests are in urban sustainability transformation, urban regeneration, ecological aspects of urban development, and urban green space development. She particularly focuses on the role of formal and informal instruments of urban planning.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 202–215
https://doi.org/10.17645/up.v6i4.4484

Article

Area-Based Urban Renewal Approach for Smart Cities Development in India: Challenges of Inclusion and Sustainability

Sarbeswar Praharaj

Knowledge Exchange for Resilience, School of Geographical Sciences and Urban Planning, Arizona State University, USA; E-Mail: s.praharaj@asu.edu

Submitted: 7 May 2021 | Accepted: 1 July 2021 | Published: 17 November 2021

Abstract
Cities in the Global South face rapid urbanization challenges and often suffer an acute lack of infrastructure and governance capacities. Smart Cities Mission, in India, launched in 2015, aims to offer a novel approach for urban renewal of 100 cities following an area-based development approach, where the use of ICT and digital technologies is particularly emphasized. This article presents a critical review of the design and implementation framework of this new urban renewal program across selected case-study cities. The article examines the claims of the so-called "smart cities" against actual urban transformation on-ground and evaluates how "inclusive" and "sustainable" these developments are. We quantify the scale and coverage of the smart city urban renewal projects in the cities to highlight who the program includes and excludes. The article also presents a statistical analysis of the sectoral focus and budgetary allocations of the projects under the Smart Cities Mission to find an inherent bias in these smart city initiatives in terms of which types of development they promote and the ones it ignores. The findings indicate that a predominant emphasis on digital urban renewal of selected precincts and enclaves, branded as "smart cities," leads to deepening social polarization and gentrification. The article offers crucial urban planning lessons for designing ICT-driven urban renewal projects, while addressing critical questions around inclusion and sustainability in smart city ventures.

Keywords
ICT; inclusion; India; smart cities; Smart Cities Mission; sustainability; urban renewal

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

Debates about the future of urban development and planning have been increasingly driven by discussions of smart cities (Batty et al., 2012; Hollands, 2008; Kitchin, 2014; Townsend, 2013; Yigitcanlar, 2015), with many smart city projects surfacing worldwide. Open data, the internet of things, and new digital urban solution-focused public-private partnerships are critical pillars of the smart city strategies in the European cities of Barcelona, Amsterdam, Dublin, and London (Caragliu et al., 2011). In Australia, a $50 million "smart cities and suburbs program" (Dowling et al., 2019; Rahmat et al., 2020) materializes Sydney's smart mobility project and Melbourne's Interactive City Management Platform—a sensor network for collecting data on the use of public spaces. In the USA, several cities have opened avenues to renovate urban spaces into technological testbeds resulting in transformative projects such as the LinkNYC in New York, a first-of-its-kind communications network providing fast and free public Wi-Fi, phone calls, device charging, and interactive tablet-screen for accessing city services, maps, and directions (Shapiro, 2018; Sinky et al., 2018). The technology-driven urban development policy has made deep inroads in Asia, too, with more than 500 smart cities coming up across China (Bacchi, 2020) and 100 cities selected for development under the Smart Cities Mission (SCM) in India (Praharaj et al., 2018b).

Recent studies suggest smart cities will grow in popularity and value in the post-pandemic world (Kunzmann, 2020), with the global market for urban technology-intensive services soaring up to $3 trillion by 2027.

While ICT and digital solutions have indeed uplifted quality of life and improved service delivery models in many cities across the world, researchers argue that the impacts of smart city interventions are not always equitable (Nugent & Suhail, 2021; Seta et al., 2015). The first concern surrounds the question: Who is the target audience of high-tech urban investments? Hollands (2008) found that smart cities often have a narrow spatial focus to create infrastructure for a specific (in most cases affluent) area of the city, designed to attract high visibility. The assumption is that the potential mushrooming of smart pilot projects will somehow assimilate into a utopian smart city (Townsend, 2013). However, researchers rarely investigate the social impacts of these so-called smart projects, leaving critical questions unanswered. Beretta (2018), while examining smart cities in Italy, argues that smart cities' benefits do not extend to all citizens; instead, they are designed for the better halves, risking—among other things—promotion of the phenomenon of gentrification. Wiig (2015) suggests smart cities demonstrate a new form of corporate-driven development where international firms are engaged in transporting urban technology solutions from one part of the world to the other, which McCann (2011) calls urban policy mobilities and global circuits of knowledge. Such approaches promote a one-size-fits-all model of urbanism (Han & Hawken, 2018) that is a significant barrier to shaping a culturally sensitive and inclusive urban landscape.

Moreover, the smart cities commentary suffers from a "north-centrism" (Robinson, 2003) ailment, with most critical urban technological studies focusing overwhelmingly on the parameters, processes, and practices in the Global North (Praharaj et al., 2018a, 2018b). Söderström et al. (2014) suggest the smart city promoters take for granted that foundational infrastructures are already in place in the cities for technology to improve their efficiency. They fail to consider the context of most cities in the Global South, where lack of services, spatial inequality, and unmanaged infrastructure systems is the norm. Considering the increasing rate of smart city efforts in the Global South and an estimated 81% of the five billion population expected to live in the region by 2030 (United Nations, 2019), the need for on-ground investigations of case studies to address the existing knowledge gaps is evident to shape inclusive, sustainable, and resilient cities.

This study critically investigates the smart cities development in India to highlight the inconsistencies between the promise and delivery of the technology-driven urban development model. The article seeks to answer the research question of whether the digital urban renewal strategies put forward by the Indian cities provide a practical approach for shaping sustainable and inclusive cities or not. This research views "sustainability" and "inclusion" as intertwined concepts that help us examine how urban systems function, remain diverse, and produce solutions for communities to sustain our modern way of life. The two concepts help us assess what processes were adopted to identify projects and solutions, which communities are served or excluded by the smart city ventures, how their implementation impacts the social and economic fabric, and whether the overall outcome leads to sustainability and inclusion. The approach to study "sustainability" in this article explores the fine line between competing needs of digital urban transformation and the need to protect the social and community networks in which our populations lives. We follow James (2014) in emphasizing that "sustainability" is not just about the environment or economy; it is also about our health as a society in ensuring that people are not excluded or suffer because of new policies of grand urban (re)developments.

This study is both timely and essential as India implements one of the world's most extensive smart city program engaging 100 cities and a $14 billion investment. Indian authorities adopt an area-based development (ABD) approach (Praharaj et al., 2018c) with intensive use of ICT to develop certain parts of the city as "smart precincts," more critically referred to as "smart enclaves" (Hollands, 2008). These ABDs cover a meagre average of 2.4% of the total area per city—however, a staggering 81% of the total funds are being allocated to develop these exclusive zones (Housing and Land Rights Network, 2018). The skewed investment towards creating exclusive enclaves threatens to magnify an already-existing intra-city divide and social segregation unique to developing world cities (Mitlin & Satterthwaite, 2013; Seta et al., 2015). The current study is critical as these developments pose irreversible consequences for inner-city gentrification, ignoring social sustainability in shaping urban landscapes, as smart cities have to be inclusive, not just technological (Nam & Pardo, 2011; Yigitcanlar et al., 2019). Coe et al. (2001, p. 90) fittingly argue that "local community partnerships—not wires—are the fibers that bind" smart communities and cities. The findings from this study advance knowledge and build on the critical smart city studies while offering a broad and large-scale perspective on integrating digital technologies into urban renewal decisions moving towards smart city development.

2. Review of the Global Discourse on Smart Cities and Their Interplay With Digital Urban Renewal

In the fields of urban planning and public policy, researchers use "smartness" as a normative claim that essentially means efficient urban management. Being smarter indicates a specific strategic policy direction adopted by urban authorities to distinguish their new policies and development programs (Yigitcanlar, 2015). The smart city concept has become topical in academic and policy discussions in recent times. However, the

phrase "smart city" is not new. Downs (2005) suggests that the concept originated in the late 1990s as part of the USA's "smart growth movement." The phrase became widely recognized after it was adopted by several global technology corporations, including IBM, which defines the smart city as an "instrumented, interconnected and intelligent city that uses ICT to sense, analyze and integrate critical information on core systems in running cities" (IBM, 2008, p. 2). The focus of the smart city discourse largely rests on the role of ICT in efficiently managing urban infrastructure and services. Over the last decades, the concept has evolved to mean almost any form of technology-driven innovation in urban management and operations with wide-ranging applications in areas of mobility, environmental management, emergency command and control center (Praharaj, 2020), and energy efficiency.

Alongside technology, a fundamental characteristic of smart cities is their underlying emphasis on self-branding and image building to attract businesses and the creative class (Florida, 2005). Smart cities are an emerging information marketplace with a strong reliance on ICT networks and market networks (Cosgrave et al., 2013). To this end, experts apply system thinking to scope how concepts of the "living lab" and the "innovation districts" work together in a complementary fashion to create a candidate model for implementing the smart city. The premise of the living lab is that the city can be used as a real-world testing ground for new technologies, sensors, and wireless networks that enhance innovation and the creation of new products and urban solutions (Baccarne et al., 2014). Experimentation with technology is also a core philosophy of innovation districts which are small, gentrified pockets in a city supposed to bring together start-up companies and creative industries clustered in large, skilled, economically diverse, and well-connected urban environments. The "triple helix theory" builds on these foundations of living lab and innovation districts (Pancholi et al., 2019) where creativity supposedly stimulates new links, fluid exchange of ideas, technologies, and information between the industry, government, and universities, creating a backbone for smart city collaboration (Yigitcanlar et al., 2020).

From Google's Sidewalk Labs engagement in Toronto waterfront renewal (Morgan & Webb, 2020) to 22@Barcelona innovation district (Bakıcı et al., 2013), an increasing body of literature emphasizes the growing challenge of smart city policies that risk being more focused on technology-push than on demand-pull, where citizens are treated as users and consumers rather than producers and sources of creative innovation (Hollands, 2008; Söderström et al., 2014; Yigitcanlar et al., 2019). The numerous assumptions behind smart city labs and innovation districts are open to questions: What happens when there is the unavailability of research-intensive higher education institutions? Will these cities survive if there is a lack of skilled ICT workforce to create a start-up innovation culture? How will the cities in developing economies roll out smart cities without an extensive telecommunications infrastructure base? What happens when resources are scarce for governments to provide tax relief and liberalized environments for big businesses to flourish? While smart city urban regeneration areas can create new opportunities for innovation and improve service delivery, they have also proven to promote spatial inequalities by concentrating resources and infrastructure in select enclaves (Caprotti, 2014). Such processes pose a barrier to designing sustainable and inclusive cities, especially in the Global South, where a significant share of urban populations live in acute poverty (Teferi & Newman, 2017). This article addresses some of these contradictions in urban planning literature while providing a detailed case study analysis of India's ongoing smart cities development.

3. Methodology

This study accessed the smart city policy document for each of the 100 selected cities under the SCM (available through https://smartnet.niua.org). Only the winning city proposals approved for funding by the Indian government were chosen. A content analysis of these proposals was undertaken to identify the smart city vision and processes employed for the plan preparation by the cities. The proposals were also scanned for identifying the area and population coverage of the ABDs, across cities that allow us to measure the spatial inequality and intra-urban disparities. A series of smart city project-level information was collected from the cities' profiles (Ministry of Housing and Urban Affairs, 2021a) to identify the project names and itemized costs outlined by cities in the smart city proposal. These data were later transformed to present the sector-wise analysis depicting the networks of investments. The study also referred to the smart cities' dashboard (Ministry of Housing and Urban Affairs, 2021b) from the Indian Ministry of Housing and Urban Affairs that publish city and project level implementation progress reports. This source was used to compile data on the city-wise number of project tender issued, projects completed, and fund utilization efficiency as of April 20, 2021.

The quantitative data was processed through R, an open-sourced programming language for statistical computing. Functions from "tidyr" packages of "tidyverse" in the R library were first used to transform the data, so it is more evenly distributed across the graph. Data transformation was also necessary to calculate a simple correlation coefficient between variables (area coverage and population coverage of ABD) that need to show a linear relationship. Through the data transformation process, functions in R were explored to sort out the observations, select variables or columns, and filter observations by their values, and summarize data into groups. The study used a combination of "ggplot2" in R and Datawrapper (available at https://www.datawrapper.de) to build the visualizations and charts offering both static visuals for

print articles and open codes to embed live and interactive visualization with online articles.

4. Deconstructing the Area-Based Smart City Development Approach Advocated by the Smart Cities Mission in India

4.1. Smart Cities as a Response to India's Grand Urbanization Challenges

The urban landscape in the world's largest democracy and fastest-growing major economy—India—is changing dramatically, with the urban population increasing from 18% in 1961 to 32% by 2011 (Office of the Registrar General & Census Commissioner, 2021). By 2030, 590 million people will live in India's cities, with a net increase of 270 million in working-age population (Sankhe et al., 2010). There will be more than 68 million cities in the country by 2030, whereas all of Europe currently has 35 such urban agglomerations. Urban policymakers in India have somewhat failed to match the growing complexities of urban problems with adequate planning, governing instruments, and physical infrastructure. United Nations placed India at position 131 among 182 countries according to a citizen's quality of life ranking (United Nations Development Programme, 2020). Recently, the World Health Organization announced that half of the world's 20 most polluted cities are in India. McKinsey & Company rated the performance of Indian cities in the areas of urban planning, finance, and governance as inferior—the lowest rating on a four-point scale (Sankhe et al., 2010). Such poor standing across global benchmarks has somewhat forced India's Ministry of Housing and Urban Affairs to lay out a new strategy in which local governments must think innovatively and transform service delivery models to avoid urban decay and ensure the competitiveness of cities leading to the launch of SCM in 2015.

4.2. Defining the Goals and Approach of the Smart Cities Mission

According to the guideline issued by the Ministry of Housing and Urban Affairs, the purpose of the SCM is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology that leads to smart outcomes (Ministry of Housing and Urban Affairs, 2021c). The guideline also highlights that the mission is an urban renewal and retrofitting program to develop smart cities across the country, making them citizen-friendly and sustainable. Although the initiative primarily focuses on technology and urban renewal, the authorities did not provide a clear definition of the "smart city" concept. The SCM guideline states that there is no universally accepted definition of smart city as the meaning is interpreted differently by people, cities, and countries depending on their development trajectories and future aspirations. Many believe such an approach from the current regime inadvertently encouraged a more active role by the multinational corporations in shaping the smart city rhetoric (Praharaj & Han, 2019b). Not surprisingly, big tech companies such as PwC, Deloitte, and Cisco launched their signature smart city reports in India. Furthermore, the Ministry of Housing and Urban Affairs engaged them as project management consultants for handholding cities for smart city plan preparation and implementation.

Immediately after the launch of SCM, Cisco introduced a report to assert that digital urbanism is no more a fiction in India (Cisco, 2015). It claimed that a smart city refers to a meticulously planned city relying on ICT as an enabler to solve many urban problems (Cisco, 2015, p. 5). In the same year, PwC produced a publication that depicts the smart city concept where an ICT master plan builds on the foundation and increased digitization, offering a more sustainable and livable environment for the citizens (PwC, 2015). The report mentioned that smart cities in India must promote "modern urbanization with an organic integration of IT with the physical, social and business infrastructure in cities" (PwC, 2015, pp. 8–9). Another global conglomerate, Deloitte (2015, p. 4), in its report *100 Smart Cities in India: Facilitating Implementation*, argued that "smart cities exist on the intersection of digital technology, disruptive innovation and urban environments." The report further recommended that Indian cities leverage a "cloud-based ICT solution capable of integrating data from various sources and generating fast responses" for better infrastructure management and delivery (Deloitte, 2015, p. 4).

While the SCM guidelines did not clarify the smart city definitions, it proposed a development model for cities to design and implement projects that focuses on ABD and also the solutions that will have a city-wide impact. The Ministry of Housing and Urban Affairs asserted that ABD vis-à-vis new technologies acts as agents of transformation of existing areas through retrofitting or redevelopment strategies to improve the livability of urban precincts. These select areas will then act as lighthouses for other parts of the city as a best practice model to be replicated within and across regions. In contrast, pan-city development envisages improvements in the delivery and management of existing infrastructure or construction of new facilities to have a city-wide impact. The national government proposed that cities must leverage technology, information, and data to create smart solutions to urban problems in developing the pan-city infrastructure projects. The SCM website elaborates on a host of smart solutions, including intelligent traffic management systems, smart water metering, video crime monitoring, smart parking, telemedicine, smart energy, and sensor-based waste management.

4.3. Untangling the Smart Cities Area-Based Development Model

An analysis of the smart city plans undertaken through this study reveals that the 100 cities allocated a

staggering 81% of total funds for ABD. The national smart cities guideline encouraged cities to focus both on ABD and pan-city infrastructure, but soon after the individual city proposals came to light, it was becoming apparent that they decisively moved towards creating area-based urban regeneration creating space for technology experiments to develop smart precincts within cities. Overall, the national program funds one area-based project in each city that would showcase 100 smart precincts across the 100 cities.

The SCM outlines three strategic components of area-based smart city development (see Figure 1): city improvement (retrofitting), city renewal (redevelopment), and city extension (greenfield development). They propose retrofitting techniques for existing built-up areas to achieve the smart city objectives by enhancing the efficiency and livability of neighborhoods. The size of the selected area must be 500 acres or more for retrofitting model implementation. Rather than suggesting an enhanced land consolidation strategy, the guidelines expect existing structures to remain intact and call for some handpicked smart solutions injected into the identified area via the retrofitting approach. Examples of retrofitting projects include installing Wi-Fi hotspots, energy-efficient LED street lighting, CCTV surveillance, smart water metering, and intelligent traffic and parking management solutions.

Redevelopment models will affect a more significant makeover of the existing built-up environment with the development of new layouts, enhanced infrastructure, and using mixed land use and increased density strategies. As per the SCM guidelines, a redevelopment project shall cover over 50 acres and emphasize a higher floor space index, high ground coverage over the selected land parcel, and the release of more green spaces. The vision of this development model is influenced by the former town planning schemes of Gujarat and Maharashtra, considered the best available land development models in India. Smart city redevelopment precincts engage in projects such as road widening: pedestrian and bike infrastructure development, design-implementation of waterfront public spaces, and high-intensity mixed-land use development around public transit stations.

Greenfield development seeks to introduce advanced infrastructure solutions in a greenfield area (over 250 acres) using modern planning strategies, green technologies, and innovative financing and implementation tools. The Ministry of Housing and Urban Affairs (2021c) explicitly suggest that greenfield developments should address the needs of the expanding population

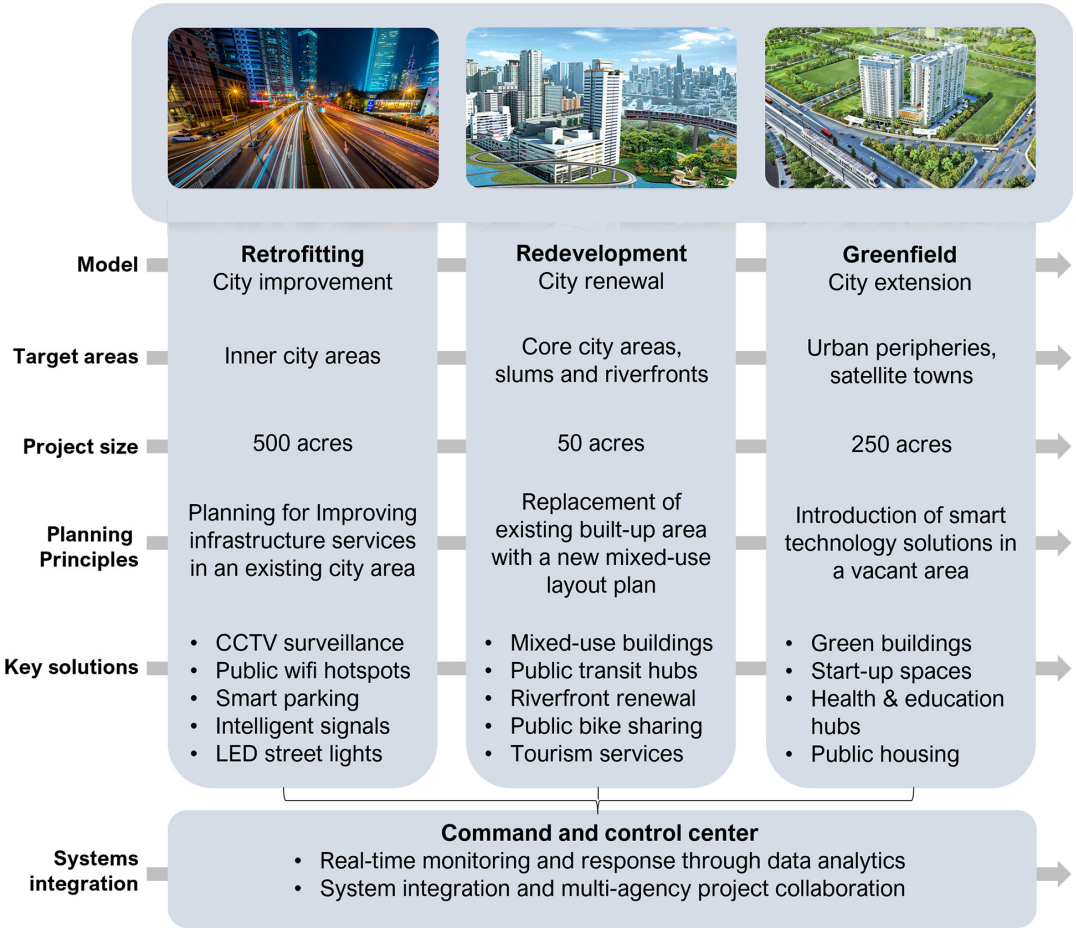

Figure 1. ABD model of the smart cities in India.

in urban peripheries to tackle future growth while also providing high-end infrastructure for attracting businesses. While the retrofitting and redevelopment strategies implemented within the limits of the core city area, greenfield development ideally take place beyond them but within the jurisdiction of the metropolitan authority. Key features and projects of greenfield city extension are green buildings, adequate provision for affordable housing, quality health and recreation facilities, trade facilitation, and startup incubation centers.

The smart cities in India have set out an ambitious plan to develop integrated command and control centers for building synergy between various projects and monitor the performance of urban services and infrastructure (Praharaj, 2020). These centralized urban monitoring systems connect, integrate, and analyze information streamed by the sensors and digitally instrumented devices plotted across the city, somewhat embracing the model of data-driven networked urbanism (Townsend, 2013). The command center projects are based on the premise that rich seams of data can capture, model, and predict the urban processes (Batty et al., 2012) and guide the design of future urban policies and interventions. Moreover, they act as a systems integrator to increase interoperability between various projects and solutions developed by different vendors within the ABD and citywide projects, as well as offering a platform for multi-agency collaboration for planning and designing rapid response to emergencies.

5. Critical Analysis of the Area-Based Smart City Development Processes and Outcomes in India

5.1. What Processes Were Employed for the Selection of Areas for the Smart City Pilot Project?

As outlined earlier in the study, each designated smart city in India selected a particular area for precinct-scale pilot project development. Hence, the contentious issue in the entire development process was: Which area of the city is chosen and how do governments make the selection? An analysis of 100 smart city proposals in this research suggests that authorities primarily relied on voting through online portals and social media to prioritize and identify locations for an area-based urban renewal project implementation. A review of the smart city proposal of Bhunaeswar—the first-ranked smart city by the Ministry of Housing and Urban Affairs—reveals that 26% of the urban population voted in the consultation process, with a substantial number of votes recorded on the government website and through social media drives. Pune city, which received the highest funding allocations through the SCM, boasts on its website (Pune Smart City Development Corporation, 2020) that it has undertaken the largest envisioning exercise in the history of Indian cities, a full-fledged 24×7 virtual war room enabling them to attract participation from 3.5 million citizens. However, the claim appeared to be grossly exaggerated, as the Census of India data shows only 3.12 million people living in the city (Office of the Registrar General & Census Commissioner, 2021). A relatively smaller town in the Himalayan region of India, Agartala, could only engage 11.3% of the city population for its smart city proposal.

The analysis in this study indicates an average of 10 to 15% of the citizens in each city took part in the public participation processes. It is not just that a high majority of people were left out of the consultation process, but an over-reliance on digital means of engagement undermines the value and contribution of the non-digitally inclined population. The citizen engagement mechanisms deployed in the aspiring smart cities failed to acknowledge the challenges posed by the "digital divide," that is, the deep-rooted social and economic inequalities that come about as a result of who has access to communication technology and how they use it. A quick fact-finding from the Census 2011 data shows that a meagre average of 9.8% of households in Indian cities has an internet connection at home (Office of the Registrar General & Census Commissioner, 2021). Household internet access in smaller towns under the SCM such as Pasighat, Dahod, Kavaratti, Satna, Rampur, Sagar, Agartala, and Dindigul is even below 5%. Only seven out of 100 smart cities provide over 20% of households with internet infrastructure. We found the reflection of this digital divide in the areas prioritized for ABD. In the Indian capital of New Delhi, Cannaught Place was selected under the ABD project as it attracted a high number of citizens votes. This exclusive zone has a significant concentration of skilled workforce and serviced industries which meant that people living or working in these clusters could voice their preferences over the rest of the city.

A recent report by the Housing and Land Rights Network (2018) verifies that participation of low-income communities in the smart cities' consultation process has been inadequate. The global agency surveyed five different locations in Bhubaneswar—where nearly half the population affected by ABD lives in slums—to find that none in the disadvantaged settlements were consulted, nor were the residents aware of what smart city development meant for the city or for them (Housing and Land Rights Network, 2018). These findings point to cutting loopholes in the project visioning and prioritization process adopted by emerging smart cities, challenging their sustainability. There is an increasing risk of spatial inequality in physical infrastructure development and the potential of the digital divide between communities as a consequence of such flawed designs.

5.2. Do the Area-Based Development Projects Promote Spatial Inequality and Intra-Urban Disparity?

This study investigates the scale and reaches of the ABD projects across the 100 cities to measure the mission's inclusiveness. An analysis of the smart city proposals in

Figure 2 shows that ABD projects impact less than 5% of the total area per city. This research analyzed data from 75 submissions for which information is available. While there is some variation in the area covered by these cities, an overwhelming number of them (58 out of 75) allocated less than 10% of the urban authority area for smart precinct development. This analysis found that 41 out of the 75 cities earmarked less than 5% of the urban expanse for ABD. In Ludhiana, only 0.3% of the city's total area is covered under the SCM, while in Ahmedabad and Jaipur it is 0.5%. The site developed as a smart city in New Delhi accounts for 0.6% of the total city area, which is only 0.0015% of the total area of the National Capital Territory of Delhi. The cities of Pune, Indore, Lucknow, Amravati, Guwahati, Ranchi, Nashik, and Kota have defined just 1% of the municipal area under the smart city ABD.

Research into the population served by the ABD projects undertaken in this study reveals that only up to one-tenth of the urban population per city is targeted under the proposals. In Pune, a meagre 0.8% of the population will be impacted; in Nashik, 1%; in Ahmedabad, 1.5%; in Bhopal, 1.7%; in Lucknow, 2.5%; in Nagpur, 2.6%; and in Chennai, 3.4%. The scatterplot in Figure 3 characterizes this trend, wherein quadrant B, a number of smaller towns showcase a higher share of population and city area served by ABD. Whereas, in Quadrant A, as many as 29 cities, mostly large ones,

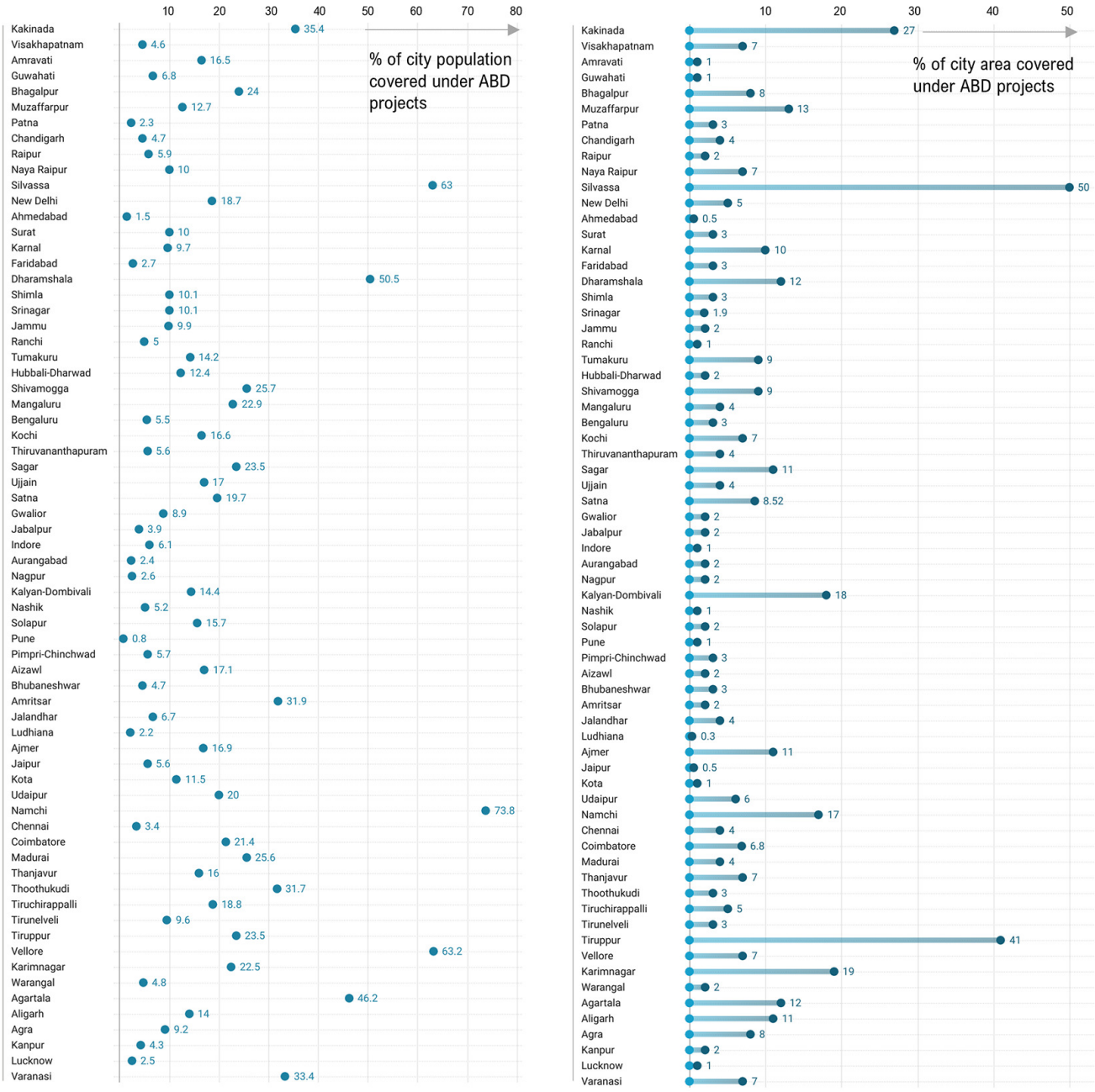

Figure 2. Quantification of the city area and population covered under the ABD projects.

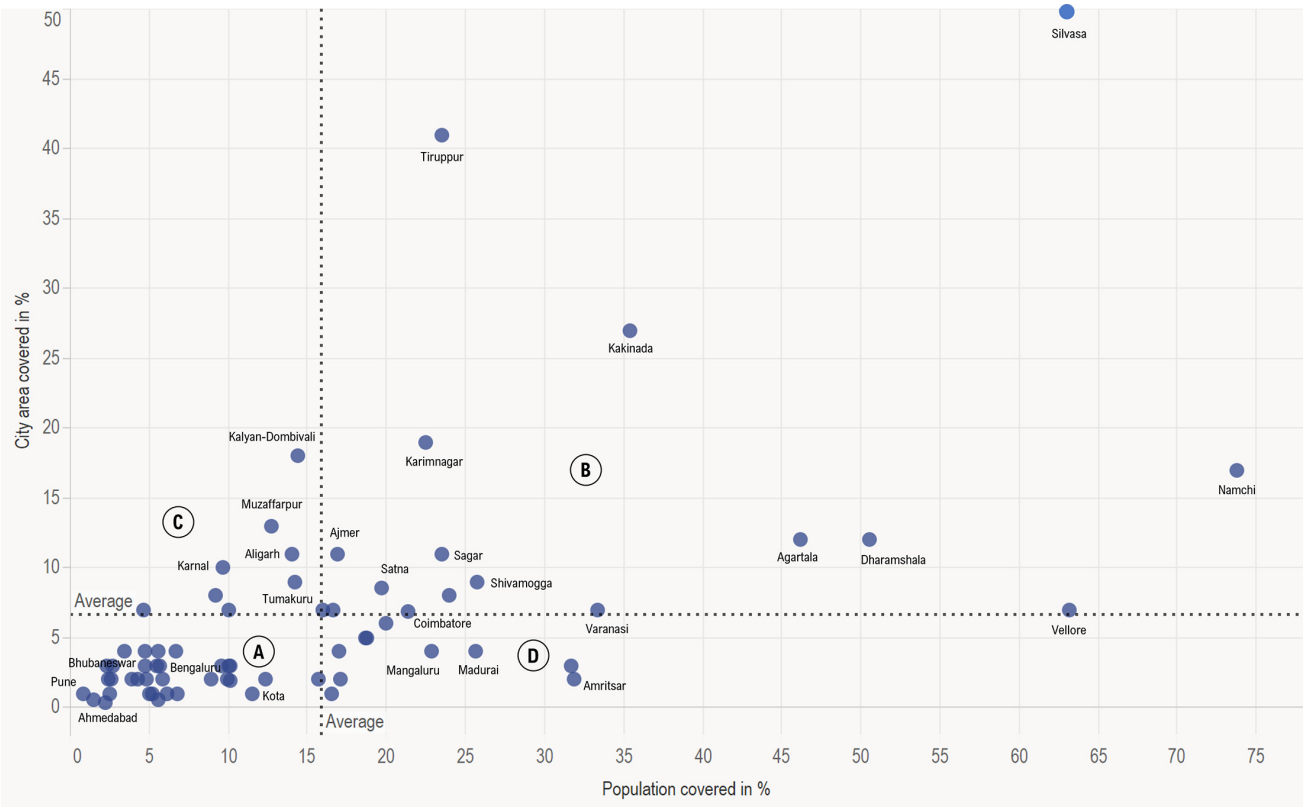

Figure 3. Typologies of cities based on area and population coverage under the ABD projects. Notes: Quadrant A: Low city area and population coverage; Quadrant B: High city area and population coverage; Quadrant C: High city area and low population coverage; Quadrant D: High population and low city area coverage.

show below-par area and population coverage under the ambit of the smart city urban renewal program. Cities that have adopted a more inclusionary approach to include a more substantial share of population under the ABD are Port Blair (77%), Namchi (74%), Pasighat (63%), and Vellore (63%).

Thus, the analysis reveals that 81% of the investments under the SCM allocated for ABD will impact one out of ten people in the 100 selected cities. In the large cities, an average of three out of 100 people will be benefited from ABD projects. The skewed investment towards the development of elite enclaves reinforces existing power geometries and social and spatial inequalities rather than eroding or reconfiguring them. These pilot urban renewal ventures fuel the debate on the possible class inequality effects of policies oriented towards creating smart cities by prioritizing certain areas over others, deepening intra-city inequalities against principles of democratic and sustainable urban development processes. The findings resonate with what Kitchin (2014) emphasized: Smart cities are the vision of certain vested interests, and they serve the interests of those constituencies, both through enacting their sensibilities and politics, and by advancing their economic concerns and material desires. Such approaches have long-term consequences on how infrastructure is planned and distributed, how resources are allocated, and on who can access them within and across cities and regions.

5.3. Local Issues or Global Technology Solutions? A Sector-Wise Analysis of Smart City Urban Renewal Investments

This study brings together data from the various projects and investments identified in the smart city proposals to categorize them under broad sectors. The analysis presented in Figure 4 shows investment share in various sectors across 100 smart cities and the number of projects undertaken by the 33 cities selected in the first and second phase of the SCM. The urban mobility sector received the highest priority, with more than one-fourth of the investment allocated through the program. Economic development, including establishing start-up clusters and innovation spaces within ABD, was issued over 15% of the funds under the SCM. ICT and centralized command and control center projects attracted nearly 14% of the total spending. Education and health sectors and solutions that improve environmental quality and management received the most negligible share of investment (just over 3% each). The analysis suggests that Indian smart cities design favors "hard infrastructure" domains such as transport and utilities where large-scale technology deployment is likely, with a significant presence of vendors in the market having numerous "plug and play" digital solutions. In contrast, "soft infrastructure" domains like education, health, and affordable housing, where ICT application has a seemingly limited

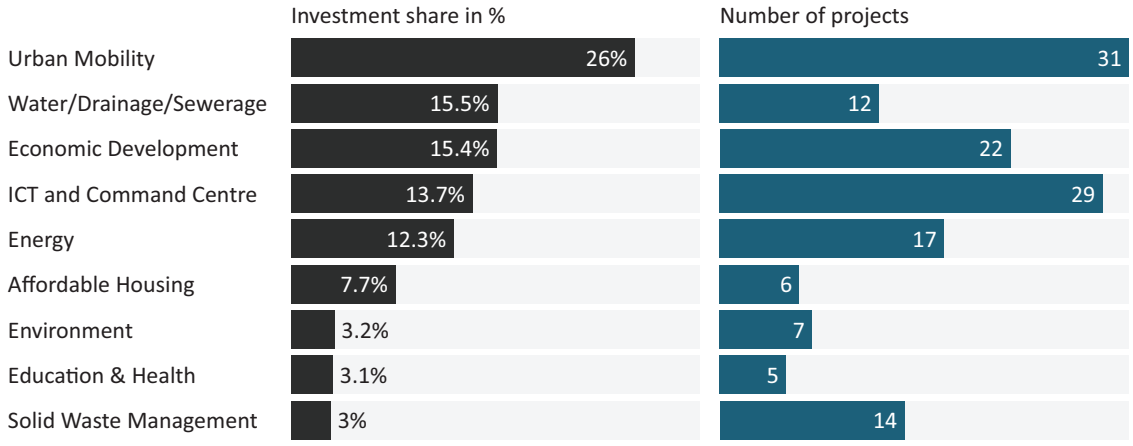

Figure 4. Sector wise investments and projects identified in the smart city proposals. Notes: Investment share was calculated from smart city proposals from across 100 cities. The number of projects reflects data from the 33 cities selected in the first and second phase of the SCM in India.

role (Caragliu et al., 2011), was ignored with limited activities proposed in the sector.

While the Indian smart city plans suffer from a narrow spatial focus and developments targeted exclusively of handful sectors and ICT solutions, recent studies emphasize the need for critical social infrastructure for sustainable development in the region. Praharaj and Han (2019a), while building a typology of these 100 smart cities using a series of key performance indicators, found that social capital, including education, health facilities, and lack of access to housing, severely impact the quality of life in small and medium-sized towns in India. Similarly, Rana et al. (2019) asserted that environmental challenges of growing pollution, social challenges of urban safety, and lack of community services are significant barriers to smart city development in the Indian context. Overall, these analyses show that the SCM lacks an objective approach to engage with local issues. Instead, the attempted design of high-tech urban precincts and elegant digital solutions through vendor-driven policy and technology mobilities suggests that aspiring smart cities concentrate on building "smart utopias" rather than "smart realities." As Datta (2015) explains, attempts to provincialize western models of smart urbanism in India show no concern for producing socio-political and material outcomes. Instead, such utopian urban planning envisages urbanization as a business model rather than a model of social justice for sustainable cities.

5.4. The Likelihood of Increased Segregation and Gentrification From Smart City Area-Based Development

This research finds that 92 among the 100 cities have adopted redevelopment and retrofitting models for ABD that target urban core and central business districts. Ironically, a large number of populations in the inner-city areas across India lives in slums. As per the 2011 Census (Office of the Registrar General & Census Commissioner, 2021), nearly 14 million households live in urban slums, with three million homeless living on city streets in India. The drive for smart cities is triggering evictions of people from slums and informal settlements. There are already reports of slum demolition from Indore, Bhubaneswar, Delhi, and Kochi without adequate compensation or alternate accommodation (Housing and Land Rights Network, 2018). Besides state-sponsored evictions, there is a growing likelihood of market-driven evictions in some of these smart city enclaves due to a sharp increase in rental rates and housing prices. Experience from global cities suggests that high-quality services and concentrated prosperity of workers in the digital economy lead to rising rents and increased demand for housing that places disadvantaged citizens, such as slum dwellers and urban poor, at risk. For example, Caprotti (2014), examining the smart Chinese cities, found that materialization of flows of capital and smart technologies in urban centers leads to glittering real estate developments built from scratch by low-paid workers, in which they cannot afford to live themselves, and these geographies of inequality often see low-income households denied access to schooling and critical healthcare. This constitutes the generation of a class of "new urban poor" on the fringes of flagship smart cities and other spectacular urban developments.

The area-based smart city development in India promises high-quality infrastructure and ICT-driven services, including free Wi-Fi, improved traffic control, intelligent sensors, and better utilities with significant contribution from the private sector participation and investment. The SCM guidelines encourage cities to charge higher taxes and user fees for providing modern infrastructure, a convenient policy to attract private capital. The Housing and Land Rights Network (2018, p. 41) quotes the Pune city CEO, saying: "The government is spending more than Rs 1,000 crore for better infrastructure and facilities in the ABD area. Since the area residents are getting better infrastructure, they won't mind paying increased water charges and taxes."

The high quantum of charges for essential services like water and sanitation could potentially increase the financial burden on the poor, pushing the low-income groups to city peripheries. Thus, smart city policies and technologies in India threaten to marginalize particularly those in acute poverty and informal economies, leading to irreversible consequences of economic, spatial, and cultural polarization.

5.5. Does the Area-Based Smart City Strategy Enable Convergence and Integration?

This section positions the smart city ABDs within the broader context of urban planning and policymaking in India to examine how the SCM aligns with the overarching city goals. Alongside the SCM, the Ministry of Housing and Urban Affairs announced the Atal Mission for Rejuvenation and Urban Transformation, focusing on infrastructure upgradation across 500 cities in India and the Housing for All mission to supply affordable housing for the poor in 305 cities. The Ministry of Culture simultaneously implements the National Heritage City Development and Augmentation Yojana to preserve and revitalize cities with heritage character. These mega schemes are accompanied by the Clean Indian Mission for improving urban sanitation and the Digital India program to ramp up fiber infrastructure connectivity across the large cities. Most of the 100 smart cities are entrusted with implementing these schemes simultaneously, raising apprehension about the occurrence of multiple planning documents with different visions emerging from these programs. A close look at the SCM guideline shows it did not have a framework or outline regarding how these different initiatives will be coordinated for the cities' common good.

As cities are beginning to engage in smart city projects, it is becoming apparent that they are looking to implement pilot projects focusing on a narrow scope with high visibility. There is an absence of strategies to integrate smart city projects with existing planning instruments. For example, this study finds that there are at least eight different plans simultaneously being executed in the city of Bhubaneswar, all aiming at urban development, either holistically or focused on a sector. The smart city proposal is unconnected and has little convergence with the existing state and city-level statutory plans. In stark contrast to the Comprehensive Development Plan, which emphasizes strengthening existing traditional industries and heritage zones, the Smart City Plan promotes technology and knowledge-based enterprises.

A lack of cohesive approach to development and continuous experimentation with new plans work as barriers to project implementation and achieving sustainable urban development goals. Figure 5 shows the fund utilization efficiency and project completion performance of the top 20 cities selected in the first phase

Cities	Number of project tender issued	Number of projects completed	Fund utilization efficiency (%)
Chennai	45	37	62%
Kakinada	93	51	47%
Indore	280	226	46%
Surat	87	64	43%
Udaipur	128	68	36%
Belagavi	217	126	33%
Bhopal	96	55	28%
Ahmedabad	73	42	24%
Coimbatore	72	55	22%
Pune	60	19	18%
Jaipur	143	35	17%
Visakapatnam	66	41	17%
Jabalpur	97	42	15%
Davanagere	106	36	11%
Solapur	46	23	6%
Ludhiana	46	8	6%
Guwahati	10	3	1%

Figure 5. Status of project completion and fund utilization by the top 20 cities selected in the first phase of SCM. Note: Data for three cities in this list (Bhubaneswar, Kochi, and New Delhi) were not available.

of the SCM. These cities were supposed to complete all project delivery by January 2021 as per the SCM deadline. However, the data collected through this research on April 20, from the Ministry of Housing and Urban Affairs' (2021b) website, highlight that nearly half of those cities are struggling even to spend one-fifth of the funding allocated. Guwahati could spend as much as 1%, and Solapur and Ludhiana consumed 6%. Dvangere completed just one-third of the projects identified in the smart city proposal, whereas Jaipur implemented 35 out of 143 projects. The below-par performance in project execution by the so-called top-ranked smart cities exposes the acute lack of capacity, planning, and desired impact of the grand utopian scheme.

6. Discussion and Conclusions

The much-debated concept of smart cities can potentially play a significant role in addressing sustainability and quality of life issues in cities. At the same time, there are severe challenges posed by the emergence of technology and business-driven urban development processes. This article critically analyzed India's SCM to highlight the design, implementation, and impact of a new area-based urban development model implemented across 100 cities with global implications. The three strategic components of area-based smart cities—retrofitting, redevelopment, and greenfield development—somewhat reflect the aspirations of living labs (such as the 22@Barcelona) and innovation districts (e.g., Medellínnovation District of Medellín, Colombia) where ICT infrastructure, clustering of innovative businesses, and neoliberal urban spaces serve a digitally-inclined "creative class" (Florida, 2005). This study finds that although the smart cities program is a timely initiative considering the surging urbanization and multifaceted challenges facing Indian cities, there are flaws and inconsistencies in the narrative, design, and implementation.

Results show that area-based urban renewal projects in Indian smart cities follow an exclusionary development approach, targeting an average of less than 5% of the city area and denying nine out of 10 people the new services and opportunities. The SCM allocates over 80% of the investment for just 10% of the urban populations across the 100 selected cities set to exacerbate intra-urban contrasts. The selection of elite localities through online and social media voting throws light on the new-age smart city that promotes the "digital divide" rather than enforcing "digital inclusion." Instead of developing social infrastructure (education and health) and affordable housing to meet the challenges of urban poverty, slums, and basic services, the SCM predominantly invests in building smart city command and control center and ICT-oriented services. In the promise of better high-quality infrastructure, the ABD model leads to evictions of slum dwellers and forced migration of low-income communities out of the business districts due to a sharp increase in rents, taxes, and amenity fees. These findings suggest that cities with a broader portfolio of investments in "smart" initiatives are not necessarily better or more livable. Instead of attaining a fairer democracy and quality of life, it may turn into a dystopian, anti-people environment where urban spaces are used to create business opportunities for corporate profits. However, the study finds that small and medium-sized towns, such as Pasighat, Silvassa, Vellore, Port Blair, Namchi, Kakinada, Agartala, Varanasi, Thoothkudi, and Amritsar, show cognizance of the social and cultural implications of the smart city movement in India to include a significant share population within their smart city ABDs. The smart city planning processes in these towns provide opportunities for in-depth research that could offer new lessons for designing sustainable future smart cities.

This study recognizes the need for Indian cities to design holistic urban planning approaches that engage and impact the diverse demographics and contested landscapes unique to the region. Mere "technological fixes" in smart enclaves will not meet the complex urbanization challenges facing cities of the global south; instead, they will lead to increased spatial inequality and socially polarizing outcomes. The smart city pilot projects should engage with the underlying environmental, economic, and social sustainability issues from the sprawling urban fringes to the congested slums and deteriorated older city areas. Social sustainability implies that smart cities have to be not just technological, but also inclusive and emphasize the construction of social relations and networks of trust and reciprocity, as well as investing in human capital to foster the urban capacity for learning and cooperative innovation (Nam & Pardo, 2011; Yigitcanlar et al., 2019). Such a change in the urban planning approach can genuinely impact ordinary people beyond the affluent class. Smart city plans should not be conceived as standalone documents but designed around the city's core long-term visions and master plans. The findings support existing literature that suggests sustainable cities require strategies and methods that incorporate the perspectives and needs of a broad range of stakeholders (Hollands, 2008; Praharaj et al., 2018b). Simply adopting sophisticated ICT infrastructure or showcasing self-promotional business hubs will not lead to practical cities. Real smart cities require a more holistic approach to digital urban renewal that involves the devolution of power and strategies that address urban inclusion, sustainability, and resilience. These lessons are critical to support humane smart cities development in the Global South, which faces unprecedented challenges to meet the global sustainable development goals.

Acknowledgments

The author expresses sincere appreciation to Alexandria Drake, global health PhD candidate at Arizona State University, for proofreading the final manuscript.

The author acknowledges the valuable and constructive suggestions provided by the reviewers during the peer-review process. The work is conducted at the Knowledge Exchange for Resilience at Arizona State University, which receives funding from the Virginia G. Piper Charitable Trust.

Conflict of Interests

The author declares no conflict of interests.

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About the Author

Sarbeswar Praharaj (PhD) is the associate director and assistant research professor at the Knowledge Exchange for Resilience, School of Geographical Sciences and Urban Planning at Arizona State University (ASU). He is a senior global futures scientist at the Julie Ann Wrigley Global Futures Laboratory. Before joining ASU, he was a postdoctoral researcher and manager of the City Analytics Lab at the City Futures Research Center, UNSW Sydney. Dr. Praharaj leads research on smart cities, data visualization and city dashboards, and resilience. He engages in research-led interactive teaching and learning pedagogies in urban planning and geographical science.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 216–227
https://doi.org/10.17645/up.v6i4.4485

Article

Can the Pandemic Be a Catalyst of Spatial Changes Leading Towards the Smart City?

Barbara Zgórska *, Dorota Kamrowska-Załuska and Piotr Lorens

Faculty of Architecture, Gdańsk University of Technology, Poland; E-Mails: barbara.zgorska@pg.edu.pl (B.Z.), dzaluska@pg.edu.pl (D.K.-Z.), plorens@pg.edu.pl (P.L.)

* Corresponding author

Submitted: 7 May 2021 | Accepted: 13 August 2021 | Published: 17 November 2021

Abstract
The worldwide spread of Covid-19 infections has had a pervasive influence on cities and the lives of their residents. The current crisis has highlighted many urban problems, including those related to the functionality of urban structures, which directly affect the quality of life. Concurrently, the notion of "smart cities" is becoming a dominant trend in the discourse on urban development. At the intersection of these two phenomena, questions about the effects of Covid-19 on the future of cities arise. These are concerned with the possible roles of the pandemic in the process of urban regeneration and the development of smart solutions. The article aims to create a conceptual framework that will allow researchers to assess the influence of Covid-19-related changes on urban structures and their functionality in the following areas: city structure, connectivity and mobility, public spaces, access to green areas, and digital transformation. In the empirical part of the article, the influence of pandemic-caused changes on the development of various aspects of smart cities is discussed. The article concludes with an analysis of the effects the pandemic might have on digital urban regeneration.

Keywords
Covid-19; smart city; urban change

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

The coronavirus disease (Covid-19) is considered to have a pervasive influence on people living in cities. But one must note that hazardous situations and extreme challenges have shaped cities/urban organisms since the beginning of times. Plagues, wars, political changes, or even abrupt economic transformations have led to new ideas in city development (British History Online, 2019; Naphy & Spicer, 2004). For instance, in 17th-century London, which at the time had about half a million inhabitants, in the face of the plague of 1663–1665 and the Great Fire of 1666, a new law was adopted. It regulated the principles of the city's reconstruction, taking into account higher fire resistance of buildings, and the creation of wider streets and pavements (British History Online, 2019). After the cholera epidemic in the 19th century, a sewage system was implemented in Paris and London by separating waste from drinking water, thus identifying the sanitary (and metaphysical) need to maintain cleanliness (Naphy & Spicer, 2004). Relatively recent pandemics (e.g., smallpox, SARS, swine flu) led to the development of mathematical solutions connected with the mobility of people and social networks, allowing the control of infectious diseases. Those analyses contributed to a better understanding of the dynamics, transmission mechanisms, and spatial correlations of diseases that can help administrative authorities in crisis management (Eubank et al., 2004; Keeling, 1999; Parimala & Lopez, 2016).

Changes brought about by the Covid-19 pandemic can be considered as a test bed for the functionality of urban structures, underlining the already existing urban problems. Thus, the question is whether the pandemic, as it is opening a new perspective on the functioning of cities and the quality of their residents' lives (Dietz et al., 2020), can be a catalyst of change. The pandemic increased the acceptance of digital transformation (Nicola et al., 2020), which is at the core of the notion of smart cities and starts to be seen as one of the pillars of future urban development (Chourabi et al., 2012; Neirotti et al., 2014). Although initially focused mainly on information technology, currently the transformation encompasses institutional and social elements related to technologies facilitating the transformation of the economy, environment, and community (Berry & Glaeser, 2005; Coe et al., 2001). Will the pandemic further change the concept of a smart city, bringing it closer to the notion of resilience and defining it as a city that is resistant to both pandemic crises and responsive to the challenges of the climate change?

Smart solutions and strategies deeply influence the spatial configuration and functioning of urban areas (Caragliu et al., 2011). Information society strongly shapes the environment we live in and influences relations within the society as well as the urban flow of materials, people, and goods. The use of big data creates new design opportunities for cities, allowing them to create better services, and more effectively address residents' needs. It also supports agile adaptation to changes. To examine how those two phenomena influence the future planning of cities, it seems sensible to ask: Will the pandemic produce significant changes in shaping the cities of the future? May it be a catalyst of urban change? If so, what kind of transition will urban areas face because of these new phenomena? What role can smart solutions play in that change?

2. Background: Influence of the Covid-19 Pandemic on Cities and Their Smartness

In this article, we aim to analyse the impact caused by the Covid-19 pandemic in the following areas: (a) city structure, including polycentricity; (b) mobility and public transportation; (c) shape and functions of public spaces; (d) access to open spaces and green areas; and (e) digital transformation. We have selected these aspects in an analysis of current trends in city transformations, bearing in mind their sustainable development and urban renewal in the post-pandemic future. These aspects are, at the same time, influenced by the idea of a smart city and the Covid-19 pandemic-related changes. These basic aspects of the functioning of cities are identified, among others, by Bereitschaft and Scheller (2020; see also Florida, 2020). In the empirical part, we analyse how changes in these aspects relate to various components of the "smart city" (smart governance, smart economy, smart mobility, smart environment, smart people, and smart living) using the proposed assessment framework. To discuss the most relevant connections and relationships, we relate both blocks of issues to each other based on the proposed qualitative assessment framework.

2.1. City Transformation Trends Strengthened by the Covid-19 Pandemic

The city structure concerns general relations between various areas. Specific attention is paid to the workplace–school–residence relationship as the most frequent transportation route for city dwellers. Changes in workplace distribution, managing public facilities and spaces are currently vital, too, in the development of spatial policies. Computer modelling allows municipalities to investigate the relationships between travel destinations and the choice of a means of transport (Frank, 1994), as well as the behaviours related to commuting to work (Smith & Zenou, 2003), or the relationship between the spatial structure and resilience of cities (Yuwen et al., 2020). In global travel destinations, the suspension of tourist traffic resulted in the emptying of city centres, highlighting the historical importance of overtourism and its impact on residents, the local economy, the preservation of public spaces, and the destination's capacity.

Mobility and public transportation refer to balancing and reducing the dependence of residents on the car, promoting public transport and planning transport in the spirit of the idea of the smart city (Diao, 2019; Nakamura & Hayashi, 2013). The city is developed to allow access to primary services on foot—following the idea of chronourbanism (Gwiazdzinski, 2015) and the 15-minute city (de Valderrama et al., 2020; Graells-Garrido et al., 2021), or even a five-minute city (Maas, 2003). In light of these trends, citizens who experience remote work or distance learning gather new habits about city mobility and space accessibility and functionality around their place of residence.

The shape and function of public spaces are considered as important elements of the visual perception, comfort, and safeness in the cities. Increasing the possibilities of exploration and reorganising towards greater accessibility also for excluded groups (Gehl, 2007) is one of the current trends in the transformation of public spaces (Stevens, 2007). Limiting individual car use during the most severe restrictions, while introducing the obligation to maintain physical distance, changed the way streets and pavements have been used in cities, which is in line with the current trends of increasing the functionality, accessibility, and quality of public spaces.

Access to open spaces and green areas is an element of urban policies developed in cities in the spirit of the idea of environmental justice as well as the quality of green space concerning the cultural needs of a given community (Kabisch & Haase, 2014), aimed at improving access to green areas (Fuller & Gaston, 2009). Increasing the availability of green areas in cities improves their resistance to climate change. During the

Covid-19 pandemic, our attention was drawn not only to parks and city squares but also to places that had not been explored, such as the so-called urban wasteland, degraded areas, and even rooftops that can be adopted for recreational purposes (Honey-Rosés et al., in press).

Digital transformation acceleration caused by the pandemic tends to be one of its most significant long-lasting effects, indirectly influencing changes leading to the development of the smart city (Soto-Acosta, 2020). The crisis has shown the potential of digital technologies. The Covid-19 pandemic has also caused ubiquitous technologies embedded in the public realm to gain higher public acceptance. The implementation of innovations in a remote form will be a permanent effect with a significant impact on relations between city residents (Hantrais et al., 2020). It may also support post-pandemic digital urban regeneration.

2.2. Smartness Embedded in City Structures

Although smart city assessment frameworks originally focused on information technologies, currently, all the analysed smart city models stress the importance of institutional and social elements related to technology that can support the transformation of the cities, their economy, environment, and community (Berry & Glaeser, 2005; Coe et al., 2001). Those assessment frameworks developed from a technology-oriented approach into a holistic framework, allowing for the evaluation of all aspects of smart urban space. Although in recent years various new smart city assessment frameworks have been introduced, both on the functional level of city development (ITU-T Focus Group on Smart Sustainable Cities, 2015; UNECE Committee on Housing and Land Management, 2015) as well as on the assessment of the spatial dimension of smart cities (Komninos, 2011), we would like to argue that the classical framework proposed by Griffinger et al. (2007) and further developed by Cohen (2014) still allows for a comprehensive evaluation of all aspects of smart urban development. Thus, for our analytical model based on the work of Griffinger et al. (2007), we have defined six distinct dimensions of smart development. With already existing studies anchored in Griffinger et al. (2007) and Cohen's (2014) respective studies based on the ecosystem approach (Coca-Stefaniak, 2019), as well as case study analyses (Boes et al., 2016), the chosen framework allows the analysis of smartness through the lens of Covid-19 impact on city transformation trends concerning cities' urban tissue, flows, public spaces, open and green areas, as well as digital layer.

Murgante and Borruso (2015) stress the need to combine the concept of the smart city with the essence of the city itself and with its structural problems. At the same time, as the majority of smart city assessment frameworks focus either on the macro scale of entire city organisms (Angelidou, 2014; International Organization for Standardization, 2014; Kourtit & Nijkamp, 2013) or directly on the assessment of single projects (Bosch et al., 2017; Monzon, 2015), in our framework, we decided to focus on the mesoscale, trying to get into more fine-grain analyses of urban structures. The second aspect of our assessment framework is to include technological issues in the planning framework, with special attention paid to social impact. Smart solutions can only help to solve structural problems of the cities if they simultaneously answer societal needs while being embedded into urban systems. For instance, if a city has a structural mobility problem, it is quite impossible to solve it only with GPS and internet accessibility. This approach formed the basis for a study of how Covid-19-imposed changes impact conceptual components of the smart city. Based on the above-mentioned criteria, the conceptual components of the smart city (see Griffinger et al., 2007) identified in this study are the following:

- Smart Governance (participation): Supports co-creation and participation in decision-making; it is also the factor that enables the use of available technology through transparent, multilevel governance and collaborations with other municipalities and stakeholders to meet citizens' needs and to improve public services.
- Smart Economy (competitiveness): An urban economy where the sector gathers innovation and productivity to adapt to the market's and workers' needs, to enhance the sharing economy, open business models, and use of smart procurements, leading to a resilient global model for both local and global market competition.
- Smart Mobility (transport and ICT): It is expected to offer innovative, clean, equitable, and safe transport systems for people, goods, and data by using available technologies to gather and provide information to users, planners, and transport managers.
- Smart Environment (quality of life): It uses data on utility networks, users, and other city resources (air, water) to establish the main areas of activity in urban and city infrastructure planning, as well as to support urban service managers in achieving sustainable environment and to improve citizens' quality of life.
- Smart People (social and human capital): It empowers citizens to participate in decision making and smart urban life, helping them to adapt to new solutions by providing creativity, innovation, and diversity to their communities; it also focuses on education, which appears to be the main tool to improve this dimension, as well as initiatives to retain creative profiles.
- Smart Living (social equity): Efficient management of urban facilities (e.g., cultural, recreation), public spaces, and services (e.g., healthcare, education) using ICT technologies to improve accessibility, flexibility of use, and to meet citizens' needs and eliminate social exclusion.

3. Conceptual Assessment Framework

To achieve the aims of our study, we introduced a framework that allowed us to evaluate the relation between the implementation of smart strategies or solutions and the changes strengthened by the Covid-19 pandemic in five main areas, described in Section 2. The conceptual framework used in this study is based on the findings of the ASCIMER project (Monzon, 2015), which show how urban challenges in European cities can be classified concerning the smart city action fields. The framework was adopted to study how different Covid-19-caused urban trends influence the smart development of the cities. Our model allows us to assess how strategies and solutions concerning different aspects of the smart city idea—governance, economy, mobility, environment, people, and living—may support the positive changes caused by the Covid-19 pandemic on different aspects of city structures. Those changes were assessed in the context of the future renewal of cities, indispensable to support their resilience to other pandemic crises and their response to the challenges of the climate crisis. Due to the fairly short period that has elapsed since the pandemic started, we based our study on short-term changes and interventions. We also tried to predict possible long-term effects of those changes.

Table 1 assesses city transformation trends strengthened by the Covid-19 pandemic (columns) concerning aspects that characterise smart solutions (rows). It was assessed crosswise whether, within a given relationship, the interactions might be strong, moderate, or insignificant. The assessment relies on the above-mentioned phenomena; evidence was gathered in desk research of scientific papers, case studies, published policy reports, and own observations from planning practice. A strong relation (++) is supported by both empirical research of case studies and policy implementation. A moderate relation (+) represents indirect influence supported by empirical research, with no policy implementation observed on the strategic level. In the case of a lack of defined association, the relationships are omitted (−).

3.1. Influence of City Structure on Development Changes in the Smart City

The research conducted in Guadalajara since 2009 (AH1N1 influenza pandemic) and on theoretical models has shown that the reduction of interactions between residents of distant neighbourhoods travelling to the centre (or other work areas) has a vital importance for reducing the spread of the pathogens (Brizuela et al., 2021). The study also indicated a need for an in-depth analysis of mobility patterns, which is crucial in shaping spatial connections. It also showed that city spatial structures based on mono functionality and separation lead to a faster spread of pathogens than the model based on dispersed areas of human activity. Research conducted in Madrid (Menéndez & Higueras García, 2020) and Porto (da Silva Lopes et al., 2021) during the Covid-19 pandemic has shown an accelerated loss of traditional service functions by city centres, especially those targeting global tourism. These studies highlighted the need to deepen the analysis in the context of the polycentric development of urban structures.

According to an IPC Research Institute (Wrocław, Poland) report based on statistics, the number of people working remotely in their place of residence increased by about 60% in the first months of the pandemic (KPMG, 2020; Krysiński, 2020). The popularisation of remote work resulted in the reduction of demand for office space. Surveyed companies declare at least partial implementation of the remote-work model on a larger scale than before (Colliers, 2021). In the field of ad hoc measures, initiatives have been taken in many cities to prevent crowded commutes and gatherings in workplaces. The local governments recommended staggered work hours e.g., in the Ile-de-France region (UN, 2020), a charter with businesses, social partners, local governments, and the public transportation sector with suggestions to stagger arrival and departure times in businesses is being negotiated.

It can be noticed that the Covid-19 pandemic has accentuated, among others, the problem of excessive concentration of areas dedicated only to tourism and

Table 1. Impact of the pandemic-caused changes on the development of various aspects of smart cities.

		City Transformation Trends Strengthened by the Covid-19 Pandemic				
		City Structure	Mobility and Public Transportation	Shape and Function of Public Spaces	Access to Open Spaces and Green Areas	Digital Transformation
Smart	Governance	−	−	−	−	++
	Economy	+	−	−	−	+
	Mobility	+	++	−	−	+
	Environment	−	−	++	++	+
	People	−	+	+	−	++
	Living	+	−	+	+	+

accelerated trends in the implementation of remote work and learning. While distance learning, especially at the primary and secondary levels, seems to be a temporary change, remote work, especially in the service and administration sector, may turn out to be more permanent and more common.

In light of individual smart aspects, it can be assumed that as a result of the pandemic, development strategy models, business models, and adaptation to current changes in the local and global economy (smart economy) will change faster. The second aspect is the interrelated change in lifestyles, ways of travelling, and especially of studying and working, resulting in changes in travel patterns that may be permanently changed (smart mobility and smart living).

3.2. The Influence of Urban Flows, Connectivity, and Mobility Changes on Smart Cities

The launch of both remote work and distance learning systems reduced individual road traffic and, at the same time, severe restrictions for public transport passengers were introduced ("Coronavirus: Wuhan shuts public transport over outbreak," 2020; Xu, 2020). According to a report by Moovit (2020), a leading website implementing mobility solutions, in the first months of the pandemic, public transport travel in cities around the world fell drastically—e.g., 86% in Madrid, 54% in New York, 24% in Lyon, 44% in London, and 30% in Gdynia, Poland (Management of Roads and Greenery, 2020). As a result of the restrictions, many city dwellers chose alternative ways of getting around, such as shared transport, bicycles, or walking (von Oldershausen, 2020).

Users of most applications admit that they are more likely to walk or cycle now than before the pandemic. The recovery of public transport depends on increasing the frequency of vehicle journeys, the possibility of contactless payment service, and improving the sanitary and hygiene conditions in vehicles, including better air exchange (Moovit, 2020).

Pilot actions in the field of mobility and public transport development have been implemented in many cities as necessary conditions for their efficient functioning. A suitable example of such an approach can be the case of Madrid, where implementation started with simple solutions to reduce direct social contact by providing the majority of trains (64%) with automatic doors and rearranging bus routes based on the current variations in demand. At the same time, due to the influence of the pandemic on urban supply chains, new innovative solutions have been introduced. Cities adopted various "responsible transport policies," which varied in their approaches and degree (Kim, 2021). Lee and Lee (2020) describe early actions which have been undertaken in cities of South Korea such as drive-thru testing facilities or aggressive contact tracing, as well as the adoption of new technologies like online mapping to track the spreading of the disease.

The cited studies indicate that, in terms of mobility, the changes caused by the current pandemic may affect the transformation of cities in the spirit of smart mobility and smart people, due to the need to adapt public transport to its users, who are now more aware of their needs after the pandemic. The post-pandemic public transport crisis may become an opportunity to create a more sustainable, digitally assisted system based on new customer-oriented technologies (Moovit, 2020).

3.3. The Influence of Change in Shape and Function Public Spaces on Smart Cities

Various cities such as Vienna, Boston, Oakland, Philadelphia, and Minneapolis limited space for cars as they wish to give it back to pedestrians and cyclists (Laker, 2020) within the World Health Organization (2021) guidelines on social distancing. These temporary road closures and other short-term measures serve as a testing ground for changes in the public realm that may eventually become permanent (Bliss, 2020; Honey-Rosés et al., in press). In Bogotá, cycle lanes were widened and 76 km of temporary cycling paths were added. Milan also added 35 km of cycling paths (Armario, 2020).

In Gdańsk, Poland, Wajdeloty Street was temporarily closed to car traffic, making it available to residents as a promenade with extended restaurant gardens established in recent years in a renewal programme (Portal of the City of Gdańsk, 2020). Prototyping and implementing solutions for the duration of the pandemic can consolidate the use of squares and streets, supporting the process of change in degraded city areas. Recognising the need to maintain physical distance, several initiatives whose goal was to widen sidewalks and separate bicycle paths in existing roadways appeared. These initiatives were described on industry portals or local government websites (Combs, 2020).

In Baltimore, a guide for model solutions for the development of space was created to support interaction between residents on streets, squares, and pavements dedicated to the time of the pandemic. The recommended solutions are universal. Using squares to create a local housing estate centre for organising social activities (childcare, snack food, daily service points, or a library) can be implemented in any city (City of Baltimore, 2020).

Monitoring tools have been implemented on a larger scale in cities. Already in 1975 Foucault indicated that public spaces were being increasingly "panopticonned," i.e., subject to observation and control (Foucault, 1977), but the Covid-19 pandemic sanctioned this situation. For instance, France used CCTV in the Paris metro to estimate the use of facemasks (Honey-Rosés et al., in press). Rapidly developing phone applications for contact tracing started to be widely accepted by the public (French & Monahan, 2020). One can find more than 50 state-driven tracking applications projects in 30 countries, in addition to the collaboration between Apple and Google (GDPRhub, 2021). It is highly probable that those kinds of

systems, when fully introduced, will stay with us for a long time. The mentioned examples of research and activities indicate that the pandemic has contributed to a change in the use of public spaces related to the notions of a smart environment. Local and bottom-up initiatives can be considered activities in the spirit of "smart people"—communities seeking active measures to improve the quality of life by strengthening social capital, increased control, and narrowing the sphere of privacy.

3.4. The Influence of Change in Accessibility to Open Spaces and Green Areas on Smart Cities

With limited access to other recreational areas, the importance of public greenery increased during the pandemic. The research conducted on global, regional, and local scales, based on data from the Google Community Mobility Report (Google, 2021) from the first wave of the pandemic (February through May 2020) points to increased activity in the immediate area of residence up to several dozen percent (Slater et al., 2020). Conclusions from the Oslo research show that densely wooded areas on the outskirts of cities and green areas within residential estates were more willingly used; this study also indicated that residents adhered to physical distancing recommendations by avoiding frequently visited areas (Venter et al., 2020).

Searching for opportunities to enlarge open spaces dedicated to recreation, city residents turned towards less frequented areas, which caused spaces that were previously used passively to become populated (Jakubowski, 2020; The Trust for Public Land, 2020; van den Berg, 2020). The research analysing park visits in 130 countries around the world has shown an increase compared with a baseline from before the outbreak and has associated this phenomenon with the restrictions in the public policies that limited people's social and physical contacts (Geng et al., 2020). These studies, even though they prove similar phenomena, cannot be universal due to various restrictions that were introduced by governments or regions.

As early as April 2020, recommendations for actions to prevent mental and psychological problems in the face of the pandemic, including the need to spend time in the natural environment, were advertised (Mental Health Foundation, 2020). In parks and squares around the world, initiatives were implemented ensuring contact with nature and interaction between people while maintaining the recommended distances (Harrouk, 2020; Union of the Baltic Cities, 2020).

Access to open areas and greenery is one of the smart factors describing the quality of life in the city related to environmental factors (smart environment). Access to green areas is related to the smart living factor through the analytical methods for better planning. The spatial structure of cities can also be planned more effectively if planners think of reusing degraded areas for recreational purposes.

3.5. The Influence of Digital Transformation on Smart Cities

Throughout the pandemic, using modern technologies, local communities and spontaneous initiative groups (e.g., in the French cities of Bordeaux and Reims, as well as in Milan) have developed platforms to exchange information based on both existing and newly created social media platforms (EUROCITIES, 2020). Industries with the highest level of remote work managed to maintain their business activity at the level of 70–80%. At the same time, the risk of deepening social and economic inequalities resulting from limited access to Internet networks (both for entire countries and social groups) remains at the same level (OECD, 2020a).

For many municipalities, the pandemic was a strong push towards promoting digital literacy among citizens. A good example is a consultation process for development plans in small Polish municipalities conducted under the project New Quality of Public Consultation. Since March 2020, meetings have been held online while local governments received technical and methodological support for the process. Inviting online participation has become common practice not only in large cities but also in smaller towns and villages. The crisis is pushing many cities to accelerate their pursuit of digital solutions not only during lockdowns but also in the long-term as part of their participatory processes. Cities like Antwerp, Cologne, and Madrid launched calls for start-ups to create innovative new ways to overcome challenges related to Covid-19 (OECD, 2020b).

The transfer of many spheres of public, cultural, and professional life into virtual space may constitute both an opportunity and a threat to the functioning of an urban society, in terms of work and distance learning. AI was considered as part of the solution to be implemented during lockdowns (Kritikos, 2020). As a result, AI-based fever detection systems and processing data to track a person's recent movements were introduced. Hantrais et al. (2020) point out, however, that the massive use of AI tracking and surveillance tools used since the outbreak of Covid-19, combined with fragmentation in the ethical governance of AI, might have paved the way for extended and more permanent use of surveillance technologies to justify personal freedom.

The Covid-19 pandemic accelerated and extended digital transformation in many areas. It affected the direction and speed of development of digital technologies such as the internet, mobile connectivity, cloud computing, big data, machine learning, AI, blockchain, IoT, smart manufacturing, and predictive and data analytics (Soto-Acosta, 2020). Due to their embeddedness in urban space, they need to be considered alongside the development of key conceptual components of the smart city. Utilising those technologies can give a strong push in the direction of predictive data analytics and allow progress towards data-driven urban planning and real-time urban management. Remote work and digitally

organised logistics have played a key role in mitigating the impacts of the pandemic; moreover, with significant resulting benefits, these trends are likely to be expanded during the post-Covid-19 recovery (Oldekop et al., 2020). Tokyo is now committed to accelerating its efforts towards a digital transformation. It promotes online learning, telemedicine, telecommuting, and the digitalisation of public services (OECD, 2020a). Madrid defines its Covid-19 recovery plans concerning the participatory processes aiming to find solutions to three challenges: facing the economic reality after the pandemic; redefining the concept of cities in the face of the need for new models of interpersonal relationships; and seeking solutions for groups with special needs (EUROCITIES, 2020).

3.6. Policy Implications

In accordance with the methodology applied here, global (or universal) and local dependencies could be distinguished. The first category includes reference materials published by the World Health Organization and systematically updated based on research, such as the guidelines for the physical distance (World Health Organization, 2021), which have significant consequences in various spheres, including cities. The UN (2020) published a report where it referred to urbanised areas. It contains recommendations for the renewal of cities after the pandemic crisis, postulating, inter alia, a strengthening of data-driven planning. The report emphasises the experience of the pandemic, and the possibility to improve air quality in cities (due to reduction in transport). It also highlights the roles of credible and solid research that allows national and local authorities to better respond to the crisis and points out that the future of urban planning and management should follow a similar pattern. Analogous recommendations were presented in the UN-Habitat document (UN-Habitat, 2020), which indicates pandemic management support tools that may be used in the future for data mapping. It proves the impact of the pandemic as a catalyst for change towards the development of the smart city model on a global scale. Data-driven planning can improve the quality of land management in light of urban regeneration and the building of resilient cities. Changes in that sphere will require new mechanisms or legal frameworks but also develop strategies and may be seen in a long-term perspective, as the pandemic did not damage urban structures.

In the "new normality," certain spatial consequences will inevitably result from the change in the residents' lifestyles. A flexible approach to the workplace may increase the interest in rental offers of smaller offices or co-working spaces, enabling greater adaptability to current needs. Both factors can contribute to the revival of services in the form of high-street or local service centres accessible on foot. The pandemic influenced the creation of sectoral policies, such as mobility in the analysed context (especially public transport). The International Association of Public Transport, publishing publicly available reports and research results, promotes a return to public transport as well as the digital transformation of "smart working practices." The new mobility model can help to reduce emissions, improve air quality, and support attempts at reducing crowds in public transport.

4. Discussion

The analysed studies, policies, and projects suggest that the experience of the effects of the pandemic might bring about significant changes in the future of cities. The recent pandemic has accelerated the smart development of urban structures and the implementation of smart solutions. Many urban areas require a transformation to solve the structural problems of their built environment. The pandemic-caused changes confirm that areas with diversified functions, mainly residential areas with good access to services, are more resilient in case of a disaster. There is a need to strengthen this aspect of city planning, especially in the face of the announcements by service providers and employers, who are going to promote remote work in the future.

Our studies have shown that the Covid-19 pandemic can become a catalyst of urban change. The multifunctional city structure based on local service centres can contribute to a transformation of the city towards a more resilient and safer environment. There is a significant challenge to meet social expectations regarding public transport. Restoring its patronage to pre-pandemic numbers will require a reorganisation of routes and timetables, but also the implementation of solutions that guarantee safety, such as the non-contact operation or efficient ventilation systems in vehicles. The main threat to this approach is the trend to use individual cars, perceived as a safer form of mobility. However, maintaining a larger share of bicycle traffic by ensuring an efficient network of safe connections and transforming temporary connections into permanent ones may have a beneficial effect, too. Also, streets, sidewalks, and squares "regained" by residents during the pandemic stand a chance of permanent transformation, especially in places where they may be associated with ground-floor services. In revitalised or degraded areas, high-quality public space is an element of the strategy to change their image. Mobility restrictions highlighted the problem of limited access to open and natural areas. The need to keep physical distance prompted city residents to explore less obvious walking routes. These places, restored to public awareness, can become the target of future local initiatives.

The pandemic may also be the catalyst for changes towards Smart City 3.0 and smart solutions support the positive direction of those changes. The examples of spatial changes introduced above, although forced by the pandemic, were adopted by cities and their residents. They represent a great potential for the implementation

of the Smart City 3.0 model defined by Cohen (2014). A smart city is not only a digital city but, above all, a city that answers the needs of its residents. During the pandemic, faster implementation and acceptance of digital innovative solutions have been observed, which, together with their larger inclusiveness, can be a test of their embeddedness in urban space.

Smart cities aim to apply digital technologies to advance the well-being of their citizens, although there are cities that are merely "smart washing" and adopt superficial technological solutions that chase the symptoms rather than causes of complex urban problems (Anand, 2021; Hantrais et al., 2020). The outbreak of the pandemic confirmed pre-Covid-19 findings that cities with robust governance and participation mechanisms were likely to be resilient and manage crises considerably better than those "using isomorphic mimicry to look like a smart city" (Hantrais et al., 2020, p. 263; OECD, 2020a).

The framework introduced in this study identifies those aspects of smart cities that were to the greatest extent influenced by the Covid-19 pandemic. Indicating connections between smartness and post-Covid-19 urban trends, this study can form a base for future comparative studies showing regional specificities, as trends, as well as solutions and planning practices, are not homogeneous between cities and regions. This study has identified a variety of direct responses to pandemics as well as the diversity of directions of future spatial development policies vectored by the urban changes caused by Covid-19.

As this study was conducted during the lockdown, it is partly empirical in nature. For that reason, it would be worth conducting an ex-post evaluation which could allow for a more rigorous scientific process based on both qualitative and quantitative indicators. The pandemic has also increased our understanding of the importance of the well-being and mental health of city residents and of how they may impact their relationship with smart city services (Coca-Stefaniak, 2020). Future studies might therefore focus on factors for providing a more intuitive relationship between smart cities and their residents and visitors alike by developing further the predictive elements of smart services. Another vital aspect is the influence of such phenomena as the pandemic on the resilience of urban structures. Our studies show that it can be both stimulating for some urban changes (such as the increase of active mobility, namely the share of bike trips in mobile-splits of the cities), but, at the same time, quite impeding for others (see the turn from public transport towards individual cars, which were perceived as a safer means of transportation).

5. Conclusions

The pandemic has continued with varying gravity for several months and it is hard to predict when it will end. Although extensive multi-threaded studies and analyses of its influence on cities together with the practical experience of local governments and residents are being gathered, the question about how the pandemic will affect cities and influence the implementation of intelligent solutions remains open. The experience of the global crisis will remain a reference point for shaping new guidelines or practices, the more so as the pandemic has not eliminated threats related to climate change and challenges city residents faced before 2020. Whether the current spontaneous changes will become permanent depends on the duration of the pandemic. The longer the "state of emergency" lasts, the more all-embracing changes in the structure of cities and their management will occur. In discussions about the city after the pandemic, two notions appear: "new normality," describing the current state of uncertainty, and the more optimistic one, "new future" (World Health Organization, 2020). Among the visions of the post-pandemic world, we can find dystopian ideas caused by fear of crowding, reduced sense of security, limited job opportunities, access to services, culture, and art, and, above all, by reduced social interactions. At the same time, urban researchers indicate that similar crises in the past strengthened cities and the present one may additionally contribute to the transformation of current cities into cities that are more resilient and more efficiently adapt to contemporary challenges including climate change (Florida, 2020). The experience of the pandemic can accelerate spatial changes both in terms of short-term actions and long-term development policies. Short-term activities in degraded areas can improve the structure and functioning of cities through the introduction of spontaneous and temporary solutions. The faster pace of digitisation in areas such as transport or education will affect the functioning of cities. Within public space, one should expect a change resulting from the experience of physical distancing. Long-term effects relate to the development policies of entire urban areas, as their strengths and weaknesses have been highlighted by the pandemic. The notions of the "new normal" and the "new future" are an opportunity to redefine development policies that fit within the idea of smart, resilient, and sustainable cities.

Acknowledgments

The authors are grateful for the exceptionally valuable comments from the reviewers and editors.

Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

Barbara Zgórska, MArch, MSc, Eng, is a PhD student at the Department of Urban Design and Regional Planning at Faculty of Architecture, Gdańsk University of Technology. She is also a charted urban planner with 16 years of experience working for both the private and public sector, and urban planning expert of the Foundation in Support of Local Democracy in Poland, since 2016. She is also an urban activist, whose main research interests are issues related to urban regeneration and involvement of local communities in city planning processes.

Dorota Kamrowska-Załuska, PhD, is an assistant professor of the Department of Urban Design and Regional Planning at the Faculty of Architecture, Gdańsk University of Technology. She is also a research fellow at several research institutions, including MIT. She has been working as an urban planner for 18 years, for both the private and public sectors. Her research interests are big data and AI in planning, smart cities, and development of metropolitan areas. She is the author of more than 50 papers and a book on sustainable urban regeneration and the president of the Association of Polish City Planners, Gdańsk division.

Piotr Lorens, PhD, is an urban planner, Gdańsk City architect (since 2021), lecturer in Urban Design and Development, and, since 2007, head of the Department of Urban Design and Regional Planning at the Faculty of Architecture, Gdańsk University of Technology. His research interests and professional practice include planning and implementation of urban development and redevelopment schemes of different nature, varying from decayed urban sites to entire metropolitan areas.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 228–241
https://doi.org/10.17645/up.v6i4.4381

Article

Revitalising South African City Centres Through ICT

Dillip Kumar Das

Sustainable Transportation Research Group, School of Engineering, Howard College, University of KwaZulu-Natal, South Africa; E-Mails: dasd@ukzn.ac.za, dkd1267@gmail.com

Submitted: 18 April 2021 | Accepted: 14 July 2021 | Published: 17 November 2021

Abstract
The majority of South African city centres are in a state of degeneration and need revitalising. The factors that contributed to the degeneration and how the integration of information and communications technology (ICT) can be used to revitalise them were examined in three South African city centres. The research was grounded in place theory. A survey method, including the Delphi technique, followed by factor analysis, and ordinal regression modelling was used to collect and analyse data. The findings indicated that enhancing accessibility and safety, social and community involvement, human experience, built-up environment, and vibrancy were the five major components which needed reinforcing to revitalise the city centres. However, ICT-linked strategies, including networking the areas with free Wi-Fi hotspots, creating places in which to congregate, providing digital screens, and installing cameras and remote monitoring, are expected to attract people and to facilitate accessing real-time information about different events, marketing, branding, and creating a unique image. Also, the use of ICT will assist in reducing criminal activities and dispel the fear of crime. The combined effect is likely to encourage people and businesses to return the city centres, making these areas vibrant and accessible.

Keywords
Bloemfontein; city centres; degeneration; ICT; place theory; Port Elizabeth; Pretoria; revitalisation; South Africa

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

City centres play a crucial role in the socio-economic wellbeing of a city. Despite the decentralisation process, which has been experienced in many cities around the world, city centres are often found to be the source of services such as commerce, administration, transportation, etc. (Alexander et al., 2020; Jones & Livingstone, 2018). City centres offer prime locations for housing and residences, as well as recreational, cultural, and tourist activities. Moreover, within a compacted area, city centres encourage diversity, enable community and social interaction, and promote communication (Das, 2016; Powe & Hart, 2008; Steyn, 2012). Morphologically, according to Swiss-French architect Le Corbusier, the structure of city centres is observed to be enormous, adaptable, active, sharp, intense, and dominant, within which a richly varied, refined vista of buildings, organised in an asymmetrical manner, generates a powerful rhythm (Laua & Lib, 2019).

However, in various countries, city centres have been gradually losing their importance (Powe & Hart, 2008; Wrigley & Lambiri, 2014). New centres of activities have emerged and, in the face of this competition, the bustling hearts of cities have increasingly been marginalised (Alexander et al., 2020; Jones & Livingstone, 2018). Some of the city centres in many developing countries have continued to exist simply for their historical importance or as tourist attractions.

Similarly, in South Africa, city centres are an integral part of most urban areas. These city centres were once the nerve centres of major commercial, residential, administrative, cultural, and recreational activities. The major public transport terminals are located close to the city centres. These areas also contain several cultural heritage and architectural monuments and other

tourist and recreational attractions. However, in recent years, it has been observed that several of the commercial and administrative elements have been moved out of the city centres. The reasons could be attributed to a range of factors that include overall degeneration of the area as a result of a decline in infrastructural facilities, poor management and maintenance, and a reduction in the number of commuting people, leading to a decline in economic activities and the emergence and availability of more affordable, modern built-up infrastructure and activity centres in other sub-urban areas. Also, the perception has been that city centres have been overrun by criminal activities. This is alleged to have happened because of poor control over the occupancy of dilapidated or abandoned buildings, lack of adequate attention to required infrastructure, such as lighting and security measures, as well as poverty, economic inequality, etc. Consequently, people do not want to visit city centres out of fear. Furthermore, the housing conditions have deteriorated. The value of the real estate, specifically in the housing sector, has declined.

In South Africa, a spatial development framework for the sustainable development of cities has been adopted, in which the main focus is on social integration and environmental considerations (Todes, 2011). Accordingly, efforts have been made to undertake urban renewal projects in some of the city centres to reduce segregation and make them more inclusive and vibrant. However, the degeneration of city centres continues, raising the question of why these areas degenerate and how this can be addressed.

Information and Communications Technology (ICT) and various products driven by the Internet of Things (IoT) have become an integral part of daily life. Smart technology has engendered functional and spatial changes in various places, including city centres, and brought about behavioural changes among people. This influence is likely to continue with further technological advancements (Alghamdi & Al-Harigi, 2015; Das, 2016). Evidence from cities around the world—e.g., New York, Toronto, London, and Vienna—suggests that ICT can play a very important role in reviving the image of city centres. Consequently, it has been argued that ICT should be considered as an integral part of re-developing or revitalising city centres in developing countries.

Therefore, how the integration of ICT in city centres can be used to revitalise the urban areas of South Africa was explored in this study, within the context of three major cities. Specifically, the current state of city centres, the presence and influence of ICT, and the role of ICT in the revitalisation process were assessed, and strategies that would enable the revitalisation of the city centres were examined. For this purpose, the following research questions were addressed:

1. What is the current socio-economic, spatial, visual, and image-building status of the city centres in South Africa?
2. What is the current status of ICT in the city centres?
3. What roles can ICT play in revitalising the city centres?
4. What strategic interventions are needed to revitalise the city centres?

2. Literature Review

The research for this study was grounded in place theory and the implications of ICT in placemaking.

2.1. Theoretical Frameworks for Urban Renewal and Redevelopment

Urban renewal is considered to be one of the most effective approaches to improving the spatial and environmental quality of a place (Zheng et al., 2014). The approach has been adopted to rectify the urban decay problem, meet socio-economic objectives (Lee & Chan, 2008), enhance existing social networks, improve the inclusion of vulnerable groups, and change adverse impacts on the living environment (Zheng et al., 2014). This approach creates an opportunity to re-use land, improve the land value and physical, spatial, and environmental quality of a place, create a unique place brand image, and it also contributes to the sustainability of cities (Wang et al., 2014; Zheng et al., 2014).

Several theoretical frameworks have been adopted for urban renewal or re-development processes, including sustainable development theory, smart growth theory, new urbanism theory, organic renewal theory, and place theory. Since this study was premised on place theory, this has been discussed separately in Section 2.2.

Furthermore, arguments for giving attention to the interaction among urban, architectural, technological, economic, socio-cultural, environmental, and political-administrative dynamics that evolve within a specific urban area have emerged (Battisti et al., 2019; Corburn & Cohen, 2012). Also, greater integration of people in the urban re-development or renewal process should be emphasised (Battisti et al., 2019).

2.2. Place Theory in Placemaking

Place theory is concerned with human-world relations through experience (Laua & Lib, 2019; Pred, 1984). Pred (1984, p. 279) defined a place by its functions, which occur ceaselessly, and its contribution to history in a particular context through the creation of a physical setting. A place is not simply what is seen on the land, a setting, or a location for human activities. Rather, "place" refers to the functions and contributions made to history, culture, society, and economy by the use of a physical setting. Furthermore, a sense of place implies the ability to recognise different identities of a place (Ralph, 1976, p. 63). However, the location or spatial and physical attributes are insufficient to create a sense of place. So, according

to Castree (2009), human experiences provide meaning to a place. In other words, not only one's perception but also one's feelings about a place constitute a sense of place. Therefore, "place" and "sense of place" are intertwined in the creation of places. Moreover, technological changes, which fundamentally affect the attributes of a place, have added another dimension to the development of a place (Ralph, 2016). Both tangible attributes, such as the physical setting and infrastructure, and intangible features, such as distinctive experience, together with the role of technology, create the uniqueness of a place (Laua & Lib, 2019; Ralph, 2016; Richards & Palmer, 2010).

In place theory, it is professed that a place should be developed in such a way that it not only has tangible aspects but also reflects intangible experiences, such as people's perceptions and feelings about the place and the community (Castree, 2009; Laua & Lib, 2019). In addition to this, the incorporation of advanced digital technology, such as ICT, should be an integral part of placemaking.

In an urban development context, a central area or city centre can be considered as a place. While revitalising the central area of a city, in addition to the creation/upliftment of a social setting through physical interventions that incorporate the intrinsic value associated with the setting (Laua & Lib, 2019; Strydom et al., 2018), the transformation must also be used as an instrument for empowerment. In other words, community empowerment, engagement of community, and community practice should be taken into consideration in the urban regeneration or revitalisation process (Al-Kodmany & Ali, 2012; Strydom et al., 2018). Furthermore, ICT should be employed as an enabler not only for the physical and spatial transformation, but also for the creation of a sense of place through empowerment and enriching human experience.

2.3. The Role of ICT in Placemaking

ICT has become indispensable in many spheres of public activity and, consequently, has transformed society and cities as well (Fernandez-Maldonado, 2012). ICT is considered to be a desirable tool for social and economic connectivity and urban efficiency (Castells, 1996; Fernandez-Maldonado, 2012; Storper, 2010). Moreover, it has been argued that innovative uses of ICT can assist in achieving urban sustainability by improving the efficient use of energy and water, decreasing carbon emissions and waste, and enabling public participation in decision-making about various urban developments (Fernandez-Maldonado, 2012; Mitchell & Casalegno, 2008).

Arguments stating that the outstanding informational and networking capacities that ICT presents should be utilised to bring about positive effects in economic and social development, and improvements in spatial development, quality of life and public participation have emerged. In this process, the use of ICT will make cities and human settlements inclusive, safe, resilient, and sustainable (Nkosi, 2018). Furthermore, it has been argued that ICT can be deployed to contribute to creating a unique image of a place as well as shape spatial development (Das, 2016). However, there must be adequate access to ICT infrastructure and connectivity for people to benefit from ICT networks (Fernandez-Maldonado, 2012).

In the context of urban regeneration or revitalisation, specifically at the micro-level of central areas, it has been argued that ICT plays a critical role. For instance, ICT can be used to influence both the agglomeration and dispersion of central functions such as trade, commerce, entertainment, and social and civic activities (Alghamdi & Al-Harigi, 2015; Castells, 1996; Pratt, 2008). Moreover, locating global economic activities with the existence of both agglomeration and dispersion and socio-economic diversity would improve the image of a place in a city, including the central area (Little, 2013; McDonald & Swinney, 2019; Sassen, 1996). For instance, ICT plays a crucial role in the retail commercial sector. If strengthened in the central areas of cities, the ICT infrastructure can be used to assist in the effective functioning of the retail environment, supply chain, and customer service management, as well linking various aspects of trade and commerce, such as financial and inventory databases. It has been contended also that ICT can be used as a tool by marketing professionals to analyse the market. For instance, through its various services, such as providing free Wi-Fi in public places or coffee shops, and providing services through mobile phones, ICT can be used to attract people and activities to the central areas, which is an important aspect in revitalising the central areas (De Filippi et al., 2020; Jeong et al., 2010). Similarly, the use of ICT would support the designing of spaces by urban planners, architects, and designers (Lepy, 2008). For example, planners, architects, and designers can use ICT to understand the available space better, examine the land use, and improve space utilisation and management of the central areas.

Furthermore, it has been argued from a planning perspective that ICT can be used to enhance people's participation in planning and decision-making and to engage them in co-design and co-production of spaces and activities (Kwon, 2009). In this context, according to De Filippi and Balbo (2011), the use of ICT enables multi-modal, synchronous, or selective representation. Specifically, the use of ICT could permit marginal citizens to participate in the development or revitalisation processes by enhancing their awareness, encouraging interaction of individuals with diverse communities beyond time and space limits, and contribute to increasing the general level of democracy and equity. Moreover, it can invoke on-demand or real-time actions by different responsible authorities. For example, people can report issues related to environmental degradation and the incidence of crimes directly to the concerned authorities by using ICT applications and services, which

can prompt the authorities to take action as needed (Kingston et al., 2005).

Although the role and impact of ICT on a regional, national, or city scale have been studied to a certain extent (Das, 2016; Mitchell & Casalegno, 2008; van den Berg & van Winden, 2002), studies in the context of central areas or on a micro-scale in the cities in developing countries have been scarce. Thus, since it has been argued that ICT plays a significant role in placemaking, there was a need to examine how ICT can be used to influence the development of city centres or assist in their revitalisation.

3. Study Context and Research Methods

A quantitative research method was adopted, using a survey for data collection, and both descriptive and inferential statistical methods were used for analysis and modelling.

3.1. Study Context

Three major cities of South Africa—Bloemfontein, Pretoria, and Port Elizabeth—were selected as the study context. These cities were selected based on a set of criteria such as heterogeneity in geographical location and spatial, structural, and functional homogeneity. These cities are located in three separate regions of the country: Pretoria in the north, Port Elizabeth (renamed as Gqeberha) in the southeast, and Bloemfontein in the centre, providing heterogeneous geographical representation. Each city has a designated central business district in which several urban functions are performed, and each city has its image. The physical form and structure of the city centres were observed to be more or less similar. These central areas enclose predominantly mixed land use, with functions including trade and commerce, administration, transportation, culture, and recreation. These central areas convey distinct images and have regional and national importance. For example, they are the major cities of each region and two of these are capital cities. While Bloemfontein is the provincial capital of the Free State, Pretoria is the administrative capital of the country. Port Elizabeth is the largest city of the Eastern Cape province. The historic, tourist, and architectural elements in these spaces offer structural homogeneity. These city centres offer similar functions that are predominantly commercial, followed by administrative and recreational functions. However, it has been argued that these cities are degenerating and that various functions are being moved out for one or more of the reasons discussed previously. Also, spatial, social, and economic activities are declining (see Section 1). So, while there is physical, structural, and functional homogeneity, the central areas of these cities represent geographical heterogeneity. Consequently, these cities were observed to be representative of similar, medium-sized cities in the country. Therefore, they were considered to be ideal candidates for this investigation.

3.2. Data Collection and Analysis

Two types of surveys were conducted to collect data. Firstly, a survey among the stakeholders in the city centres was conducted to examine the factors and attributes that would be essential for revitalisation. The stakeholders included people employed in the city centres, local visitors, residents in the area, and tourists. The survey sample included 840 respondents. The sample sizes accessed in each of the selected cities varied between 260 and 350, but valid responses ranging between 242 and 311 were returned. Table 1 shows a summary of the profile of the survey's respondents. The sample size for each city was found to be adequate at a confidence level of 95%, with a confidence interval ranging between 5.56% and 6.3%, and a worst-case percentage of 50%. However, overall, the sample size was found to be more than adequate (>384) for a confidence level of 95%, with a variance of 5%, and a worst-case percentage of 50%. Based on the willingness and availability of the respondents, random sampling and a semi-structured interviewing process were used. Care was taken to avoid bias towards any race, gender, or age of the respondents, or skewness towards one group of respondents. For this purpose, in addition to the use of random sampling methods, different sub-groups of respondents, such as people belonging to different races, age groups, and gender were selected according to a proportional distribution corresponding to their population size.

In addition, a Delphi survey was conducted among 31 experts and professionals to understand the various ICT-linked strategies and policy interventions that would be essential to revitalisation (Liggett et al., 2011). The Delphi survey was deemed to be suitable because it offers a structured group communication process, which enables a group of experts to deal with a complex problem effectively (Hsu & Sandford, 2007). Furthermore, compared with other alternative methods, such as multi-criteria decision-making, nominal group technique, and brainstorming, Delphi involves a reasonable number of isolated and anonymous respondents to guide group opinions towards a final decision or to answer questions through triangulation of subjective group opinions, according to the analytical techniques and experience of the researcher. It is also a multi-stage process, in which each stage builds on the previous one, which leads to convergence of opinions. Moreover, the Delphi method is observed to be substantially more accurate than either individual experts, traditional groups, or statistical groups in which judgements of non-interacting individuals are aggregated (Rowe & Wright, 2001). On the other hand, multi-criteria decision-making methods, (e.g., analytical hierarchy process) are data intensive. Similarly, nominal group technique and brainstorming are based on a relatively smaller size of groups in which members

Table 1. Summary of the profile of respondents.

Respondents' Attributes	Bloemfontein	Pretoria	Port Elizabeth	Total
Total of questionnaires administered	260	300	350	910
Total of valid responses received	242 (93.7%)	287 (95.5%)	311 (88.9%)	840 (92.3%)
Category of the respondents				
Local residents	216 (89.3%)	256 (89.2%)	282 (90.7%)	754 (89.8%)
Visitors	26 (10.7%)	31 (10.8%)	29 (9.3%)	86 (10.2%)
Gender				
Male	141 (58.3%)	176 (61.3%)	192 (61.7%)	509 (60.6%)
Female	101 (41.7%)	111 (38.7%)	119 (38.3%)	331 (39.4%)
Race				
White	34 (14.0%)	31 (10.8%)	38 (12.2%)	103 (12.3%)
African	186 (76.9%)	227 (79.1%)	235 (75.6%)	648 (77.1%)
Coloured	14 (5.8%)	18 (6.3%)	21 (6.8%)	53 (6.3%)
Other	8 (3.3%)	11 (3.8%)	17 (5.4%)	36 (4.3%)
Age				
18–25	64 (26.4%)	78 (27.2%)	86 (27.7%)	228 (27.1%)
26–40	82 (33.9%)	93 (32.4%)	99 (31.8%)	274 (32.7%)
41–60	73 (30.2%)	84 (29.3%)	91 (29.3%)	248 (29.5%)
≥61	23 (9.5%)	32 (11.1%)	35 (11.3%)	90 (10.7%)

might be known to each other and decisions are based on voting or consensus. Since not much structured statistical data was available and the study relied on expert opinion for developing strategic interventions through a rigorous analytical process, the Delphi technique was found to be more appropriate and was thus used.

The participants included four urban planning and design professionals, three architects, four civil engineers, six academics from the field of architecture and urban planning, three urban development executives (officers in charge of implementation), four entrepreneurs, two individuals engaged in image-building and branding, two sociologists, and three ICT experts. The experts were selected according to their relevant expertise, experience, and engagement in city development. The focus of the discussions was on ICT-linked strategies and how they could enable the revitalisation of the city centres. The responses of the stakeholders were measured using a five-point Likert scale with the values being: 1. Very Low, 2. Low, 3. Fair, 4. High, and 5. Very High.

Both descriptive statistics and inferential statistics, including a perception index (mean Likert scale score–perception index [PI]), standard deviation (SD), and z-probability were used to examine the accessibility and use of ICT in different activities in the city centres. Factor analyses, by means of principal component analysis (PCA) with varimax rotation, were used to carry out exploratory analysis of the identified components and attributes required for revitalisation. PCA is one of the most widely used tools for data analysis and is useful for a variety of situations and data types. PCA can be used to simplify the complexity in high-dimensional data without compromising the trends and patterns. One of the major advantages of this method is that it can be used to assist in reducing the dimensionality of large data sets and to increase interpretability with minimum information loss. Moreover, PCA displays similar accuracy on the validation set with various other methods such as baseline, missing values ratio, low variance filter, high correlation filter, random forest/ensemble trees, etc. Although it offers relatively less accuracy than backward feature elimination, missing values ratio and forward feature construction, and missing values ratio methods, it is much less time-consuming. PCA also helps in ranking and reduces the redundant and noisy features (Jolliffe & Cadima, 2016; Velliangiri et al., 2019). In the current study, since the data collected were on an ordinal scale and it was necessary to group various attributes under a set of limited and important components to examine the factors that influence the vitality of central city areas, PCA was found to be suitable.

Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were conducted, and communalities were calculated to check the adequacy of the sample size and the validity and robustness of the model. A scree plot was used to extract and retain the principal components. Varimax rotation was conducted to interpret the components and various attributes under the components.

Ordinal regression modelling was done to examine the relative influence of the ICT-linked strategies, while constructing the ordinal regression model, goodness of fit, likelihood test, and test of parallel lines were

conducted to check the veracity of the model (Williams & Quiroz, 2020).

4. Results and Discussion

Four aspects—namely accessibility of ICT in the city centres, use of ICT in different activities, various attributes of city centres, and the strategic measures—were analysed as presented in the following subsections.

4.1. Accessibility of ICT in the City Centres

Analysing the accessibility of ICT is essential to understand the readiness and challenges of a place so that ICT can be used to influence various activities significantly and to augment them. Table 2 shows the ICT accessibility in the city centres as perceived by the respondents. Accessibility was significant in terms of both broadband and Wi-Fi internet connectivity. Similarly, connectivity by GPS was significant in these areas. However, free Wi-Fi hotspots were available to a certain extent and people could access free Wi-Fi in a limited number of places in the central areas. Also, CCTV cameras were available to regulate and monitor traffic and other socio-economic activities at limited locations. However, the presence of digital messages and signage, intelligent transport systems and sensors for traffic control and parking, CCTV cameras with internet connectivity for real-time remote monitoring, and other IoT applications were meagre. This suggested that, although the city centres had ICT or digital connectivity, the accessibility needed significant augmentation. Evidence from literature suggested that ICT plays a crucial role in the regeneration or revitalisation of areas, for instance, through enhancing interaction among people and attracting small businesses (De Filippi & Balbo, 2011; Kwon, 2009). Therefore, to revitalise the city centres, the various attributes of ICT, as observed above, should be augmented to improve its accessibility.

4.2. Use of ICT in Different Activities in the City Centres

The use of ICT in different activities is shown below in Table 3, which indicates the contribution of ICT to different aspects related to the functioning of the city centres in the existing situation. The use of ICT or its contribution has been categorised under 11 distinct and broad categories. According to the PI, the use of ICT was significant for normal socio-economic activities that included office, commercial, and recreational activities. People used ICT for e-commerce to a certain extent. Similarly, people accessed real-time information for various reasons (for example, transportation, social and economic activities, and events or sporting activities). Advertisement of socio-cultural activities and promotion of tourism were conducted to some extent. However, ICT was not generally used for e-governance/public participation, monitoring of crime, real-time monitoring of different social activities and public places, or real-time display of information. This indicated that, although people used ICT for certain socio-economic activities and could access ICT through their private mobile devices, and the city authorities used ICT for certain promotional and advertising purposes, ICT was not used extensively in essential activities, such as monitoring crimes, public participation in governance systems, and displaying real-time information in public places, which could be a barrier to people visiting and participating in developmental and governance activities in the city centres. Furthermore, the overall role of ICT was found to be not significant statistically, but respondents perceived that it could contribute significantly to the creation of vibrant city centres. However, it has been argued that appropriate and adequate ICT infrastructure, if created, would facilitate various activities, empower people, improve human experience and interaction in the central areas, and, thus, help in their revitalisation (De Filippi & Balbo, 2011; Kwon, 2009). So, in the context of South African

Table 2. Accessibility of ICT in the city centres.

Attributes	PI	SD	z-score	z-probability	p-values
Availability of internet by broad band	4.19	0.68	1.75	0.959	0.00
Availability of Wi-Fi	4.05	0.63	1.67	0.952	0.00
Free Wi-Fi hotspots	3.25	0.59	0.41	0.659	0.00
Message and signage boards	2.60	0.58	−0.67	0.251	0.999*
GPS	4.16	0.65	1.78	0.962	0.00
Use of intelligent transport systems and sensors for traffic control and parking	2.59	0.72	−0.57	0.284	0.999*
CCTV cameras	3.62	0.60	1.04	0.850	0.000
CCTV cameras connected with Wi-Fi	2.02	0.64	−1.51	0.065	0.999*
Other IoT apps	1.71	0.54	−2.38	0.0087	0.999*

Note: * Statistically not significant.

Table 3. Use of ICT in different activities in the city centres.

ICT Use	PI	SD	z-score	z-probability	p-values
General socio-economic activities	4.05	0.55	1.91	0.971	0.00
e-Commerce	3.73	0.64	1.14	0.872	0.00
e-Governance/public participation	2.83	0.55	−0.29	0.385	0.999*
Real-time information display	1.96	0.79	−1.33	0.091	0.999*
Real-time information access from private mobile devices	3.92	0.62	1.47	0.929	0.000
Real-time monitoring of different social activities and public places	1.97	0.77	−1.33	0.091	0.999*
Monitoring of criminal and suspicious activities	2.46	0.92	−0.59	0.277	0.999*
Advertising of the social-cultural activities	3.17	0.67	0.27	0.606	0.00
Promotion of tourism activities	3.20	0.60	0.34	0.633	0.00
Current role of ICT in the city centres	3.03	0.79	0.04	0.51	0.45*
Perceived role of ICT to improve the city centres	4.02	0.35	2.91	0.998	0.00

Note: * Statistically not significant.

cities, as discussed above, since ICT was not found to be used significantly in a majority of the activities, it would be essential to strengthen, enhance, and promote ICT use in the city centres for their revitalisation.

4.3. Exploratory Analysis of the Attributes Essential for Revitalising the City Centres

The exploratory analysis of the attributes that are essential for revitalising the city centres was conducted by using factor analysis. Before the factor analysis, KMO and Bartlett's tests were conducted to check the adequacy of the sample (Table 4). The KMO measure was 0.917, which was more than the minimum recommended value of 0.6. Bartlett's test of sphericity was statistically significant (p-value = 0.000, < 0.05). Thus, the sample was adequate and the factorability of the correlation matrix was supported. Furthermore, the communalities of all the factors shown in Table 5 were greater than 0.6. Also, correlation coefficients between various variables ranged between 0.011 and 0.70, which implied that the majority of the variables did not show high correlations and, therefore, the chances of over-estimation were limited. However, in cases where a relatively strong correlation (>0.7) between two variables (pairwise) was observed, one of the variables was discarded from the PCA. This indicated that factor analysis was adequate for this study (Tucker & MacCallum, 1997).

The principal components were extracted and retained by using a scree plot (Figure 1), which showed five components with eigenvalues of more than one. Table 6 shows the total variance explained by each component extracted. Component 1 (41.86%), component 2 (20.81%), component 3 (11.89%), component 4 (5.67%), and component 5 (5.09%) were predominant, resulting in a cumulative variance percentage of 85.35% of the influence on the city centres.

Varimax rotation was conducted to interpret the various attributes of the five components that influenced the vitality of the city centres. The results are shown in Table 7. According to the close linkages observed between the various attributes of each component, the five components were labelled as: 1) Enhancing accessibility and safety; 2) Social and community involvement; 3) Human experience; 4) Built-up environment; and 5) Vibrancy.

Each component and the loaded attributes are discussed below.

4.3.1. Component 1: Enhancing Accessibility and Safety

Seven attributes were loaded onto this component, including accessibility and pedestrianising (0.955), art and music (0.933), safe (0.919), connected (0.877), walkable (0.874), cosmopolitanism and openness (0.868), and enhancing the local economy and environment

Table 4. KMO and Bartlett's tests.

Tests	Parameters	Values
KMO measure	Sampling adequacy	0.917
Bartlett's test of sphericity	Approx. chi-square	31,862.234
	Degree of freedom	300
	Significance	0.000

Table 5. Communalities.

Attributes	Initial	Extraction
Architecture	1.000	0.870
Buzz	1.000	0.960
Diversity	1.000	0.689
Nightlife	1.000	0.842
Public spaces	1.000	0.912
Accessibility and pedestrianising	1.000	0.978
Restaurants and dining	1.000	0.850
Shopping	1.000	0.747
Professional and administrative buildings	1.000	0.894
Quality of buildings	1.000	0.715
Comfortable	1.000	0.946
Safe	1.000	0.889
Vibrant	1.000	0.849
Walkable	1.000	0.806
Cosmopolitanism and openness	1.000	0.805
Social cohesion	1.000	0.889
Art and music	1.000	0.920
Lifestyle	1.000	0.843
Enhancing	1.000	0.789
Connected	1.000	0.816
Diverse	1.000	0.918
Enduring	1.000	0.873
Enriching experience	1.000	0.841
Community involvement and participation	1.000	0.756
Belongingness	1.000	0.941

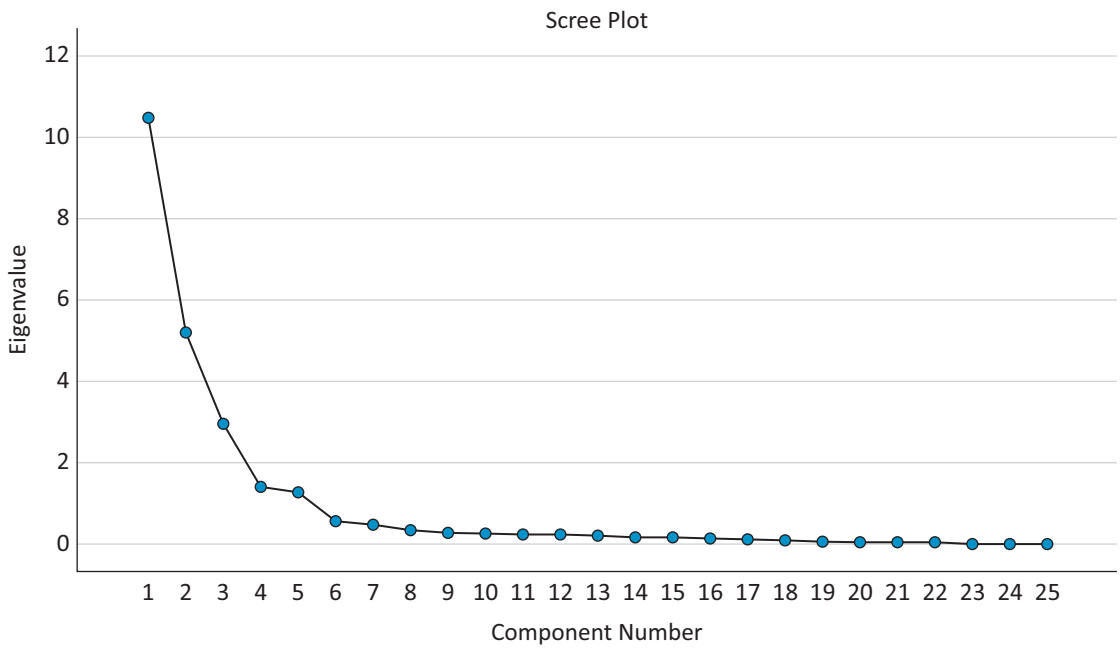

Figure 1. Scree plot showing eigenvalues of the components.

Table 6. Total variance of the principal components explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.46	41.86	41.8	10.46	41.86	41.86	6.36	25.44	25.44
2	5.20	20.81	62.68	5.20	20.81	62.68	5.98	23.94	49.38
3	2.97	11.89	74.57	2.97	11.89	74.57	4.94	19.782	69.16
4	1.42	5.67	80.25	1.42	5.67	80.25	2.36	9.464	78.62
5	1.27	5.09	85.35	1.27	5.09	85.35	1.68	6.72	85.35

(0.858). This component is related to the augmentation of economy and environment, accessibility by different modes of travel, including non-motorised, and freedom from criminal activities. Such attributes have also been confirmed in previous studies (Das, 2016; Gehl, 2016; Vanolo, 2008). This component was the most predominant, with an initial eigen variance of 41.86% and rotation sums of squared loadings of 25.44%. This indicated that the attributes associated with this component should be prioritised in the revitalisation process. Moreover, since connectivity was one of the major attributes in this component of development, ICT should act as a facilitator and catalyst to reinforce or augment the attributes.

4.3.2. Component 2: Social and Community Involvement

Seven items were loaded onto this component, including buzz (0.957), comfortable (0.950), diverse options and experiences (0.938), belongingness (0.935), community involvement and participation (0.856), social cohesion (0.838), and social diversity (0.781). This component is related to comfort, social acceptance, and openness, as well as community engagement and participation in development (Gehl, 2016; Temelová, 2007). Stakeholders, irrespective of any social solidarities, highlighted cohesive behaviour, belongingness, and being empowered to take decisions and carry out development activities in the city centres. This component is

Table 7. Rotated component matrix of the principal components and attributes of central areas.

	Components				
Attributes	1	2	3	4	5
Accessibility and pedestrianising	0.955	0.066	0.235	0.080	0.017
Art and music	0.933	0.049	0.205	0.071	0.027
Safe	0.919	0.067	0.185	0.069	0.006
Connected	0.877	0.065	0.191	0.065	0.046
Walkable	0.874	0.091	0.130	0.022	0.129
Cosmopolitanism and openness	0.868	0.116	0.177	0.076	−0.017
Enhancing local economy and environment	0.858	0.047	0.211	0.076	−0.012
Buzz	0.046	0.957	0.174	0.069	0.085
Comfortable	0.048	0.950	0.172	0.071	0.083
Diverse options and experience	0.043	0.938	0.164	0.068	0.073
Belongingness	0.061	0.935	0.237	0.080	0.010
Community involvement and participation	0.075	0.856	0.121	0.054	0.019
Social cohesion	0.370	0.838	0.201	0.096	0.008
Social diversity	0.064	0.781	0.054	0.007	0.267
Enriching experience/feel-good factor	0.101	0.093	0.900	0.071	0.086
Lifestyle	0.163	0.153	0.848	0.268	0.045
Enduring and aesthetically pleasing	0.356	0.189	0.836	0.103	0.002
Public spaces	0.363	0.175	0.108	0.859	0.009
Architecture	0.180	0.130	0.304	0.853	0.029
Professional, commercial, and administrative buildings	0.165	0.113	0.403	0.831	0.025
Residential buildings	0.030	0.006	0.174	0.827	−0.014
Vibrant with people around	−0.004	0.196	0.032	0.023	0.900
Nightlife	0.035	0.307	0.022	0.014	0.864
Restaurants and dining	0.229	0.159	0.024	0.355	0.804
Shopping	0.171	0.137	0.299	0.043	0.779

aligned with place theory, in which it is argued that empowerment of people and a place should be developed not only by considering spatial or environmental interventions but also by considering public participation (Castree, 2009; Laua & Lib, 2019). ICT can play a critical role in empowerment and public participation.

4.3.3. Component 3: Human Experience

Three factors were loaded onto this component, including enriching experience/feel-good factor (0.900), lifestyle (0.848), and enduring and aesthetically pleasing (0.836). The factors were linked to the perceptions, intangible experiences, and feelings of people which, it has been argued, are essential elements in placemaking, as professed in place theory (Castree, 2009; Laua & Lib, 2019). Moreover, this component could reinforce Component 2. ICT can be used to create intangible experiences, add perceptions, or bring out feel-good factors through making information available on demand (Laua & Lib, 2019).

4.3.4. Component 4: Built-Up Environment

The built environment is one of the most important components of a place, and the creation of an appropriate built environment assists in creating the importance or the image of a place. Four factors were loaded onto this component, including public spaces (0.859), architecture (0.853), professional, commercial, and administrative buildings (0.831), and residential buildings (0.827). Quality of place is determined by the quality of the public spaces and buildings. The demand for ubiquitous connectivity for performing urban activities, as well as public residential buildings and public places with ICT connectivity are of paramount importance in city centres (Battisti et al., 2019; Corburn & Cohen, 2012; Zheng et al., 2014). However, the relatively low ranking of this component in this study suggested that improving this component might not be most vital, but it is one of the essential components and should be considered in conjunction with the other ones for the revitalisation of the central areas.

4.3.5. Component 5: Vibrancy

A place should be vibrant and lively to attract activities and people; conversely, activities and people make a place vibrant. Four factors were loaded onto this component, including vibrant with people around (0.900), nightlife (0.864), restaurants and dining (0.804), and shopping (0.779). The presence of these attributes was very limited in the city centres of South Africa, as observed during normal hours of the day and almost non-existent in the evening hours. As argued by various scholars, these attributes need to be augmented to bring people and vibrancy back to the places (Gehl, 2016; Laua & Lib, 2019; Ralph, 2016; Richards & Palmer, 2010). ICT has the potential to be used to facilitate various activities by making information available often and in real-time for shopping, dining, and recreational activities. ICT can also be used to assist in assessing infrastructure, for example, public transportation, and making it safe (Kingston et al., 2005; Kwon, 2009).

4.4. Evaluation of ICT-Linked Strategic Measures to Revitalise the City Centres

To improve the vitality of the city centres based on the augmentation of the five principal components analysed above, it was essential to evaluate what ICT-linked strategies could be implemented to enable the revitalisation of the city centres. For this purpose, six strategies (identified by SID) and the existing status of the city centres were evaluated. Table 8 shows the relative influence of the strategies evaluated, based on their parameter estimates and significance levels.

Five strategies (ICT01–ICT05) were evaluated and compared with the existing status of ICT adoption in the city centres. Four strategies were statistically significant and were likely to assist in revitalisation. These strategies were: network the area with free Wi-Fi hotspots (ICT01), create places to congregate and provide digital screens (ICT02), install surveillance cameras to monitor criminal activities remotely (ICT05), and install digital maps and signage (ICT04). Live streaming of national and international sporting or cultural events was not statistically significant and thus could not be linked conclusively to the revitalisation of the city centres.

Networking of the area with free Wi-Fi hotspots was the most significant strategy (ICT01: B = 3.107) that should be considered in the revitalisation process. This is expected to enhance and provide connectivity for stakeholders and even for people who are without private internet to access real-time information without constraints while in the city centres. This strategy is aligned to Component 1, enhancing accessibility and safety, which was found to be the most essential component in revitalisation. This strategy is likely to assist in enhancing economic activities and improve accessibility to different means of transportation as well as improving safety through information on various criminal activities (De Filippi et al., 2020; Jeong et al., 2010).

Creating places in which to congregate and providing digital screens (ICT02: B = 2.265) was the second most significant strategy. Implementing this strategy can enable the transmission of information as well as the broadcasting of different socio-cultural, entertainment, and sporting events. Consequently, implementing the strategy can result in the creation of a vibrant environment, which can attract people to such places (Gehl, 2016; Laua & Lib, 2019; Ralph, 2016). Moreover, this might help to enhance interaction among people or communities, which might increase community involvement and participation in the activities in city centres.

The installation of surveillance cameras to monitor criminal activities remotely (ICT05: B = 1.843) was the

Table 8. Influence of ICT-related strategies in revitalising the city centres.

SID	Strategies	Estimate (B)	EXP(B)	Wald	Significance	Upper Bound	Lower Bound
ICT01	Network the area with free Wi-Fi hotspots	3.107	22.35	25.379	0.000	1.898	4.315
ICT02	Create places to congregate and provide digital screens	2.265	9.63	18.131	0.000	1.222	3.307
ICT03	Live-stream national and international sporting activities	0.795	2.21	2.674	0.102*	−0.158	1.747
ICT04	Install digital maps and signage	1.402	4.063	7.577	0.006	0.404	2.400
ICT05	Install surveillance cameras to monitor criminal activities remotely	1.843	6.31	12.370	0.000	0.816	2.870
ICT00	Current status of ICT adoption	0	1				

Note: * Statistically not significant.

third most significant strategy that should be considered for revitalisation. It has been alleged that many criminal activities take place in South African city centres and people hesitate to visit them out of fear. Remotely monitored surveillance cameras can make it possible to detect criminal activities and assist in arresting people involved in crime. Moreover, the strategy can enable law enforcement departments to detect suspicious activities or people and prevent the occurrence of any untoward or criminal incidents. Furthermore, this is expected to boost the confidence of people and alleviate their fear of visiting the city centres. On the other hand, it will discourage the criminals from being involved in criminal activities for fear of being caught. Therefore, such a strategy could be an essential element in revitalising the city centres, which has scarcely been considered in any urban renewal or redevelopment process. However, this measure must be taken without creating an impression of a heavily policed or secured area and without compromising people's privacy (Wolfe, 2020).

The fourth most significant strategy that should be considered is the installation of digital maps and signage (ICT03: B = 1.402). Although this strategy was perceived to have relatively less impact than the other three strategies, digital maps and signage are one of the most important requirements in important places. Implementing this strategy would assist in orienting people to the built environment or area in relation to a destination (White, 2014). It will provide directions and information about the location of various activities to visitors, who might not be able to access such information from their mobile devices. This would also improve accessibility to different places, activities, and modes of transportation in the city centres.

5. Conclusions

Most efforts to upgrade the built environment are made through spatial and physical interventions, the majority of which achieve some cosmetic changes, but the challenge of continual degeneration remains the same. In this study, the argument has been made to revitalise city centres by integrating ICT into the socio-economic and cultural fabric of cities.

Five components and their attributes were shown to be significant in revitalising city centres. These were: enhancing accessibility and safety, social and community involvement, human experience, built-up environment, and vibrancy. Thus, while improving the spatial built environment is important, revitalisation demands more than that. The aims of transformation should be to make the city centres accessible and safe, to enhance economic opportunities, to build on social and community involvement, to offer enriching human experiences, and to create vibrancy by attracting people and activities. It has been argued that ICT can be used as an enabler or facilitator to attain the above-mentioned transformation. However, it was found that, although accessibility of ICT in the city centres does exist to a certain extent, it needs significant reinforcement. Furthermore, although ICT is being used in different activities of city centres to a certain extent, such as in general socio-economic activities and for promotional and advertising purposes, it is not used significantly in many essential activities, such as monitoring crimes, public participation in governance systems, and displaying real-time information in public places. It is perceived that ICT could be deployed to contribute significantly to the creation of vibrant city centres if appropriately augmented.

Four ICT-linked strategies were found to be significant in assisting in this transformation. ICT networking with free Wi-Fi hotspots is expected to enhance economic activities and accessibility. Creating places in which to congregate and providing digital screens might assist in broadcasting socio-cultural and entertainment events, which could attract people and improve social interaction. Moreover, social interaction combined with the availability of free Wi-Fi will empower people to

participate in the decision-making and development of city centres. Installing surveillance cameras and remote monitoring of activities, without compromising the privacy of people and creating an impression of a policing atmosphere, is likely to help in discouraging criminal activities as well as dispelling fear by making city centres safe to visit. Installing digital maps and signage would reinforce accessibility by different modes of transportation. Thus, the combined effect of these ICT strategies is expected to make city centres more empowering, safer, and more vibrant.

Acknowledgments

The author acknowledges the support of the National Research Foundation (NRF), South Africa, for this research (Grant No. 106023, 15–12–2016). The author thanks the people who have assisted in data collection. The author also appreciates the experts who have provided their valuable opinions and suggestions.

Conflict of Interests

The author declares no conflict of interests.

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About the Author

Dillip Kumar Das (Prof.) has a PhD in Urban and Regional Planning with a civil engineering and city planning background. Currently, he is engaged in teaching, research, and community engagement activities in the University of KwaZulu-Natal, South Africa. His research and consulting interests under sustainable urban and regional development include systems analysis, system dynamics modelling, infrastructure planning and management, smart cities, and transportation planning. He has co-authored two books as the lead author and published several peer-reviewed research articles.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 242–256
https://doi.org/10.17645/up.v6i4.4490

Article

Public Space at the "Palm of a Hand": Perceptions of Urban Projects Through Digital Media

Byron Ioannou *, Gregoris Kalnis and Lora Nicolaou

Department of Architecture, Frederick University, Cyprus; E-Mails: b.ioannou@frederick.ac.cy (B.I.), art.nl@frederick.ac.cy (G.K.), art.kg@frederick.ac.cy (L.N.)

* Corresponding author

Submitted: 7 May 2021 | Accepted: 29 June 2021 | Published: 17 November 2021

Abstract
This article examines the interactions between digital and social media as the contemporary incubators of place perceptions and the critical debate of environmental quality. Digital and social media may change the way people live but not the way they use physical spaces. This indirect reading of place acts in terms of perceptual understanding in a number of ways, but, most importantly, it becomes fundamental in the "construction" of the sense of place. This is because it impacts on the way information is associated with reality or a contract of the reality which is generated through its "interference" with our intellectual and emotive understanding of place. At the same time, the politics of a new "sociality" contains participations and exclusions. The article adopts comparative case study research as the methodological approach for investigating notions of how urban space is perceived through the case study of Eleftheria Square in Nicosia, a controversial urban regeneration project that generated an extensive debate through digital and social media in Cyprus during the last two decades. It is an attempt of a parallel decoding of (i) a more formal or directive view through digital newspapers' survey and (ii) an informal view through a Facebook group content analysis. Through the case study, the inefficiencies and potentialities of the new media tools in informing the wider public are clear by providing at the same time evidence of their priorities, preferences, and fears. The article comes to two basic conclusions: (i) the perceptions of urban projects through digital media are not static but fluent and constantly updated, usually turning positive as projects are completed and experienced; and (ii) the interactive and synchronous nature of social media provides a more accurate and updated picture of the society's changing perceptions of public space.

Keywords
digital media; Eleftheria Square; Facebook groups; Nicosia; public space; urban design; urban regeneration; Zaha Hadid

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

During the last 15 years there has been a significant shift in the way we manage but also map, comprehend, and assimilate the image of existing and new places in the city (Sassen, 2017). Technological advances directly impact all activities of urban life (Certomà, 2020; Poletti, 2011; Shelton, 2016). At the same time, technologies clearly change the way cities manage the ever-growing complexity but have not necessarily yet led to dramatic changes to the physical urban settings within which we operate. The reality of operation is beginning to disconnect from the "setting" within which it takes place (Lincoln Institute of Land Policy, 2018). At the same time, gravity still constrains our movement at ground level, the classification of urban structure into centre and periphery is still a key mapping perceptual condition, and the relationship between private and public space still defines

our understanding of built and open space. Ethier (2016) refers to the three scenarios of the current transition: (i) the city of the future will continue to evolve more or less the as expected, (ii) the city will integrate smoothly the digital opportunities which add value to physical space, and (iii) digital media will dominate lives and perceptions creating a new urban digital culture. In this context, "connectivity" as the core value of digital culture will possibly affect priorities, values, and expectations from the way urban design and planning shapes physical space.

The article deals with the capital city of Nicosia in the island state of Cyprus. It examines the way cohesive social media groups express and interact through their views and shared images on their understanding of urban place and through a specific large scale associated transformation. The article explores concepts associated with digital and social media spatial constructs and assesses their compatibility with the mainstream "institutional" view and perceptions of the city as the more relevant to businesses and the lifestyle of the city expressed through digital press. A comparative case study research (Krehl & Weck, 2020), based on exploration of consents, maps the way "space" and "place" are perceived through the recording and analysis of views expressed and debated by social media interest groups, such as those on Facebook, which discuss city design issues in Nicosia. The parallel documentation of the same project through references in the digital press, which outlines the institutional or sociocultural view of the city image, is benchmarked against the perceived importance of various aspects of the project dominating the online media exchange. The assessment of the social media perceptions uses three analytic tools: (i) evaluate maps of posted images, (ii) measure popularity of posts by theme, and (iii) collate comments regarding their positive or negative views. The review of the digital media relies mainly on the quantitative and qualitative analysis of a topic-based referencing focusing on common debates. A key interest in both data sets is the observation of changing views and positions at the point of the opening of Eleftheria Square, where the theoretical imaging through the project presentation by the city and media overlays the experience of inhabiting the actual physical space.

2. Concepts Associated With Digital and Social Media Spatial Constructs

Online communication changes "the frameworks for seeing the city" and impacts on the construction of our "urban diaries" (Wolfe, 2016). Traditionally, our sensory understanding although personal (through physical presence) relied on physical clues and references such as the geometry of the path or the dominant element in the experience of a view (Lynch, 1960) often common across cultures. According to Cullen's (1961) "concise townscape," "serial vision" relies on the construction of townscapes as a critical perceptual tool which not only relies on architecture or urban "components" but also on an observable "art of relationship" in the urban setting which characterises them (Wolfe, 2016). Relational referencing was acting as a strong learning mechanism of an increasingly complex system of overlaying parameters which constitute a condition on which we reflect intellectually and emotionally (Van Dijck, 2012).

The ability to walk through digital space or online referenced spatial components, order or map them in a variety of ways (often through big data difficult to access in the past), or derive digital storytelling, generates more complex approaches to place assessment (Wolfe, 2016). Van Dijck (2012) also recognised the impact of the digital era and the platform society as a non-static but dynamically emerging entity with obvious difficulties in conceptualising its long-term impact on the way we understand space but also construct physical space within a different structural order.

2.1. Impact of Online Communication on Perceptions of Space

There are key differences in the way the reading of space changes when perceived solely through digital tools. Two-dimensional fragments instead of a three-dimensional total experience constitute a quite different experiential tool. The representation of reality alters to an extent (or perhaps fundamentally in the future) our "construction" of the sense of place through the way explicit information is associated with spatial reality (or an impression of the reality) and the "interface" between the intellectual and emotive understanding of space (Lomax, 2020). Digital press and/or social media interferes with the intellectual and emotive activity associated with the process of opinion formulation of notions of place.

An often-personal experience and process of formulating an opinion is becoming a collective activity that carries the "baggage" of overlaid views and opinions which continue to transform the framework of our "online experience" of place. The content of digital platforms is co-created, shared, and re-negotiated between both places, human and non-human actors, reshaping traditional urban space (Håndlykken, 2012). The dynamics of group membership is an aspect which needs to be considered in drawing conclusions about the production and sharing of knowledge through social media platforms: "As we observed the downside of social media in the context of collective protests is their tendency to echo the voices of likeminded people, discouraging critical engagement or dissent" (Van Dijck, 2012, p. 3).

Our research case study consists of participants who are not only "likeminded" professionally but largely part of the same social circle with personal contact outside the media platform. Levenda et al. (2020), when examining the value of media tools in public consultation, confronted the claim that digitally enhanced public participation in planning increases engagement but not

necessarily the diversity of participants or the derivation of meaningful transformational opinions. He concludes that "smart city technologies complicate this dilemma of increasing tokenism through the proliferation of online platforms of engagement that facilitated public comment, not paired to other forms of meaningful participation" (Levenda et al., 2020, p. 347).

The impact on our sensory experience of "background knowledge" and referencing available at an instance during a site visit was traditionally clear—to a great extent—of socio-political or economic "inside," since the experience derived mainly from the sensory understanding with less intellectualised knowledge references as a background for the observer (Singh & Christmann, 2020). Literature on the issue of participatory process in planning (Douay, 2018), the formulation of planning policy, and/or conducting city branding/promotional exercises through social media tools is part of the contemporary smart city communication context (Cleave et al., 2017; Kowalik, 2021). There seems to be an agreement that there is a difficulty of defining and engaging the "public" in its totality, managing institutional interference or "evening out" bias embedded in the design of tools, collection, and processing of data, etc. (Carson, 2016).

One set of relevant references derives from the exploration of the literature on the construction of the digital city. The bottom up and relatively fragmented approach is also identified when exploring the nature of place in digital cities as constructed products of network activity. Exploring the notion of the digital city and the associated perceptions of space, Håndlykken (2012, p. 25) suggests that digital constructs "contain symbolic meaning, and can be seen as a metaphor, where digital networks, architecture and cities represent hybrid, fluid and relational space." Considering the constant flow of information about the context of the conceptual "making" of place, one can suggest that while we investigate what characterises spaces in the digital city (and perhaps the understanding of space through digital media), "the intertwined physical and digital city shapes our experience of the city as well as the potential for agency of users" (Håndlykken, 2012, p. 27) who are no longer only users but also creators of the digital city.

It is obvious that a one-time activity has little relationship with the perception of the spatial structure of the city, which challenges existing city views comprising singular or statutory uses. City image analysis across time is critical in future research if we are to understand the ways cities will be experienced in the future through social and digital media.

Despite the enormity of the change in the way we communicate through online tools, what, and with whom, there is relatively little empirical exploration in the literature of issues of perception and the understanding of physical space, in what way it is effectively communicated, or how views on environmental quality are formulated or re-defined.

2.2. The Politics of a New "Sociality": Participations and Exclusions

Other than shaping our perceptions of space the creation of agencies of users in a hybrid urban environment generates a new social reality and fluency for new ways of sharing, co-creating, and mixing but also politicizing the debate around the environmental condition.

The literature focuses extensively on the role of social media in the different but relevant context of political activism, the mechanisms through which grassroots groups emerge, expand, and grow through annexations into significant pressure groups, shaping into political activism organised within online environments (Eizenberg & Jabareen, 2017). Facebook membership goes beyond online interactions to support a movement/event in several different ways providing financial support, attending face-to-face meetings/gatherings demonstrations etc., but also impacts on the outsiders. It creates a community membership, which is much wider than the online participation. In contrast to random social gatherings, online media engages in a very different way with a number of layers of long-lasting imprints of processes, which very rarely accompany physical co-presence in space. Online media communication is also selective with its own distinct demographic makeups of race, age, and gender. The issue of reliability of data, intentional or associated with misconstrued reality, is particularly relevant to using digital data for research (Sanfilippo & Strandburg, 2020).

In the way the conversation operated in the Facebook platform investigated in our sample, there was a sense of a more informal operandum relative to how people interacted and what was acceptable information to share, with ad-hoc comments emerging and by examples rather than from thoughtful strategic planning. The only sound strategy may rest on the initiative of the media administrators (as in this case) in setting the title, the description, and the periodic feedback to the media group. Under these terms, nobody can have a total view of the process of a social media group without interviewing the administrators.

What is interesting and raises another aspect our research wants to investigate is how layers of media communication interact in bridging understanding and data, and impact on opinion formulation. One can easily notice the close relationship between digital media (press) and social media exchanges (Facebook) where usually the first provides extensive and easy feedback to the second and vice versa.

3. Investigating Notions of Neighbourhood Design: Towards a Methodological Approach

3.1. Case Study Overview

Nicosia is the capital of Cyprus, a divided city of a total population of 300,000 inhabitants in its two parts, north

and south. Eleftheria Square was traditionally considered the centre of the city but also the location where all major public rallies took place during the 20th century.

Charis Christodoulou provides a brief summary of the project Eleftheria Square (Tuck & Karnezis, 2019). In physical terms the place was never a square but actually a bridge that connected the old city with the modern city. It became an area for people gathering for festivities, rallies, and other public events due to its important position in the city centre. This fact led the authorities to consider the redesign of this "bridge" as a "square" to provide an important public space with on objective to integrate the square to the moat of the Venetian walls—another important open space element that characterises the city centre.

An architectural design competition was launched by the Municipality of Nicosia in 2005, one year before Cyprus' entry to the EU, marking, in a way, the celebratory spirit of the time. Zaha Hadid's office won the competition with the jury admiring the proposal's contemporary style. As soon as the proposal was displayed publicly, a public debate started about the project's appropriateness for the location and how far it would enhance or hinder this historical part of town. The main objections reflected on the massiveness of scale and the sense of imposition and contrast of the new design on the medieval Venetian walls, the environmental impacts of the project associated with the cutting of trees and the sparse additions of green space, the increase of soil sealing, and the thermal comfort that the square would lack during the extreme heat conditions of the Nicosian summer.

During February 2012 the construction started, with a programme timescale of two years. The project was only partially delivered in January 2021 after almost nine years (Figure 1). The Municipality attributes this extended delay to the project's technical challenges and technologies that were never tested before by local contractors and to the negative impact of the bureaucratic procedures of the central government. On the other hand, various opinions suggested that the chain of inefficiencies was rooted in the call for competition terms of the contract, the jury decision in relation to the inadequacies of the design in the local context, the elitist attitude of Zaha Hadid's office, the inadequacy and lack of capacity and project management skills on behalf of the Municipal Service Department (sometimes the Mayor of Nicosia himself), for the ineffectiveness in project management, and, finally, the speculative role of the contractor. Figure 2 presents the timeline in accordance with the construction budget so far of the relatively modest in scale landscape project. One other issue worth noting is the total lack of public consultation on the nature of such an important project for the city in a location charged with contemporary sociopolitical references. The competition and associated decisions were purely board-room decisions taken by the local government.

3.2. Methodology

Facebook was for Eleftheria Square the digital space which accommodated the extended storytelling among the citizens of Nicosia. de Jong recognises the value of Facebook as a space for storytelling and as a research tool in geography despite the difficulties it poses regarding data collection (de Jong, 2015, p. 211). For over a decade and a half, Facebook has come to be recognised

Figure 1. Night view of the implemented Eleftheria Square. Source: Unseen Views (2019).

Date	Event	Actors	Budget
1882	Opening in the Venetian walls (Trypioti opening)		
1972	An architectural competition was announced, but the implementation process was interrupted by the events of 1974		
2003	A new architectural competition was announced	Mayor Michalakis Zambelas	€6,492,685
2005	The assignment of the project was given to the 1st prize	Zaha Hadid	
2008	85% co-financing from the European Regional Development Fund (2007–13) was secured (provided that the project will be implemented by 31.12.2015)	Mayor Eleni Mavrou	
2011	After public bids, the Municipality of Nicosia awarded the project to the lowest bidder	Mayor Eleni Mavrou Miltiades Neophytou Civil Engineering Contractors & Developers Ltd	€22,969,825
2012	Works started and the whole project was expected to be completed in 2014	Mayor Konstantinos Yiorkadjis	
	Nicosia Municipality announces the development budget for lhe project		€23,985.130
2014	The Municipality of Nicosia and the company Miltiades Neophytou Ltd announced a joint consent to terminate the contract	Mayor Konstantinos Yiorkadjis Miltiades Neophytou Civil Engineering Contractors & Developers Ltd	
	The Municipality of Nicosia assigns the project to LOIS Builders Ltd	LOIS Builder Ltd	
2017	Nicosia Municipality announces the new development budget for the project		€45,800,000
2018	Opening of lhe upper part of the square to the public		
2021	Opening of the lower part of the square (moat) to the public		

Figure 2. Timeline of events for Eleftheria Square.

not as an object to be studied but rather a means, to examine the "ways both researcher and participant produce research within online space" (de Jong, 2015, p. 213). Facebook posts and reactions hold the potential to be both irreducibly personal and expressions in broader social and political contexts.

The authors adopt the main principles of comparative case study research which involves theoretical, empirical, and conceptual challenges based on real projects. In this context the researchers' own positioning with regards to a particular epistemology is a subjective but fundamental part of the case study analysis, so the authors are also benefitted by their own knowledge and experience of the spatial aspects of the case study project (Krehl & Weck, 2020). Relying on the study of Facebook social media interactions with parallel cross-referencing of issues through press annotation, during the past 10 years we have been investigating a city centre bespoke intervention programme, which is also an image changer and regeneration catalyst project. The scope of the case study assessment aims at analysing one specific publicly programmed urban project to decode the

conflicting urban narratives through both digital media (the formal vision) and social media (Wimmer, 1997).

The case study explores and compares how an ongoing project is described and perceived through two media categories digital press (daily newspapers) and social media (Facebook).

A more formal or institutionally controlled view is expected through digital newspapers' survey and content analysis, and, for this reason, research goes back more than 10 years. An informal view through a Facebook group content analysis focuses on the more recent aspect where digital narratives coexist with an almost completed real project. Both analyses decode positive, negative, and neutral views on the issues of:

- How collective vs. individual perceptions and the role of membership dynamics inside and outside the media impacts the nature of narrations and debate;
- What kind of intellectual product place emerges through these digital fora where users are the creators of the digital space;
- The way the new social reality and fluency of sharing information co-creates and mixes but also politicises the debate around the environmental condition and qualities;
- How is the three-dimensional aspect of space perceived through the foreground and background of a two-dimensional image and how this impacts the comprehensive understanding of environmental character and quality.

The article uses a simple approach of collecting data through surveys and content analysis which is considered adequate for case specific qualitative research (Snelson, 2016). In any case, social media, and especially Facebook, are relatively recent phenomena, so uncertainty still exists about the most effective ways of conducting research with opposing views and how far this tool constitutes an effective research method (de Jong, 2015, p. 213; Wilson et al., 2012). To assess the data, the article uses a simple classification of posts and publications as positive, negative, and neutral. Whether this classification is either obvious (i.e., through Facebook emojis and emoticons) or derives from the authors' own subjective knowledge and experience, it is an essential part of the comparative case study research (Krehl & Weck, 2020).

4. Eleftheria Square: An Ongoing Debate About Space and Its Politics

4.1. The "Institutional" View of the City Image Through Traditional Media Channels

Different types of mass media are reaching an increasing number of people every day; thus, their role and influence must not be neglected in shaping our perception on specific topics, including the spatial perception and management of our urban environment (Matoga, 2019). Where printed press was traditionally the media of communication, with a declining numbers of readers digital versions of the same publications now seem to experience a regeneration through the attraction of a wider clientele.

Currently, in Cyprus, there are 33 Greek, 11 Turkish, and six English newspapers. Due to language issues, the research takes into consideration only Greek- and English-language newspapers and focuses on main publications with higher circulation. Newspapers that did not offer an online archive were also excluded from the sample. In total, eight digital newspapers were included in the research and 101 articles with references to the regeneration project of Eleftheria Square in Nicosia, from 2009 to 2021, were studied. The articles were written by general interest journalists and not by specialised columnists in architecture or urban planning. No other research tools were applied (e.g., questionnaires, interviews, etc.). It is assumed that journalists did not have any interest invested in the project, the Municipality, the project architects, and/or other stakeholders related to the project. Moreover, among the digital media (eight newspapers), one is close to the centre-right local political party and another two are close to the left local political party. As referred to in a previous section, the political affiliation of the press is a strong characteristic of published information.

The main topics covered in the articles were: the delays in the regeneration process of the project, issues concerning the design concept, the influence of the project on the regeneration of the city centre, financial issues, pedestrian accessibility and traffic management, references to the history of place, environmental impacts, and concerns about the cultural and political issues around the project. Other than identifying the type of debate/concern, each article was categorised according to the "personality" of the main actors leading the key topic conversation as well as the position of the author regarding the content raised by the article and in relation to the topic explored. This nature of the "position" taken by the author was then documented in three main categories: positive, negative, and/or neutral (Figure 3). There is, at this point, an assumption that the author's position not only shapes public opinions but, to an extent, reflects the public view on the issue in discussion. The shift in the debate's interest in various events can be better understood through Figure 2 which in turn reveals the key points in the timeline of this regeneration project of Eleftheria Square. These key dates were further correlated with the main actors involved (Latour & Yaneva, 2017), as well as the key topic and issues addressed (Latour, 2005; Figure 2) from information collected from the content analysis of the documented articles.

Regarding the period from 2009 until today (March 2021), the general position of the articles concerning

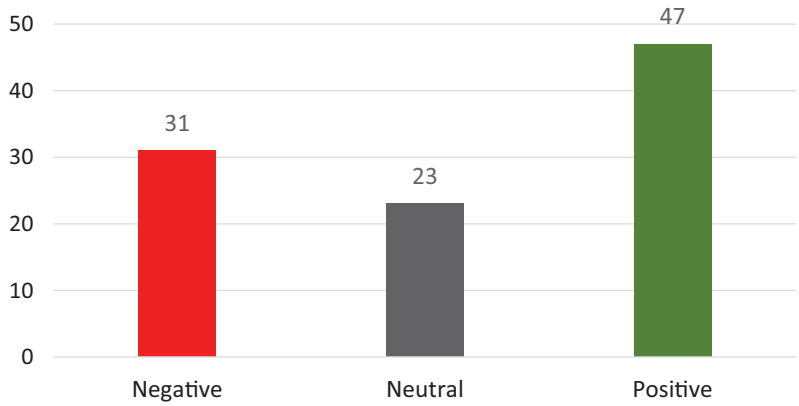

Figure 3. General position (2009–2021).

the redesign of Eleftheria Square was positive in the majority (46.5%), a considerable 30.7% of the articles presented a negative position, and 22.8% were characterised by a neutral position toward the value of the project and how far it was perceived in the public's interest (Figure 3). The main topic of the titles of the newspaper articles throughout the period (38.6% of articles) was the issue of project management which specifically focused on the ongoing delays regarding the project's completion (Figure 4). Other topics with a relatively high percentage of frequency in appearance in the newspaper titles concern the issue of the "design concept" of the square and its appropriateness in the surrounding area (14.9%). Financial issues and especially the ever-increasing budget of the project (13.9%) are considerably important. More complex topics followed, such as the importance of the new square/urban landscape space as a major prerequisite for the essential revitalization of the centre of Nicosia (10.9%) and references to other political controversies (10.9%). Less significant topics recorded among the headlines of the newspaper articles were about issues of pedestrian accessibility through the square (5%), management of traffic around and inside the square (2.9%), and issues which related to the configuration of the square in relation to environmental, cultural, and historical issues (2.9%; Figure 4).

If we further analyse the content of the articles regarding the spatial reference to the project itself, we observe that more than two thirds (72.3%) of concerns have non-spatial references focusing mainly on the topics of delay, economy, and politics. Consequently, less than one third of the articles (27.7%) were concerned with space, focusing mainly on the topics of the appropriateness of the nature of design in its historic context, accessibility, and traffic management. Interestingly, of the articles that refer to the spatial dimension of the project, only one third (28.6%) describe the project as a "piece of architecture" while two thirds of the articles (71.4%) present mainly the aspects of the square as part of a wider "urban project" indicating a clear understanding of the impact of such a large-scale intervention. Based on the latter, one would expect the opposite, since the Eleftheria Square project was a product of an architectural competition, won by a renowned international

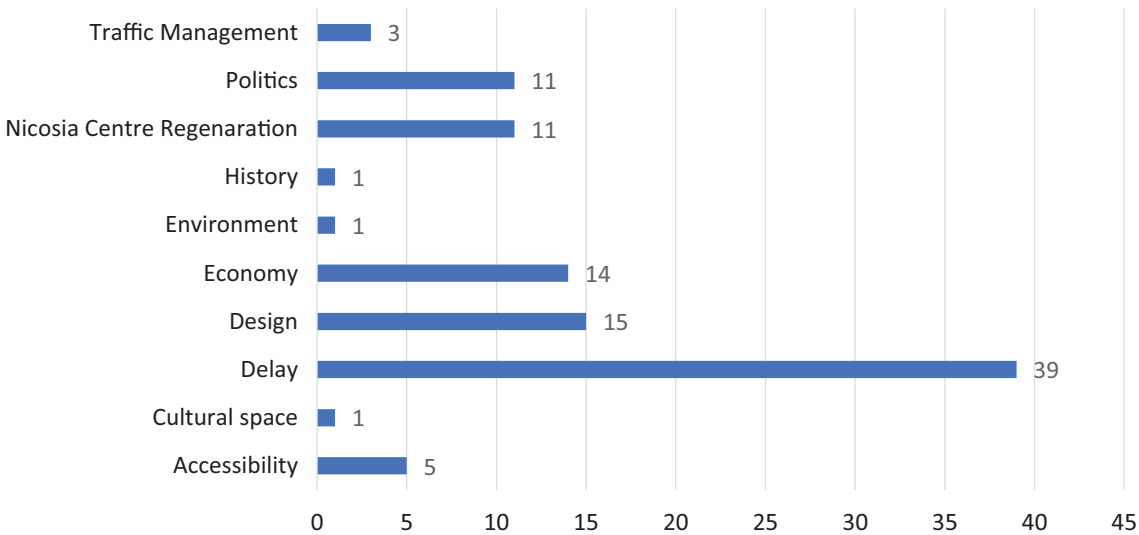

Figure 4. Main topics.

architect (Zaha Hadid Architects), and, throughout the project's lifespan, was presented in images as a singular free standing architectural product without giving much importance on contextual references. It is suggested that the continuous delays on the delivery of the project as well as the lack of spatial images during the construction period (Figure 5) were mainly a factor that led the discussion on other aspects of the project that included the role of the square in the wider strategy of the Nicosia centre urban transformation. Newspaper digital platforms during the construction period of the square created a different "image" not directly connected with the architectural three-dimensional images produced by the office of Zaha Hadid Architects but closer to the expectations and lifestyle of Nicosians, with emphasis on the ongoing traffic arrangement around the construction site area, the spatial accessibility problems created by the continuous delays (disconnection of the old city with the commercial city centre), and the importance of the project for the urban transformation of the city centre.

Examining in more detail the topics reflecting the "articles positions" indicated in Figure 3 and starting with the negative positions, we observed that most of the articles referred to the issue of delays (42%), the budgetary and financial issues (22.6%), and to political issues (22.6%). Other issues, such as environmental, historical, design, and accessibility ones cumulatively contributed a much smaller percentage to the negativity of authors' opinions (12.8%). In fact, the issue of the design of the square and its integrational impact on the historical environment and the Venetian walls (irreversible construction, in stark contrast to the character of the walls), as well as the lack of climatic design features (cutting of existing trees, lack of shaded areas), were topics that paradoxically did not dominate the newspaper articles. To be precise, they appeared as topics at the beginning of the construction of the project (2010) and then reappeared with less intensity after the delivery of the first phase of construction: the upper part of the square to the public in 2019. The latter was probably because of the publication of the first spatial images of the implemented project at that stage, as well as the possibility of visiting the site and having an immediate experience of the place, which did not happen before the end of 2019.

The issue of implementation regarding the Eleftheria Square project became the subject of intense political debate which was used as an argument in up-coming mayoral elections. Moreover, it was closely linked to an inadequate government and financial management of internal and external funds and resources, especially during the economic crisis period in Cyprus (2011–2013). In many cases, the project is presented more as project of "victory" over the financial crisis by the politicians rather than a public project of poor financial management. This displacement of the conversation around the spatial aspects of the project or even its implicit regeneration impact toward the "handling" of its delivery did not perhaps allow an informed, strong debate which could have led to the restructure of aspects of the incompatibility of the design within local context.

Regarding the positive views (articles which in their overall position supported the project; Figure 3), we noticed that most topics referred also still negatively to the issue of the delay in the construction programme (44.7%) and with quite a big difference to the next issue, that of the approved design concept (23.4%). The number of negative views in articles referring to the bad financial management of the project (10.6%) followed and was almost more than offset in percentage by the articles referring to the positive impact of the project on the revitalization of the city centre (8.5%) and the increase of pedestrian accessibility to the area of regeneration (6.4%).

The topic on delays was the most prominent topic overall with the highest percentage of appearances in newspaper articles. Nevertheless, as mentioned before, the topic on delays conserved the same percentage

Figure 5. Number of images per articles in digital media (2009–2021).

of articles with negative and positive positions on the subject.

Moreover, what is remarkable is that throughout the digital media documented period (2009–2021), there were periods of negative position peaks and periods of positive position peaks (Figure 6). While the negative position articles were prevalent throughout the construction of the project, peaks were observed in 2011, 2014, and 2019, and articles with positive positions peaked in 2011, 2015, 2018, and 2021. Comparing these peak periods (Figure 6) with the timeline of events (Figure 2) and starting with the negative position peaks, we notice that in 2011 was the initiation of the construction works, as the project was assigned by the Municipality to the lowest bidder. Most of the negative positions probably were due to the lack of public consultation regarding the winning proposal in relation to the inadequacies of the design for the local context. 2014 was also a peak period of negative positions and that had to do clearly with the undelivered expectations for the completion of the project by that time and relation to the delivery date. The negative positions were further strengthened by the announcement of a joint consent for the termination of the initial construction contract by the Municipality of Nicosia. In 2019, there was a third peak of negative positions probably again due to the expectations for the construction completion of Eleftheria Square, following the opening of the upper part of the square to the public in 2018 or the fact that the upper part alone did not fulfill the expectations for a signature project.

As far as the positive position peak periods mentioned before are concerned, 2015 was mentioned due to the events following the termination of the contract with the initial contractor of the project in 2014 (Figure 2). Specifically, just after the first contract termination, the Municipality announced new public bids and a new contract was assigned again to the lowest bidder, in 2015. In addition, articles with a positive position on the issue of delays appeared at the end of 2015 where the construction work had already progressed with the new contractor as well as at the end of 2018, where the upper part of the square was opened to the public. As expected, the issues of delay and project management appeared more intensively during periods of changes in either the overall economy or the management of the project.

Furthermore, a cumulative number of articles with a positive position and specifically a positive position peak regarding the design of the project appeared just after the opening of the landscaped lower part of the square (moat) to the public, in 2021. Through the digital media, the square was presented as a series of "instagrammable" photos, introducing a contemporary image of the city of Nicosia but in a rather fragmented way.

Focusing on the content analysis of the last documented year (2020–2021) of digital media articles (Figure 7), we notice that a series of events and actions enhanced the positive position regarding the project. Referring to the newspaper articles of that period, we notice that for example the lighting of the square, the delivery of a number of public roads back to traffic, the operation of the newly constructed public underground parking of Eleftheria Square, the official presentation of the lower integrated space of the square (moat) by the Mayor to the journalists, as well as the dedicated articles on the world famous projects of the architects of the square are some elements that greatly enhanced the positive views and positive references to the Eleftheria Square project.

Finally, as mentioned before, there were articles that held neither a negative nor a positive attitude towards the project, keeping in that way a neutral attitude towards the presented facts. In this case, the issue of the revitalization of the city centre came first on the titles of the newspaper articles (30.4%), followed by the issues of project management and the delays (21.7%), as well as the issues of the design concept (13%) and the

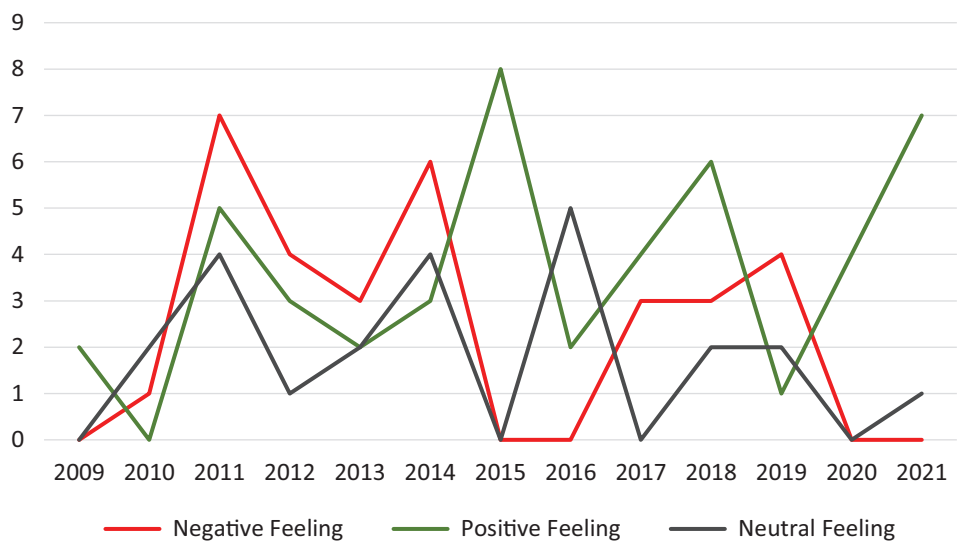

Figure 6. Digital media negative, positive, and neutral positions timeline (2009–2021).

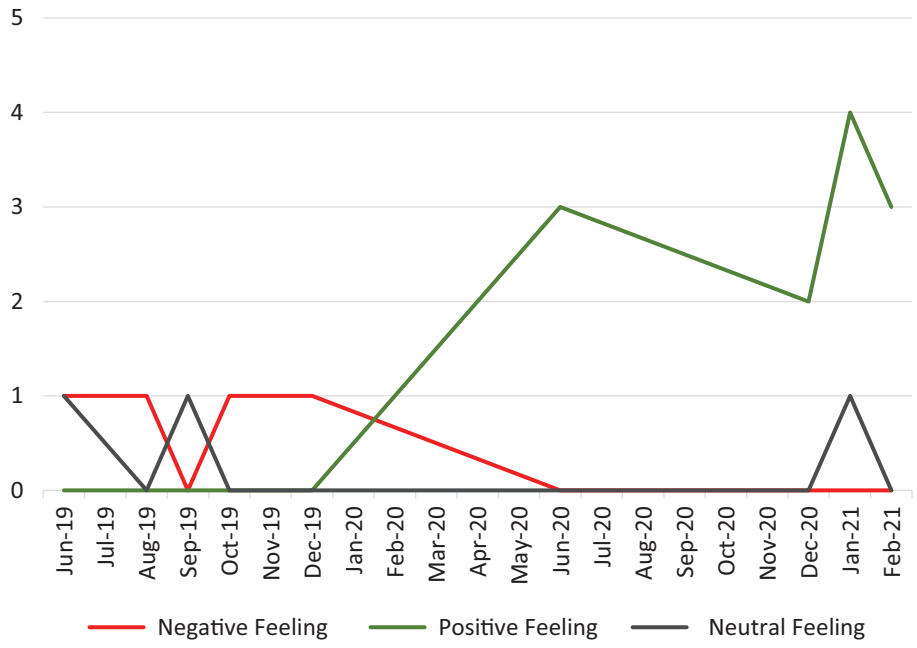

Figure 7. Digital media negative, positive, and neutral positions timeline (June 2019–February 2021).

traffic management (13%). Other issues related to budget and finance (8.7%), pedestrian accessibility (4.4%), culture (4.4%), and politics (4.4%) appeared in the article titles, although with a quite small percentage. A probable assumption regarding the neutral attitude towards the issue of regeneration was due to the lack of sophisticated and informed debate about the potential impact of the new design on the old town of Nicosia and specifically on how open public space improvement can have a major impact on the economies of the city.

What is clear from the analysis of the data of this first part of the research is that media responses are relatively opportunistic, close in time to specific events, more than having the stamina to follow up the conversation in the long run, reporting issues in the context of their immediate timeframe and not their significance in the overall success of the project. The balanced view from positive to neutral and negative references reflects perhaps the complex nature of the particular debate and the lack of in-depth presentation of city design and its consequences on city regeneration.

4.2. The Informal View of the City Image

The second part of this research examines the perceptions of the wider public through social media (Facebook) during the last stages of the project completion (post-2017). In this period there are growing and active social media groups when compared to the initial stages of the project where social media was not so widespread in the community. For this purpose, a Facebook group with a strong representation is selected for data analysis. Nicosia Today and Tomorrow is the largest active citizens' local Facebook group in Cyprus dealing with all issues relevant to the place making of Nicosia. Kagarise and Zavattaro (2016) comment on the validity and the compatibility to the views of the broader public of the social media pages. Some of the basic criteria of the soundness of these digital fora are: (i) organisational awareness (number of group members), (ii) follower engagement (posts and level of interactions), and (iii) sentiment (tone and emojis) to which Nicosia Today and Tomorrow comply with.

The group has been active during the last three years and engaged 2,803 members (51% female, 49% male). The most highly represented group is the 35–44 age group (around 30%), while the 25–43, 45–54, 55–64, and more than 65 groups are around 15% each. The 18–24 group is close to 4%. 78% of the group members are permanent residents of Nicosia City, while the remaining 22% have a very close affiliation to the city. Less than 10% of the group members are design professionals or associated with architecture, planning, engineering, or any other field relevant to public governance or city design. The group founder and administrator, George Mesaritis, is a civil engineer and the director of an established local architecture and urban design studio. Mesaritis has been preliminary interviewed for verification purposes and approvals for the use of data deriving from this Facebook platform. In our opinion, Nicosia Today and Tomorrow satisfies the validity criteria as an active and sound digital platform, due to its scale of membership and followers, the frequency of posts and interactions, and the activity of sentiment as regards the tone and the emotions. The scope of this part of the case study was to illustrate how citizens perceive and respond through digital media to information associated with this project in terms of its design quality, project management, and users' experience. Most of these topics became the focus of the public debate around the project during the last decade.

The research of the Facebook platform Nicosia Today and Tomorrow focused on the period between January 2020 and January 2021. During these 13 months, the Facebook group had grown enough to provide a daily flow of posts and reactions. We have examined all the posts of this period, isolating the posts referring to Elefthteria Square. Each post was identified as positive, negative, or neutral, similarly to the analysis of the previous part of the study. At the same time the impact of each post was counted in terms of the relevant number of comments and emotive reactions. Project management was an issue preferred frequently by the digital press (Figure 8). As mentioned above, it is a common belief that the project delivery was excessive and something which was illustrated daily for years by the "open hole" of the ongoing construction site and the interruptions of circulation in the central area of the city. It seems that this negative performance increases the general negativity about the project in terms of reactions (Figure 9) as an effect of membership dynamics. Positive and negative emotional reactions (love, care, haha, wow, sad, angry) are connected to more emotional and extroverted users who sometimes exaggerate their responses. Figure 9 documents the chain of negativity emerging in all the three key points of the public debate.

The public perception of the project had been shaped by newspapers and posts for the last two decades until part of the project was delivered to the public on January 1st, 2021. Figure 10 refers specifically to the posts commenting on the "design quality," which is considered as the most subjective set of opinions, but also to the ones referring directly to the nature of the resulted physical space and the urban landscape. At this point, it is clear that after January 1st, 2021, the narratives about the project were enriched by users' site visits and real pictures taken on the site and posted. There is a clear positive turn that reveals the significance of real space experience in opening formulation of views, compared with relying on two dimensional images or being informed about relevant parameters indirectly.

Comments on design quality were in favor or against the unusual futuristic form of the architecture, the domination of concrete volumes and surfaces, the massiveness of the structures, and the overshadowing of the medieval wall. Few comments only dealt with the wider regeneration impact of the project. A lot of comments were superficial, the debate was not in depth, and, to some extent, failed to contextualise issues, with an overall opinion in favor of the originality of the project since Nicosia Today and Tomorrow is not composed of a pool of experts. The Nicosia Today and Tomorrow administrator was neutral on the issue of design quality, trying to encourage all the aspects in the exchange of views. Most of the commenters and/or participators in the debate were, across the examined timeframe, campaigning constantly for or against the project. In this context, leading voices from the site of design professionals were visible but not dominating the debate, even on design issues.

Figure 10 correlates closely mostly with the interest of the digital press during the same period. Usually, a press release on behalf of the municipality increased the media interest on covering the project progress often with negative commentary and this was reflected also in the Facebook activity from time to time. This trend was reversed at the point of the project opening to the public in January 2021. At this point, the sophisticated and new (for Cyprus) design of public space and landscaping surprised the visitors positively. Unfortunately, this article cannot follow through post-January 2021 any possible future negative posts or run an audit check after possible deterioration of the project due to insufficient maintenance or even wearing of the viewers' interest due to the lack of complexity in the detailing of the space and landscape.

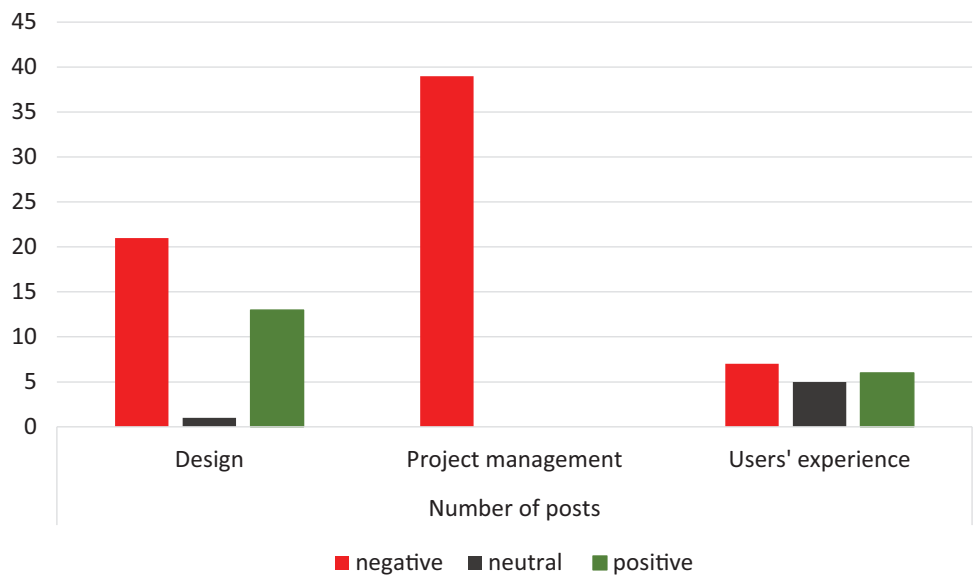

Figure 8. Negative, neutral, and positive posts, from January 2020 to January 2021.

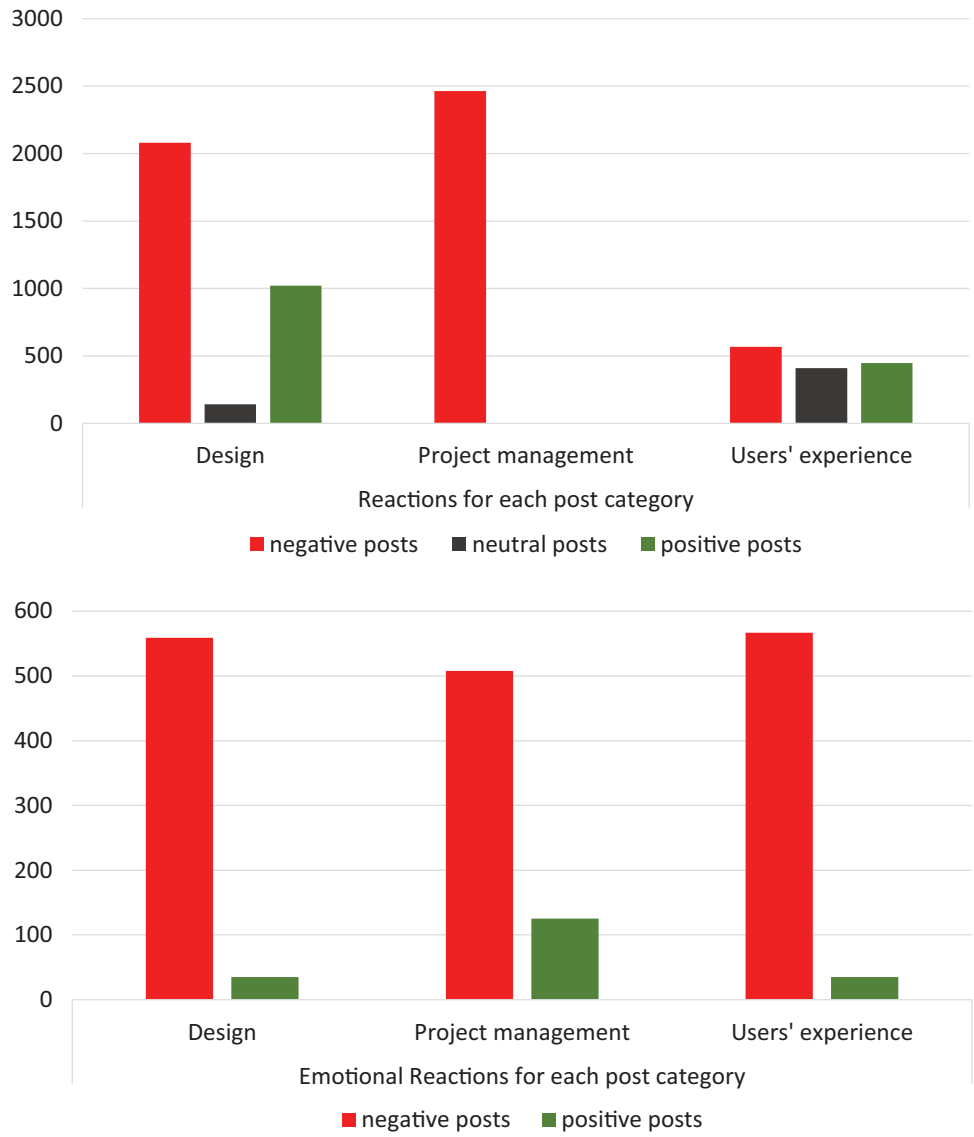

Figure 9. Moderate supportive reactions (likes) to the posts of Figure 8 (top) and strong supportive reactions (emotions) to the posts of Figure 8 (bottom).

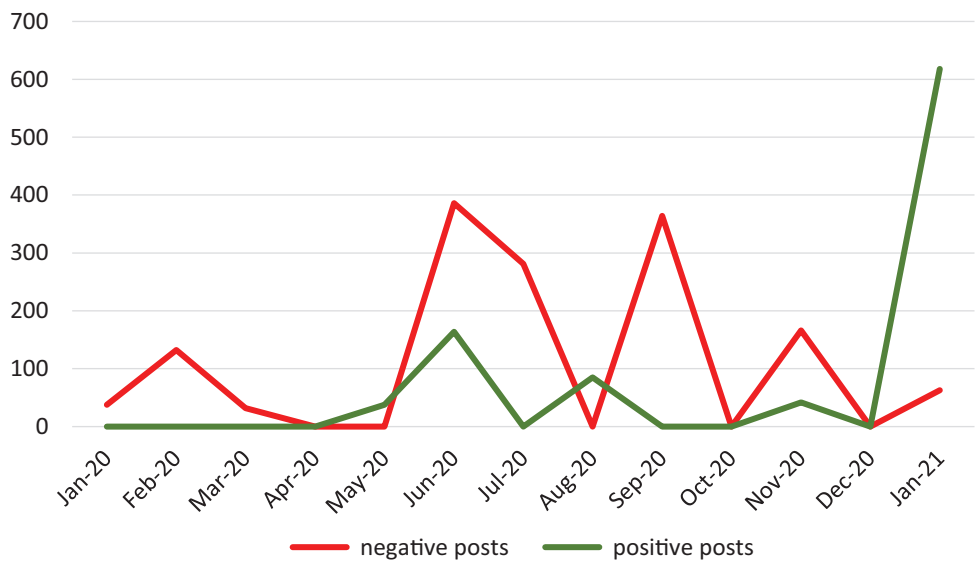

Figure 10. Timeline of reactions on design quality.

5. Discussion

Both parts of the comparative case study analysis show collective perceptions impacting on the nature of narratives. Priorities revealed through digital media as budget issues, project management, and delays provide feedback to social media commenters. Social media narrative is of course more pluralistic providing views and aspects from a variety of perspectives, while digital media are more "contained" and uniform according to the timing of events. Membership dynamics can reveal whether an image or a view of the project has a public acceptance.

In both cases, the examined media users are the creators/generators of the digital perception of space. In the case of the digital media, a journalist, as a creator and as a professional author, is more objective and more willing to revise their narrative according to new data. In the case of social media, the poster reflects an immediate raw judgement of a position which is perpetuated and is consistent through changing circumstances. In our case, Facebook provided more images and spatial references and opinions than the electronic press, and the reactions were more polarized, leaning either in favor or against, without the "balancing of views" or "neutrality" of some of the institutional press.

The way the new social reality is constructed through the selective participation in both groups and the fluency of sharing information, co-creates, mixes, but also politicises the debate around the environmental condition and qualities. In our case, the newspapers' behavior was more opportunistic at times close to specific events than having the stamina to follow up conversations and sustain views in the long run. Social media, on the other hand, looked more capable of supporting a conversation on substantial issues of environment, cultural heritage, and preservation, usually neglected by the digital press.

Inevitably, the three-dimensional aspect of space perceived through the foreground and background of a two-dimensional image limited the associated reference to the spatial condition. In the case of digital media, the two-dimensional image was narrated by journalists, without in some of the cases a prior visit and experience of the space. On the other hand, in the social media platforms a two-dimensional image is commented by numerous physical visitors of the space, rendering the image a supportive medium for the associated narrative with several different supportive references deriving from various site visits and real time and place experiences. In this manner, social media was more effective in comprehensive understanding of environmental character and quality.

The overview of the interaction withing digital media (press) and social media, using as a case study a regeneration project in Nicosia, shows that both platforms indicate the same temporal pattern in terms of negative, positive, or neutral posts. The online press is less critical to negative commentary with all references focusing on more tangible topics which can easily be quantified and referenced through formal sources. This was expected since the online press is edited before publishing compared to the impromptu commentary of the Facebook group. The time lap and parallel interest in topics with a huge number of posts following official statements in the press was also expected. The online media responses seem to be relatively opportunistic and react closely to events rather than having the stamina to complete/inform a debate in the long run. The balance of view from positive, neutral, and negative references reflects perhaps closely the level of complexity associated with the debate, the cross referencing of information, and, therefore, opinion formulation across the two media. A significant finding is the relatively but clear lack of in-depth presentation of city design issues, the consequence of long-term impact on regeneration, etc. Although the complexity and the novelty of the design has been adequately communicated, experiencing this project only through digital media is still less appropriate to the multilayered and relatively long debate associated with design issues.

6. Conclusions

The perception of urban projects through digital media is not static but "changeable," usually turning positive as projects are completed and experienced. The interactive and synchronous nature of social media provides a more accurate and updated picture of the society's changing perceptions of public space.

The Facebook platform with the "in real time" and informal commentary generated a more open debate; it influenced views, shifted the debate, diversified topics, and associated narratives. The multiplicity of participation in a single conversation made the debate more fluent and versatile with frequent shifts from positive to negative commentary and continuously changing positions even by the same participants on a specific topic. It appears that Facebook could be a constructive tool for public consultation on urban projects if managed appropriately and could set agendas for debate in a structured manner.

Paradoxically, the issue of design, environmental quality, and regeneration value did not appear highly on either negative or positive positions in neither of the media samples, despite the leading role of the high proportion of professionals in the field. This might perhaps relate to the nature of information conveyed about the projects design attributes and/or the difficulty in conveying more complex descriptions and narratives through the short references imposed by the medium of communication. Interestingly, the notion of regeneration is more prominent in the discussions but again, in neutral terms, fails to debate the more complex characteristics and mechanisms.

At the same time, nonmaterial aspects of perceiving space as project management, budget, sitework programme, and local politics seemed more prominent.

We could not verify how this relates to the ease of referencing these topics or why they are becoming critical "political" aspects associated with the generation of the "city image" that begin to concern a more active and sophisticated public. Such aspects are clearly less dominant as parameters in our experience during the physical exploration or experience of the city. In this respect, the debate on perceptions associated with media platforms cannot concern purely spatial and sensual aspects but more subjective, even biased references to more attainable topics.

The complex context of urban regeneration, as a decisive environmental change, relates equality to spatial configurations and the re-shaping of cultural constructs associated with issues much more complex to discuss through the simple two-directional communication mode of a media platform. The interactive and synchronous nature of social media cannot stand without a more active multi-dimensional debate before formulating opinions. Social media platforms could be a part of public consultation but only additionally to face-to-face communication mechanisms which are more suitable to the understanding and debating of design issues.

Acknowledgments

To George Mesaritis, administrator of the Nicosia Today and Tomorrow Facebook group for the useful information provided.

Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

Byron Ioannou (PhD) is an associate professor at Frederick University. He has also taught urban design, planning, and sustainable built environment in a number of universities of the Mediterranean region. He is an accredited expert on built environment by EU bodies, with a diverse portfolio on urban, coastal, and countryside projects of different scales. His current research focuses on development plans and regulation processes, planning law and inclusive urban development, social and environmental aspects of urban space, density, and sprawl.

Gregoris Kalnis is an assistant professor in the Department of Architecture at Frederick University (FU). He studied architecture at National Technical University of Athens (NTUA), followed by an MSc in Urban Design at University College London, and a PhD in Architecture at University of Cyprus (UCY). He was a visiting lecturer at UCY and a researcher at the Centre of Documentation for Architecture and the City at NTUA. He has been involved in a number of research projects and he is an affiliate of the Urban Planning & Development Unit at FU (www.frederick.ac.cy/updu). He was an associate of the Famagusta Study Advisory Group and he is currently a member of the Cyprus Management Committee for the EU research program on circular cities.

Lora Nicolaou (PhD) is an assistant professor of urban planning and design at Frederick University. She was the director of Urban Strategies at DEGW (London). In parallel she held the positions of the head of research for the Urban Renaissance Institute at the University of Greenwich. She taught at Coventry Polytechnic, Oxford Brookes University, and the University of Cyprus. Her particular interest is the interpretation of users' needs and preferences in a way that can intelligently inform building design and integrated development strategies.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 257–272
https://doi.org/10.17645/up.v6i4.4406

Article

Digital Placemaking for Urban Regeneration: Identification of Historic Heritage Values in Taiwan and the Baltic States

Chih-ming Shih [1], Sandra Treija [2], Kęstutis Zaleckis [3], Uģis Bratuškins [2], Chi-Hui Chen [1], Yen-Hung Chen [1], Charles Tzu Wei Chiang [1], Laura Jankauskaitė-Jurevičienė [3], Jūratė Kamičaitytė [3], Alisa Koroļova [2,*], Huei-Chen Lee [1], Arnis Lektauers [4] and Aušra Mlinkauskienė [3]

[1] Department of Architecture, National Taiwan University of Science and Technology, Taiwan;
E-Mails: scm@mail.ntust.edu.tw (C.-m. S.), ccccccccay@gmail.com (C.-H.C.), yh-chen@mail.ntust.edu.tw (Y.-H.C.), charlechiang@gmail.com (C.T.W.C.), hueijane.lee@gmail.com (H.-C.L.)
[2] Faculty of Architecture, Riga Technical University, Latvia; E-Mails: sandra.treija@rtu.lv (S.T.), ugis.bratuskins@rtu.lv (U.B.), alisa.korolova@rtu.lv (A.K.)
[3] Faculty of Civil Engineering and Architecture, Kaunas University of Technology, Lithuania;
E-Mails: kestutis.zaleckis@ktu.lt (K.Z.), laura.jankauskaite-jureviciene@ktu.lt (L.J.-J.), jurate.kamicaityte@ktu.lt (J.K.), ausra.mlinkauskiene@ktu.lt (A.M.)
[4] Department of Modelling and Simulation, Riga Technical University, Latvia; E-Mail: arnis.lektauers@rtu.lv

* Corresponding author

Submitted: 29 April 2021 | Accepted: 24 June 2021 | Published: 17 November 2021

Abstract
The active use of modern technology has affected the relationship between people and place. The "digital environment" and the "digital community" are becoming an increasingly important factor in people's daily life, leading to a loss of belonging to a place, an entire neighbourhood, and a community. In the long run, this poses risks to the unification of values and the loss of identity. In this context, the involvement of the local community in the identification and preservation of historical heritage and defining the specific values of each site is particularly important. Thus, both the attraction of the local community to specific places and the revealed potential of local tourism are promoted. Digital placemaking enters urban regeneration as a logical approach to mixing digital and physical environments and involving the local community. Several GIS-based platforms and other tools are used to identify heritage values, both tangible and intangible. Although digital placemaking is emerging worldwide, its manifestations are closely related to specific local circumstances. The article focuses on the key characteristics and configurations of the digital placemaking tools within particular communities. The study tests digital placemaking practice in the historical districts of three cities: Taipei (Taiwan), Riga (Latvia), and Kaunas (Lithuania).

Keywords
Baltic states; digital placemaking; heritage values; public involvement; Taiwan; urban regeneration

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

People and place relations are playing an increasingly important role in ensuring the quality of the urban environment. At the turn of the 21st century, "in the urban design and conservation fields, despite a strong interest in people-place relationships, the emphasis in practice was on structures and forms of urban areas, with little attention to cultural values" (Stephenson, 2010, p. 14), whereas contemporary urban regeneration

practices focus on place identity (Boussaa, 2017; Zheng et al., 2014), involving cultural heritage in the core of regeneration strategies (Tweed & Sutherland, 2007).

In the process of urban regeneration, the placemaking approach is used as one of the tools to form the identity of a place to determine heritage value (Sepe, 2015). The placemaking approach in this context offers ample opportunities in urban regeneration to recognise people's needs and interests as one of the driving forces of the process (Sweeney et al., 2018).

Today, digitalisation brings new opportunities in many areas. It also provides excellent opportunities for urban regeneration processes and placemaking activities. Digital placemaking is becoming an increasingly used approach in urban regeneration, providing a multifaceted exchange of information and views (de Filippi et al., 2020; Freeman et al., 2019).

This article aims to highlight approaches and tools for digital placemaking in urban regeneration in historic areas of different scales and contexts. The study focuses on key characteristics and configurations of the digital placemaking tools within particular communities in Taipei (Taiwan), Kaunas (Lithuania), and Riga (Latvia).

2. Digital Placemaking for Urban Regeneration

Heritage, as described by Ashworth (1997), is a term that includes almost anything that is inherited from the past and destined for the future. It refers to the outcome of the past, through the combination of three different aspects such as the process of interpretation of history, consolidation of memory, and collection of relics (Pendlebury, 2014). Heritage is defined in UNESCO documents as "our legacy from the past, what we live with today, and what we pass on to future generations" (UNESCO, 2008, p. 5). It is something that is, or should be, passed on from generation to generation because it is valued. Pendlebury and Porfyriou (2017) also explained "heritage" as the outcome of success from past urban environments that witnessed the process of transformation through time. "Urban-regeneration" is referred to by planners and designers as the enhancement of an urban situation, specifically regarding social and economic statuses. The use of "regeneration" concerning "heritage" often linked both strategies for the development of cultural industries and the improvement process of an urban environment, as "placemaking" (Pendlebury & Porfyriou, 2017).

The growth of both cities and tourism has a significant impact on heritage and the appreciation of its value so that the relationship between the surrounding heritage and residents plays an important role in the urban regeneration process (Drury & McPherson, 2008; Loulanski, 2006; Tweed & Sutherland, 2007). Such dimensions of heritage as intensions and behaviour; heritage reputation, and beliefs/attitudes towards heritage develop an understanding of future challenges in urban regeneration (Monteiro et al., 2015).

As cultural heritage is a shared resource and part of the cultural identity of communities and individuals, an evolving area is the involvement of new audiences and the continuous development of participatory interpretation and governance models (Teller & Bond, 2002). Community involvement can be classified according to the level of public impact: inform, consult, involve, collaborate, empower. The lower level of involvement is "inform," which ensures the provision of balanced and objective information on time, while the greater level of involvement, "empower," places final decision-making in the hands of the public (International Association for Public Participation, 2021).

Urban regeneration is the process that requires the interconnection of different strategies and objectives, and collaboration between various actors. Different scholars have stressed the importance of different actors' involvement, including local communities, city authorities, property owners, environmental organisations, investors, etc. Collaboration between actors on different stages of urban regeneration, like preliminary studies, the definition of objectives, planning, and implementation is a complex and long-term process (Roberts, 2000; Tanrikul & Hoskara, 2019). The scale of urban regeneration influences the variety and types of involved actors and necessities for institutional action, management models, communication, participation, and financing. Digital placemaking offers an opportunity for new models of collaboration of these different actors within various scales of urban regeneration projects.

"Placemaking can be understood as an intentional process of situating, revealing, and creating meaningful environments" (Freeman, 2020, p. vii). The Project for Public Spaces, which is known to have played an important role in advancing the placemaking movement in the US, began consistently using the term "placemaking" in the mid-1990s. According to Project for Public Spaces:

> Placemaking inspires people to collectively reimagine and reinvent public spaces as the heart of every community. Strengthening the connection between people and the places they share, placemaking refers to a collaborative process by which we can shape our public realm to maximise shared value. (Project for Public Spaces, 2018, p. i)

It is a multi-faceted approach to connect people to a place, urban planning, and to the design and management of public spaces. While the placemaking movement has flourished globally in the last two decades, the concept behind placemaking can be traced back to the 1960s: The ideas introduced by Jacobs' "eyes on the street," Whyte, who emphasised essential elements for creating social life in public spaces, and Gehl's (2010, p. 193) claim to cities in his famous quote—"First life, then spaces, then buildings. The other way around never works" (Foth, 2017; Gehl, 2010; Jacobs, 1961; Strydom et al., 2018; Whyte, 1980). "Placemaking" in a digital

sense refers to digital applications which allow the transitional method of placemaking strategies to extend.

With the development of digital technologies and digital culture over the last ten years, opportunities afforded by information and communication tools and the emergent field of ubiquitous computing started to be identified, studied, and applied to the built environment. The growth of public Wi-Fi service and smartphone usage enabled devices to reshape how we plan and design cities and public places; it has also led to the rise of the term "digital placemaking." Digital placemaking is an emerging area of research and practice that focuses on the integration of social media and digital technologies within placemaking (Toland et al., 2020). It boosts the social, cultural, environmental, and economic value of places and fosters deeper relationships between people and the places they inhabit (Morrison, 2020). Digital placemaking can also be considered as a part of the wide-ranging and rapidly burgeoning literature on the blurring of physical, digital, social, and spatial experiences through the proliferation of smartphones, social media platforms, or IoT and AI applications (Griffiths & Barbour, 2016; O'Neill, 2016).

Spatially, digital placemaking opens up a "hybrid space" between the physical and the digital world. It contributes to the impression of a world in liquid where the "space of flows" dominates the "space of places." While on the more personal scale multiplying public and private uses of digital media, this phenomenon is consistent with Bauman's (2000, p. 11) liquid modernity; as he mentioned, "the advent of cellular telephones may well serve as a symbolic "last blow" delivered to the dependency on space." Digital placemaking is not meant to replace real places; it is about assisting placemaking to make a place stronger and more durable than what already exists. Despite all the opportunities offered by digital placemaking, there are also challenges like those of exclusion and the fear of privacy loss, which may directly influence the level of different community group involvement. With the rising use of digital technologies, people are becoming disconnected from places and left to self-definition of identity.

The global availability of information also promotes the phenomena of universal and unified solutions in urban regeneration processes. Consequently, highlighting local identity by focusing on cultural heritage and identifying its values is becoming increasingly important. Still, the meaning of cultural heritage is discussed in connection with its identification (Rautenberg, 1998; Teller & Bond, 2002). Heritage is a broad notion which embraces diverse categories. The listed heritage objects and sites (e.g., World Heritage List, local heritage lists, etc.) undergo the traditional process of evaluation by experts. Most commonly, identification and inclusion in the heritage list is a top-down process, where less room is given to public involvement. On the other hand, the growing democratisation of culture shows how local communities define their own heritage values. Attitudes and behaviour towards certain objects and places define these places as valuable by determining their historical and cultural value for the general public. Thus, the growing inclusiveness and public participatory processes allow recognising heritage and its relation to the place's identity and sense of belonging. Moreover, the sense of belonging to the place raises public responsibility and interest in the place (Rautenberg, 1998).

Digital placemaking employs possibilities of virtual space to support the functioning of urban spatial structure. Virtual space, virtual reality, or virtual environment presents an environment in which various subjects are "continuously producing, packaging, re-packaging, recording, discarding, modifying, transferring, disseminating, accessing, and using information" (ScienceDirect, n.d.). Virtual spaces are divided into non-immersive (e.g., web page or smart app which submits simple information about a certain place), semi-immersive (e.g., games which partially replace stimuli of physical space), and fully immersive (e.g., program for virtual reality). All three types can have a different role and significance in digital placemaking, but the presented research focuses mostly on the non-immersive virtual spaces of each case: in Kaunas, it focuses on the most widely accessible non-immersive spaces, such as webpages; in Taiwan, it focuses on the information platform and the database system; and, in Riga, on the digital platform based on an open-source content management system (CMS). Information in virtual spaces can add to or modify the majority of aspects of the above-mentioned model of place according to the Project for Public Spaces concept (Project for Public Spaces, 2007). The hybrid space is understood as a place where the most important spatial structures in terms of placemaking and virtual spaces in terms of the amount of information overlap.

> When a person is in a public space, their attention can therefore be focused on the point at which physical and digital space interconnect. This new hybrid space expands the range of ways a person can experience the physical space around them. (Morrison, 2020)

Morrison's *Digital Placemaking Guide* (2020) highlights semi-immersive or immersive virtual reality as one of the formants of hybrid spaces, but the fact that "attention and memory cannot operate without each other" (Chun & Turk-Browne, 2007, p. 177) allows to see a non-immersive virtual environment as a formant of hybrid spaces too.

3. Methodology and Approach

Digital placemaking encompasses a variety of approaches, methods, and tools which can be used for different purposes. In general, digital placemaking aims to improve relationships between people and places (Marques & Borba, 2017; Morrison, 2018; Wyckoff, 2013). For that reason, digital technologies can be implemented

on different stages of urban regeneration as supporting collaborative processes through multi-stakeholder engagement at the early stages of project development while collecting feedback on development visions and as a tool for co-creation of places (Fredericks et al., 2018).

This research uses a practice-based approach to explore the diverse ways in which digital placemaking can be used for urban regeneration and the identification of heritage values. As digital placemaking is an emerging practice, this approach enables actors to map out commonalities and differences across different case studies and define the opportunities and challenges of each case. The chosen cases include the urban regeneration of the Dadaocheng (Taipei) historical district, the regeneration of interwar modernism architecture sites in Kaunas, and the regeneration within the Riga historical centre and beyond.

The Dadaocheng historical district, as one of the most successful examples for Taiwan's urban regeneration, demonstrates a balance between cultural preservation and industrial revitalisation. However, most of the online tools for obtaining information regarding urban development are based on government-related platforms, as well as sensor data, such as population, land use, urban planning, land ownership, regional historical maps, and geographic information systems, which can be obtained from the national research centre in Taiwan. In addition to dedicated official platforms, other data regarding social, cultural, and economic related information are often scattered across various websites. In recent years, urban regeneration issues have been highly valued and related data are in demand but rarely provided. It triggers the opportunity to develop a Dadaocheng information platform as a collective information hub for share knowledge, updated news, and stories from the past. As various types of information can cooperate into an organised system, it helps to better understand local situations from different aspects and it promotes cultural heritage tourism.

In Kaunas, the investigation of interwar modernism architecture potential for placemaking and digital placemaking based on the hybrid space concept was conducted while combining few methodologies. The identification of the most active/important physical spaces for placemaking was made using the space syntax approach, which is a type of mathematical graph model (Hillier, 1996). Its essence: urban spaces make a graph which is represented by nodes (streets or street segments) and edges (crossroads). The calculation of the centralities of the nodes serves as a background for calculation of space syntax indicators, such as choice (transit flows) and integration (the most reachable and accessible zones). In appearance, space syntax was criticised because of the generalisation and subjectivity of axial maps which were used to create mathematical graphs (Ratti, 2004). The introduction of a segment map (Hillier & Iida, 2005; Turner, 2004) modified the model and created premises necessary for its objectivisation while using GIS street maps for analysis (Kolovou et al., 2017). Space syntax models are validated in many pieces of research which describe configurations of a network of urban spaces with a focus on its potential social content, e.g., transit movement, attraction points, areas of social interaction, etc. Such concepts of placemaking as proximity, connectivity, accessibility, walkability, etc., could be easily measured using corresponding space syntax indicators. In some cases, space syntax models are used in connection with placemaking (Gurkas, 2010; Patil & Raj, 2013). In terms of digital placemaking, space syntax could be used for modelling hybrid space physical components. The space syntax graph model was additionally validated in Kaunas while using different data. Statistical analysis of the data demonstrated moderate and strong person's correlations (up to 0.587) versus allocation of the most functionally important objects and commercial establishments and strong significant Spearman's correlation (up to 0.654) versus the density of the same objects. Because of the fundamental importance of movement in the city, the previously mentioned part of the place model (Project for Public Spaces, 2007) focused on the accessibility of urban physical spaces was chosen. All six aspects of accessibility were identified and measured using space syntax calculations. Six placemaking access aspects were modelled based on the following syntactic indexes: readability as intelligibility (Hillier, 2015), continuity as embeddedness (Yang & Hillier, 2007), walkability based on a World Bank report (Fang, 2015) as metric reach (Peponis et al., 2008) weighted by building perimeter, proximity as integration within close pedestrian reach (500 metres), transport-oriented development convenience as multiplication of pedestrian integration and public transport, and accessibility as distance (metric step depth) from the main parking lots. Space matrix (Berghauser Pont & Olsson, 2017; Ye & van Nes, 2014), as a tool that allows combining and generalising different information and classifying it based on statistical cluster analysis, was used for the combination of six syntactic layers and identification of the areas with the biggest potential for placemaking. Information about the most often mentioned objects of the investigated area in Google search in Lithuanian was performed from Kaunas, thus reflecting the local situation. The results were mapped in GIS and space matrix of hybrid spaces, based on the previously-mentioned six quantitative qualities of physical space and information from the web. The matrix of hybrid spaces was compared with the allocation of modernistic cultural heritage buildings in the investigated area.

Participatory technologies have been deployed in a variety of built environment settings as a means of engaging with citizens on local issues using specific platforms (Krivy & Kaminer, 2013). Nowadays, civil society and social urban movements in the Baltic states are emerging. A diversity of urban activism initiatives such as grassroots communities or neighbourhood associations, interest groups, politically- or culturally-oriented pressure

groups, housing associations, groups against globalisation, and organisations for sustainable development and social justice are emerging all around the world. There has been significant growth of public participation initiatives in the process of urban regeneration in Riga since 2016. Urban regeneration is interconnected with the identification of neighbourhood identity. Local activists often exploit cultural heritage as a foundation for building local identity and foster the regeneration process. Thus, the case of Riga shows the use of digital media for community engagement in urban regeneration. To facilitate the participatory budgeting process in Riga, a competition has been organised on an online platform to support citizens' initiatives since 2019 (Riga City Council, 2021). On the online platform, NGOs, such as neighbourhood associations, publish prepared application materials, visualisations, descriptions, as well as approximate calculations. Then, every interested resident of Riga is invited to vote on the project application which is considered the most important, and thus the most significant and topical issues are expressed. During the two years, about 60 project proposals were submitted for the participatory budgeting competition. This study describes the intensity of public involvement in different neighbourhoods of Riga in the context of the topic of cultural heritage both in the historical core of the city and beyond.

4. Case Studies: Digital Placemaking in Taiwan and the Baltic States

4.1. Dadaocheng Historical District in Taipei: Information Platform and Database System

The Dadaocheng historical district in Taipei began to develop during the late Qing dynasty in the 1850s. In 1895, under Japanese colonisation, Dadaocheng became the centre of business, culture, and daily life for people in Taipei. During the 1980s, Dadaocheng became an urban fringe as a result of the expansion of Taipei. In 1997, a road widening policy for regenerating the declining Dadaocheng historic district in Taipei City roused a petition for the preservation of the old street. Through the planning of specific districts and regulations of bulk transfer for the historic site, the Dadaocheng historical district has been preserved, trying to aim the development towards the cultural tourism industry. The district has become a win-win case for Taiwan's urban regeneration, demonstrating that cultural preservation can balance with industrial revitalisation.

The Dadaocheng information platform was created to promote local culture and tourism industry, as well as to provide customised apps for increasing vitality for the urban regeneration. Two key aspects were designed, including the information platform and database system (see Figure 1).

The information platform gathers resources from Dadaocheng to develop a searchable database for users with easy access. Various categories are organised for assisting convenient information finding, such as Dadaocheng architectural and cultural assets, Dadaocheng celebrity and family, Dadaocheng industry and business, Dadaocheng historical map, Dadaocheng-related information platform, and Dadaocheng-related publications and research (see Figure 2). The Dadaocheng information platform encourages a mental connection between users and the site, provides knowledge from history to current events, from the story of celebrities to local architecture. Thus, related information enhances the impression of users regarding spatial quality and the urban condition. The development of the

Figure 1. User interface.

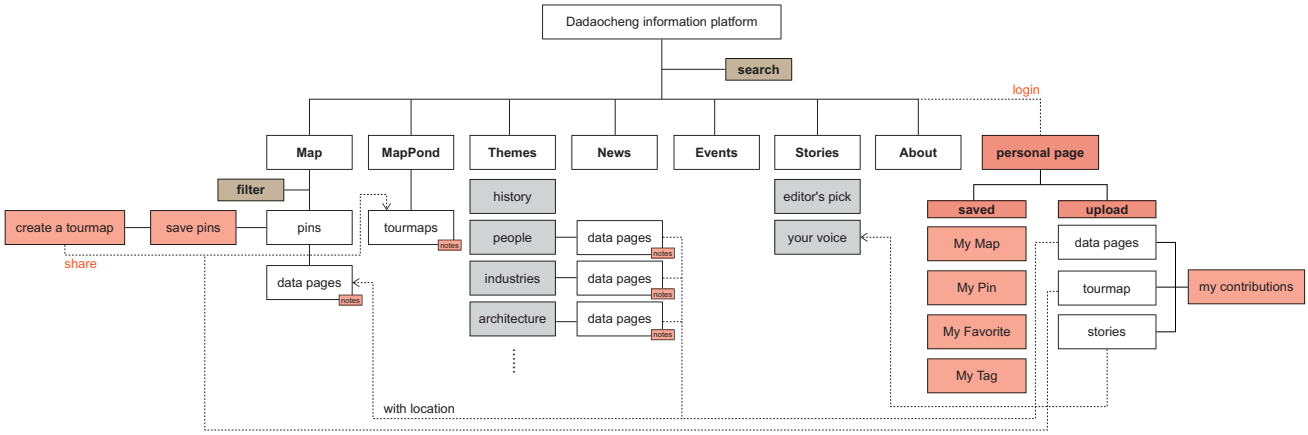

Figure 2. Overall structure.

database system is based on Notion and Google Maps. Adopting open-source software allows further development of a website and a smartphone application. Control of administration enables filtering information for web posting and data sharing to maintain the overall quality of the Dadaocheng information platform (see Figure 3).

To suggest further development of urban regeneration, specific functions were designed for the administration to better understand users' behaviour. Accordingly, to transform gained information into collectable data for conducting further research, functions such as the My Map document how different users prefer to travel and explain users' moving patterns. My Pin refers to personal preference of site attractions. Information of the Dadaocheng district regarding themes, news, events, stories, can be saved in My Favorite, which helps to imagine users' perception towards the site, based on the historical story of people, industries, architecture, or up-to-date events and news according to different times of the year. My Tag allows the grouping of users with a similar preference for their shared post or viewing information, thus developing coherence interests towards other posts or users.

4.2. Historical Kaunas City Centre: Space Matrix and Simulative Bottom-Up Modelling

Historical Kaunas city centre was and is actively formed during various periods: Old town development could be traced back to the 12th century AD with introduction of the Gothic Plan around 1540 and the inclusion of buildings of various architectural styles until now; New Town was planned in 1845 in Classicism-like fashion under the occupation of the Russian empire as an expansion of the Old Town; it got the first push for more rapid development with the construction of Kaunas fortress in 1882–1915 and especially during the period of the first independence in 1918–1940, when Kaunas became the temporary capital of Lithuania. During the period of the second Soviet occupation (1944–1990) and since the 1990s, this area has functioned as a vibrant city centre. It is confirmed by the actual Kaunas City Master

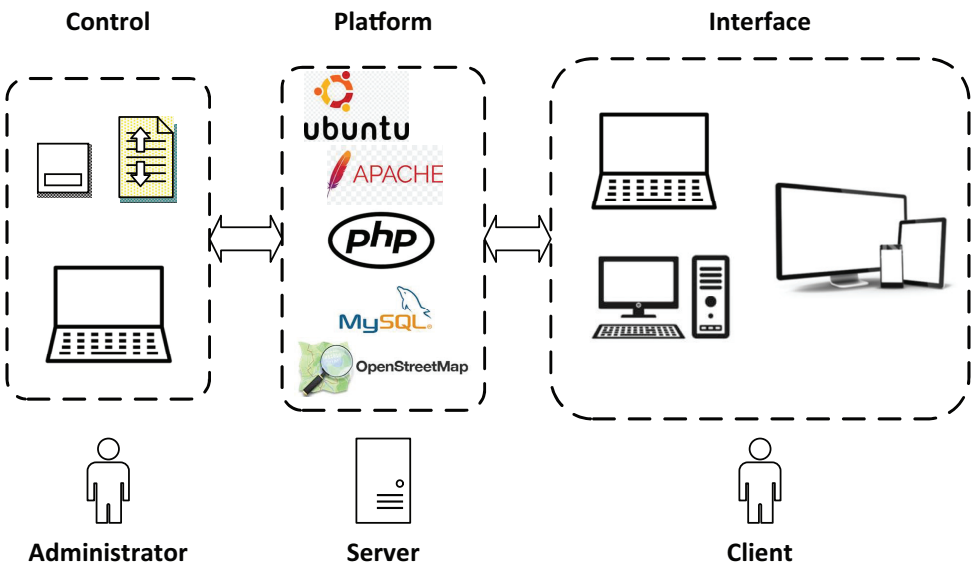

Figure 3. Operation system.

Plan, that both the Old and New Town zones of cultural heritage protection and city centre, which consists of mixed land use and intensity of buildings (ratio between building area and land plot is equal to 3.5; Kaunas City Municipality Administration, 2014b). The City Master Plan points out interwar modernism architecture and the entire investigated territory as the most significant formant of the city's identity (Kaunas City Municipality Administration, 2014a). Nomination for inscription on the UNESCO World Heritage List of Kaunas interwar modernism (Kaunas Region, 2021) in the proposed management plan of the heritage highlights the importance of collaboration with local society for heritage preservation. In such a situation, the issue to preserve urban identity and combine it with new development becomes a challenging task that could not be successfully addressed without the involvement of society and contemporary tools of placemaking. It is especially true if the so-called interwar modernism architecture is considered. On the one hand, it is highly valued by the professionals as a part of the Kaunas European Capital of Culture 2022 event and submitted as a candidate for the UNESCO World Heritage List as a unique heritage type in Eastern Europe and Lithuania; on the other hand, it could not be effectively protected and utilised without the involvement of the wider society through education, an increase of visibility, etc. The interwar modernism architecture, based on both efforts of professional historians and its cultural association to the First Republic of Lithuania (1918–1940), becomes a powerful cultural symbol that could be utilised in many spheres of functioning of urban reality (marketing, tourism, local cultural narratives building, etc.) and whose significance is not discussed in Lithuania. The travelling national and international exhibition "The Architecture of Optimism" could serve as an illustration for the increased visibility of modernistic architecture (Kaunas 2022, n.d.).

The Kaunas case evaluates how significant the role of modernism architecture is for placemaking and digital placemaking in the city centre, addressing it through the eyes of the local inhabitants. Placemaking potential aspects are addressed based on space syntax analysis. Digital placemaking analysis investigates which objects and to what degree of intensity, including heritage, are present in the non-immersive virtual spaces as the only widely available spaces. The presence was measured based on photographic search results from IP addresses located in Kaunas while using such keywords as "Kaunas + Old Town/New Town + Buildings" (in Lithuanian). The first 1,000 search results were analysed. The combination of urban spaces considered most important for placemaking and non-immersive virtual spaces were used to identify the hybrid spaces in Kaunas. The GIS database was created as a platform for analysis. To combine various types of data effectively, the space matrix methodology was used. It was performed in the following steps: the entire investigated area was tessellated into square polygons of 100 m by 100 m; the network of the polygons was intersected with separated layers of data as space syntax indicators, allocation of heritage, etc.; the classification of spaces based on the potential for placemaking and digital placemaking was made based on statistical cluster analysis of the information in the space matrix. Cluster analysis identified the Old Town and two big "islands" in the New Town allocated along the main pedestrian street as the areas with the biggest potential for placemaking. The buildings most often found in the Google search were identified based on the 2,000 first results (1,000 for each part). Subsequently, 162 objects repeated from 58 to 1 time in the Google search were mapped. The mean repetition rate is 4.44, demonstrating how often each picture of a physical building was found during the Google search, which can serve as a benchmark for the number of times each precise building is mentioned. The matrix of virtual space, if compared to the physical one, is much more scattered, but still its highest values are concentrated inside or around the most important clusters of the accessibility matrix. Modernistic buildings are mainly represented at the periphery of the New Town and all repeated just once. The main research steps and results, as well as space syntax indicators used for space matrix, are summarised in Figure 4.

4.3. Riga: Digital Platform Based on Open-Source Content Management System

The historical centre of Riga is included in the UNESCO World Heritage List. The site reflects various architectural styles, which provide valuable insight into the stages of development of Riga as a city (UNESCO, 2021). Thus, protection and urban regeneration for this part of the city get more attention. Unfortunately, regeneration actions and identification of the value on the fringe of the city is not very active. Greater community involvement and participatory actions create an opportunity to identify tangible and intangible heritage values and to support the regeneration of places both in the centre and on the fringe of the city in a more unified and fair way.

Participatory planning and co-creation can increase the efficiency of regeneration proposals and help to create spaces, which will be used by local inhabitants (Kamrowska-Zaluska, 2016; Krivy & Kaminer, 2013). As sustainable development is the main goal of many cities, ensuring public participation in urban regeneration is crucial while searching for effective long-term solutions (Laws et al., 2004). Digital technologies can be implemented on different stages of urban regeneration: e.g., supporting collaborative processes through multi-stakeholder engagement at the early stage of project development while collecting feedback on development visions, and as a tool for co-creation of places (Fredericks et al., 2018).

In 2019, the Riga City Council launched a new participatory budgeting pilot program called For Riga Neighbourhood Development Project Realisation (Riga

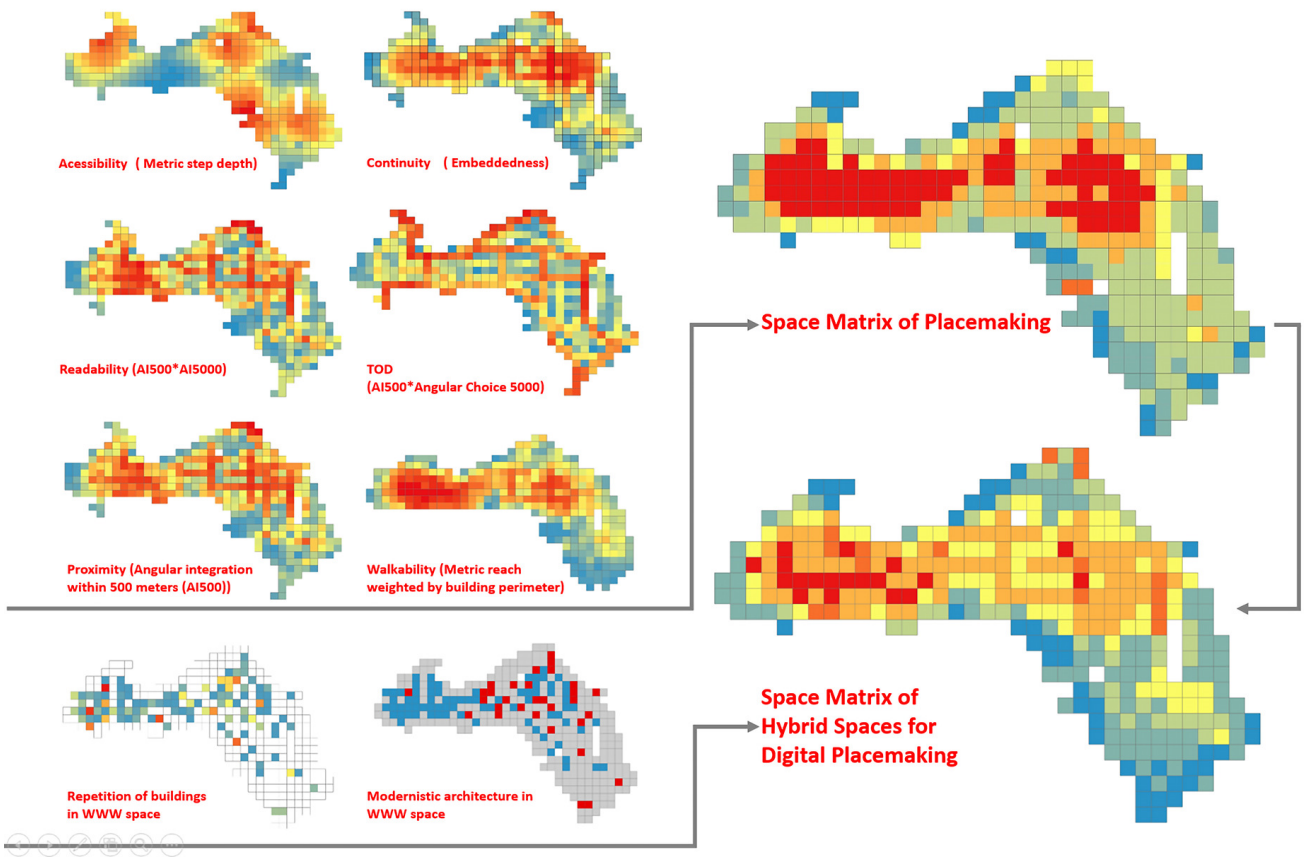

Figure 4. Construction of space matrixes for placemaking and digital placemaking. The red colour indicates the high importance of areas for placemaking in all maps except "World Wide Web [WWW] spaces." The red colour identifies positions of modernistic architecture there.

City Council, 2020, 2021). The digital platform of the program is based on the open-source CMS (Drupal, 2021), providing an integrated back-end and front-end solution for easy content authoring, reliable performance, and security both for desktop, as well as for mobile users. The CMS is integrated with Google Maps web mapping service for visualisation of GIS data. The electronic voting for submitted projects is organised through integration with the state service portal (latvija.lv). The digital platform is also integrated with the social networking platforms Facebook and Twitter. The GIS data on the project webpage shows how many projects have been submitted in each neighbourhood and allows analysing how fragmented the urban regeneration process is. Also, it facilitates the search for projects in specific neighbourhoods while voting.

In total, 58 project proposals have been submitted during the first two years of the program: 34 proposals in 2019 and 24 proposals in 2020. More detailed information is presented online (Riga City Council, 2020, 2021). The most active neighbourhoods in terms of number of submitted projects in 2019–2020 are Centrs, Agenskalns, Teika, Imanta, Vecmilgravis, Sarkandaugava, Mangalsala, and Jaunciems (see Figure 5). Four out of 12 approved projects are in neighbourhoods that are inside or partly inside the Riga historical centre and its protection zone. Results show that the local community supports the regeneration and creation of identity and local landmarks (e.g., Agenskalns, Centrs), as well as projects that support the development/regeneration of passive and active recreation sites (e.g., Brasa, Teika). Thus, the tool appears to be an effective approach to support regeneration outside the historical centre (Figure 6).

5. Findings and Discussion

As seen from the presented cases, each of the described solutions has common foundational features oriented to identify the role of heritage values within the urban regeneration process. However, the used digital technologies and implementation details are different for each of the cases reflecting the fact that currently there are no unified standards for the development of information technology platforms in the area of digital placemaking. The case of Kaunas presents the most advanced and full-fledged GIS usage for analysis of urban activities, in comparison to the cases of Riga and Dadaocheng. In the case of Riga, the digital participation and involvement of users in the evaluation and voting for various city projects play a vital role. However, the usage of GIS is limited mainly to the mapping and information presentation levels. The Dadaocheng information platform is similar in

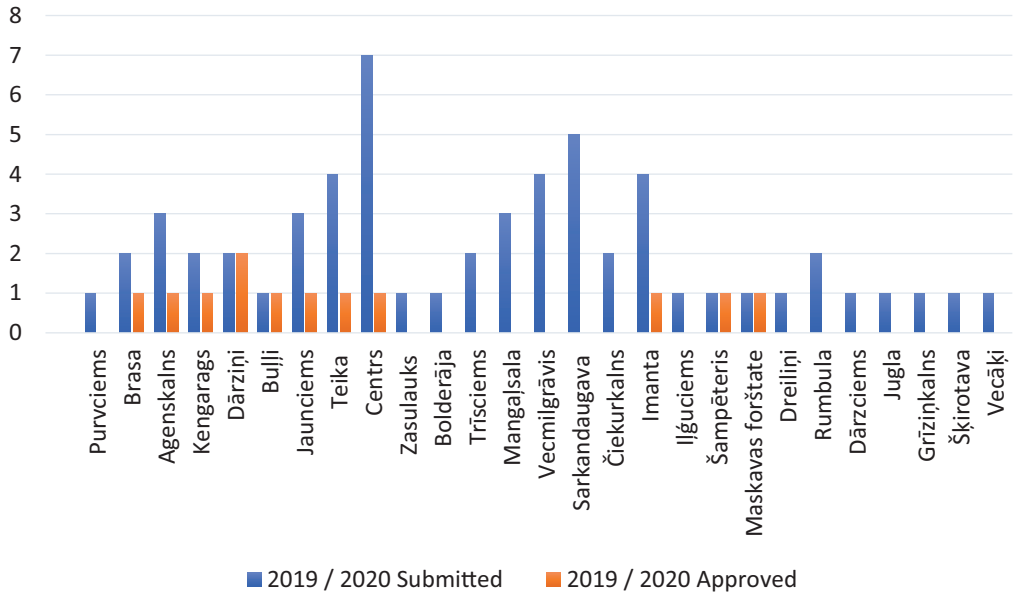

Figure 5. Submitted and approved projects in relation to neighbourhoods.

that sense to Riga's case because the usage of geographic data is limited to web-mapping purposes. From a high-level technological point of view, the digital platform for Dadaocheng is conceptually similar to the platform used in Riga adopting open-source software for participatory urban solutions.

Table 1 presents the key characteristics and configurations of the digital placemaking tools in Dadaocheng, Kaunas, and Riga. In all three cases, local people appear to play a crucial role in the effective operation of the tool, being involved actively (direct interaction with the digital platform) or passively (providing data for analysis). In the case of Dadaocheng, the digital tool encourages a better understanding of heritage site value and allows changes in perception. In Kaunas, the tool allows making heritage more visible based on the targeted actions in both virtual and hybrid spaces. In Riga, the tool allows proceeding with regeneration actions not only in the listed heritage sites but also in areas chosen by local people and considered valuable for the local community. Here, GIS allows easy searching for regeneration projects in specific neighbourhoods.

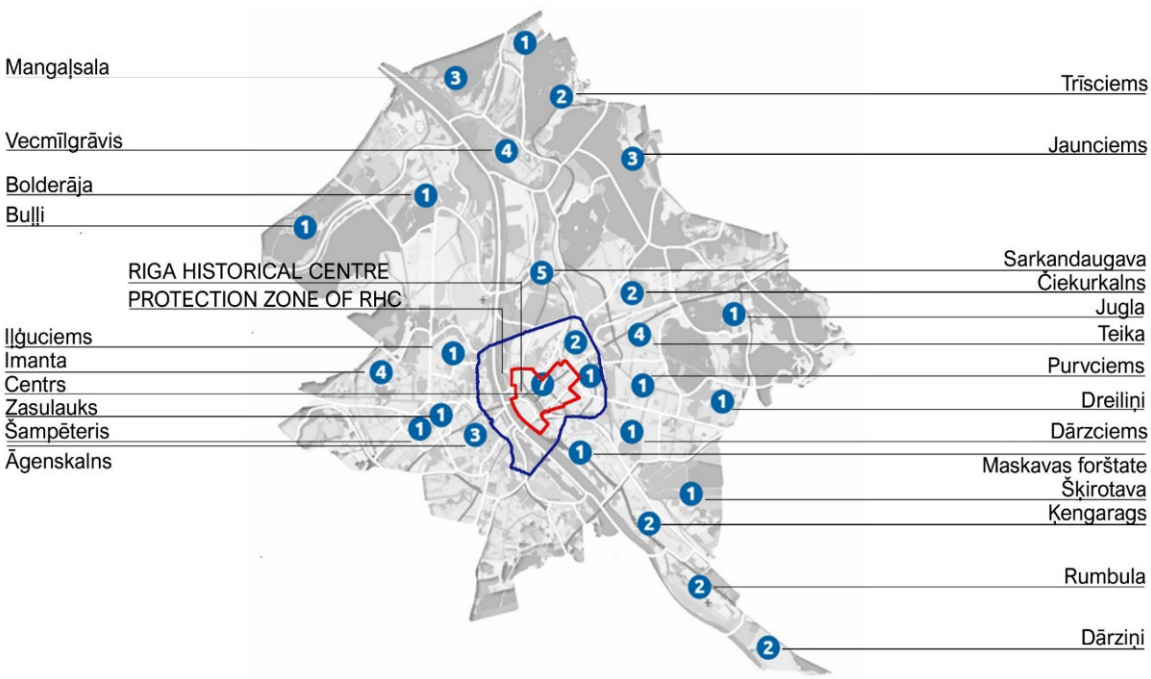

Figure 6. Geographical distribution of submitted projects. Source: Authors' work, based on Riga City Council (2021).

Table 1. Key characteristics and configurations of the digital placemaking tools.

TOOL		Information platform and database system.	Space matrix and simulative bottom-up modelling.	Digital platform based on open-source CMS.
SCALE		District; regional scale.	District or few districts (city centre).	City scale; neighbourhood scale.
ACTORS		Users: Residents, store owners, local tourists, foreign tourists.	Academia and residents.	Residents, NGOs, and the municipality.
COMMUNITY INVOLVEMENT	Active Consult, involve, collaborate, empower	Interaction with the digital platform.		Voting, co-planning, and co-design.
	Passive Inform, observe, analyse	Collectable data analysis (My Map, My Pin, My Favorite, My Tag).	Analysis of simulated urban structure and web content analysis.	Analysis of inhabitants' level of involvement, types of supported projects, etc.
VIRTUAL SPACE	Non-Immersive E.g., web page or smart app which submits simple information about a certain place	Web pages for supporting comprehensive information for this district.	Web pages both specialised and general.	Digital platform, which supports involvement, collaboration, and empowerment of local people.
	Semi-Immersive E.g., game that replaces partially stimuli of physical space	Allowing different users to share thoughts and news.	Could be created based on the conducted research on non-immersive virtual spaces.	Could be created based on submitted projects and qualitative visualisations.
	Fully Immersive E.g., program for virtual reality	Travelling routes are shared as a visiting guide for various purposes.		Could be created based on submitted projects, for a better understanding of urban regeneration visions.
HERITAGE VALUE	Intentions and Behaviour Towards Heritage	Encouraging better understanding of site value by sharing local information.	Check if it is a part of virtual space and hybrid space and create a background for its activation in both spaces.	Allows submission of projects focused on heritage protection and regeneration. Improves and raises the value oflocal community-supported sites.
	Heritage Reputation	This district has been valued highly by locals and governments.	Heritage is seen as an iconic symbol and a state's cultural progress.	Raises awareness regarding regeneration and allows understanding of community preferences.
	Beliefs and Attitudes Towards Heritage	This district serves as a regional cultural hub since an early period.	Heritage could be made more visible based on targeted actions in both virtual and hybrid spaces.	Raises awareness of heritage objects and sites.

The Dadaocheng information platform is designed to encourage users to explore this operation system and aims to develop the local information hub. It focuses on the connection between the mentality of users and the physical condition of the urban environment. The development of urban environment is always according to the perspective of local government, which can also be referred to as a top-down approach. However, the collection of data regarding the mental impression and behaviour of users concerning the urban condition allows better suggestions from a bottom-up approach. It not only demonstrates the real situation but also sets the direction of future improvement for urban designers and planners to better bridge the gap between the perspective of governments and local communities, as well as taking up the challenge of urban regeneration.

In Kaunas, the space matrix of digital placemaking based on current situation analysis of Google search results demonstrates quite weak relations between modernistic architecture and areas with the highest potential for placemaking (Table 2). A not very strong but significant correlation could be observed between existing objects during the Google search and quite a large number of space syntax indexes, thus confirming the premise that non-immersive virtual spaces are at least partially related to more intensive movement and activities of people in a physical urban space. Weak and moderate correlations between human activity patterns as identified by space matrix and the physical allocation of cultural heritage objects might mean that the latter could be more actively involved in placemaking while employing semi-immersive or immersive virtual tools.

Research results in Kaunas (Figure 4) demonstrate quite a fragmented and scattered picture of hybrid spaces despite some specialised activities such as memory maps (Atminties vietos, 2020) or various Kaunas 2022 digital initiatives (Kaunas 2022, n.d.). The same is true if modernistic architecture is considered: There is very little overlapping with the map of hybrid spaces and, even if 41 out of 162 Google searches pointed out modernistic buildings, they were all mentioned just once while the mentioning of the other objects varies from 53 to one with mean 4.44. Statistical analysis reveals that Cramer's Association coefficient between the most important hybrid spaces and modernistic buildings is just 0.044, while with the other types of heritage is 0.373. Such a situation could be explained by the peripheral location of the majority of modernistic buildings in the New Town and its lower attractiveness to a general audience if compared to more easily recognisable architecture from earlier historical periods. The open web-based database on heritage in Kaunas in the Archive of Architecture and Urbanism Research Center (Architektūros Ir Urbanistikos Tyrimų Centras, 2020) is not very effective in terms of relations to very general web search algorithms. Configurations of the digital matrix relatively concentrated around the main zones of the spatial accessibility matrix show that the web content approximately follows human flows in the city and more autonomous or interactive virtual spaces are needed to transform the matrix of hybrid spaces more effectively.

The analysed participatory budgeting tool in Riga is a step towards more active engagement of the community in the process of placemaking, by upgrading the traditional "informing" and "involving" to the visions and projects developed by local communities on the specific site they have chosen. Here, GIS is used by the municipality to illustrate the on-going processes. Still, this type of digital participation has some limitations and needs to be upgraded. For example, it reaches only certain demographics within certain communities. Therefore, participatory technologies should be deployed also in the urban environment by allowing the wider public to express their opinion "on the go."

In general, the conducted research proves potentially significant relations between digital placemaking through targeted and non-targeted creation of hybrid spaces for expansion of inhabitants' experiences and connections with historical places and immovable cultural heritage. Depending on local settings, the degree of involvement of local societies and available digital tools, the processes of digital placemaking can have different forms which might evolve from bottom-up generated to more precisely target-oriented activities.

Table 2. Pearson correlations in space matrix.

	Modernism Presence	WWW Mentions	Heritage Presence
Embeddedness or zones of a dispersed street network	−0.132*	−0.135*	−0.302**
Choice or transit within 500 m	0.126*	0.131*	0.281**
Integration or closeness within 1,000 m	0.160**	0.077	0.272**
Integration or closeness within 500 m	0.108*	0.164**	0.303**
Reachable length of a street network within 500 m	0.078	0.162**	0.352**
Reachable building perimeter within 400 m	0.022	0.204**	0.362**
Straightness of street network within 400 m	0.000	0.193**	0.348**

Notes: * Correlation is significant at the 0.05 level (two-tailed); ** correlation is significant at the 0.01 level (two-tailed).

6. Conclusions

In the process of urban regeneration, the placemaking approach is used to form the identity of a place and to identify heritage value. The involvement of the local community in the process of urban regeneration and identification of heritage values is crucial for the creation of a mental connection to the place, ensuring a sense of belonging and so influencing people's behaviour and attitude towards heritage.

The information platform and database system in Dadaocheng district does not directly refer to the physical making of places, but through learning from the behaviour of users and appreciating the value of heritage, it triggers constructive design and planning strategies for opportunities of placemaking within the urban environment. Digital tools, such as the Dadaocheng information platform, can therefore enhance the urban character regarding social, cultural, and economic conditions for regeneration.

The space matrix and investigation of the content of non-immersive virtual spaces in Kaunas allowed identification of clearly defined and consolidated zones of spatial structure with the greatest potential in terms of placemaking. The case shows that non-immersive virtual space content more or less follows objects and territories which are not in such favourable spatial positions for placemaking. It means that only specific target-oriented, more immersive digital placemaking tools can compensate for limitations of physical spatial structure.

The digital platform based on an open-source CMS in Riga supports participatory budgeting processes. The advantage of this tool is the assistance provided in the creation of local identity and local heritage values. The tool allows the involvement of the local community in the identification of their own values, the places, and objects they consider as a priority in the urban regeneration process. Comparing to the regeneration of listed heritage sites, the tool also supports sites that might be of undefined value on a larger scale but are crucial for the local community and their quality of life. The tool supports the development of real urban regeneration projects.

In the process of digital placemaking, different cooperation models are possible: (1) residents, local tourists, foreign tourists, and private sector; (2) residents and academia; and (3) residents, NGOs, and the municipality. The type of the tool used defines the selected model and the level of engagement of different actors. The choice of a specific tool is determined by local opportunities and targets problem solving for various urban conditions.

GIS allows easy searching for regeneration projects in specific neighbourhoods and allows following up geographical distribution of urban regeneration. GIS-based technologies provide not only mapping tools for digital placemaking but could also serve as a powerful analysis and modelling platform of various digital tools' effectiveness.

As current trends show, digital innovations will play an increasingly important role in digital placemaking for urban regeneration in the future by transforming existing solutions into highly immersive intelligent predictive platforms tightly integrating advanced methods of augmented/virtual reality, simulation, and machine learning. The development of digital technologies will increasingly contribute to new opportunities and challenges in the maintenance and management of digital placemaking and will allow more comprehensive public involvement in this process. At the same time, it is vitally important to remember that successful digital placemaking solutions would be determined by people and place, but technology can only be an enabler of success and not the driver of a digital placemaking project of any scale.

Acknowledgments

This research is funded and conducted within the framework of the Taiwan-Latvia-Lithuania cooperation project *Up-To-Date Information Systems in Urban Regeneration* and is supported by the State Education Development Agency Republic of Latvia, the Ministry of Education, Science and Sport of the Republic of Lithuania, the Taipei Mission in the Republic of Latvia and Lithuania, and Taiwan's Ministry of Science and Technology (MOST 109–2923-E-011—002—MY3).

Conflict of Interests

The authors declare no conflict of interests.

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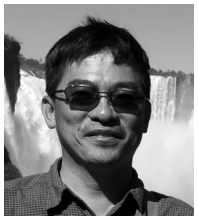
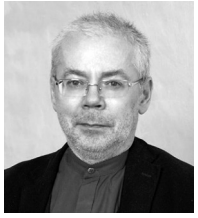
About the Authors



Chih-ming Shih is an architect and professor in the Department of Architecture at the National Taiwan University of Science and Technology. His research interests lie in design thinking and contemporary architecture criticism. He has published several books in Chinese and articles in *Environment and Planning B: Planning and Design*, *Environment and Planning D: Society and Space*, *Journal of Architecture and Planning Studies*, *Journal of Visual Impairment & Blindness*, *Inter-Asia Cultural Studies*, and *Journal of Asian Architecture & Building Engineering*.

Sandra Treija, PhD, is an architect and professor at Riga Technical University. She is also vice dean for research and director of the Centre for Urban Planning of Riga Technical University's Faculty of Architecture. Her field of research includes sustainable housing, regeneration of neighbourhoods, quality of the residential environment, and sustainable urban development. She is a coordinator of the national group of the International Organization Docomomo and MC member of the COST Action CA18137 European Middle-Class Mass Housing. She regularly speaks at international conferences and is the author and co-author of more than 50 scientific publications.



Kęstutis Zaleckis obtained the qualification of Architect at Vilnius Gediminas Technical University (VilniusTex) in 1991. In 2002, he successfully finished his PhD studies at Vytautas Magnus University and the Institute of Architecture and Construction. He is a full professor at Kaunas University of Technology's Faculty of Civil Engineering and Architecture and a senior researcher. His research focuses on the modelling of urban spatial structures in the perspective of spatial determinism by using graph models, space syntax, fractal analysis, and other complex methods.

Uģis Bratuškins, PhD, is a Latvian architect, professor, and the present dean of the Faculty of Architecture of Riga Technical University. His research interest is focused on an up-to-date design and usage of public open space in urban areas. He is the author of more than 80 publications, a member of the editorial boards of several scientific journals, and an expert in Fondazione Romualdo Del Bianco (Florence, Italy), Latvia Science Council, and Slovenian Research Agency.

Chi-Hui Chen received her undergraduate degree in Information and Communication at Yuan Ze University and completed her MA in Architecture at the National Taiwan University of Science and Technology, where she is currently a PhD student, also in Architecture. Her research interests lie in interactive design, design thinking, social sustainability, and anthropology of architecture. She is a member of Interaction Design Association Taiwan and also holds the certificate in LEED AP BD+C and DGNB Consultant-International.

Yen-Hung Chen has been involved in teaching and research for computer-aided design and knowledge management since his early years. In his participation in a government-sponsored research project, Computer-Assisted Building Code Checking, the importance of BIM implementation for the design and construction industry was recognised. Great efforts were made to promote the use of BIM-related technology.

Charles Tzu Wei Chiang is assistant professor in the School of Architecture at the National Taiwan University of Science and Technology. He holds a PhD in Engineering from the University of Tokyo. His research focuses on architecture planning, architecture and urban design, design methodology, as well as the theory of ageing society.

Laura Jankauskaitė-Jurevičienė obtained a master's degree in Architecture from Kaunas University of Technology in 2001. She is an architect and lecturer at the Faculty of Civil Engineering and Architecture at Kaunas University of Technology, since 2007. She is the coordinator of international study projects and tutor of the student groups in international students' competitions. She is an organiser of international summer schools and several international scientific conferences. Her main research areas are cultural heritage, architectural design, urban structures, and public participation in urban planning.

Jūratė Kamičaitytė is professor at the Faculty of Civil Engineering and Architecture (FCEA) of Kaunas University of Technology. She holds a PhD in Technological Sciences. Her research focuses on the analysis of landscape visual quality, methods of visual impact assessment, evaluation of potential and dynamics of urban structures, landscape, and cultural identity studies. Since 2018, she has been a member of the FCEA's research group Cultural and Spatial Environment and an associate member of CNRS ESPACE UMR 7300 (University of Ex-Marseille).

Alisa Koroļova is a researcher and PhD candidate at the Faculty of Architecture of Riga Technical University (RTU), lecturer, and managing editor of the RTU's scientific journal *Architecture and Urban Planning*. Her research focuses on outdoor space regeneration strategies, nature-based solutions, and participatory urban planning. She is a Management Committee member and a working group Built Environment member of the COST Action CA17133 and MC member of the COST Action CA18204.

Huei-Chen Lee holds a PhD in Architecture from the National Taiwan University of Science and Technology. Her doctoral thesis focused on policy, community, and professional practice in Taiwan's historical districts. She also managed the Dadaocheng community planner workshop for the Institute for Historical Resources Management and Taipei City Urban Regeneration Office from 2015 to 2016. Her main research area is cultural heritage, conservation and regeneration in historical districts, architecture, and urban history.

Arnis Lektauers is an associate professor at the Department of Modelling and Simulation of Riga Technical University (RTU). He obtained the degree of Doctor of Science in Engineering (Computer Science) from RTU in 2008. His research focuses on the development of high-performance computing-based interactive hybrid modelling and simulation methods and algorithms applied to complex systems analysis in the area of industrial, economic, ecological, and sustainable development. He is co-author of more than 45 articles in scientific journals and conference proceedings.

Aušra Mlinkauskienė is an assistant professor in the Faculty of Civil Engineering and Architecture at the Kaunas University of Technology. She holds a PhD in Environmental Engineering and Land Management from Kaunas University of Technology. Her research focuses on heritage protection and urban spatial planning, management, and protection. She is also responsible for the identification of valuable properties of heritage objects in the regional heritage assessment council and is a member of the research group Cultural and Spatial Environment.

Urban Planning (ISSN: 2183–7635)
2021, Volume 6, Issue 4, Pages 273–282
https://doi.org/10.17645/up.v6i4.4574

Article

Scanning for Cultural Competency in Online Urban Planning Programs

Brian Garcia

Urban and Regional Planning, California State Polytechnic University Pomona, USA; E-Mail: bpgarcia@cpp.edu

Submitted: 31 May 2021 | Accepted: 5 August 2021 | Published: 17 November 2021

Abstract
This article investigates online urban planning degree programs. The Covid-19 pandemic forced urban planning programs to pivot to online delivery instantly. However, there is little preexisting knowledge on online learning in place-making fields of study both in the literature and in practice. Meanwhile, working and learning from home is expected to continue as part of urban planning education and practice. The key tension of teaching urban planning online, as a traditional place-dependent field, is the starting point for our inquiry in this article. To understand the state of online urban planning programs, an internet search was conducted. A database of 176 higher education programs was created that identified only eight online programs including degree-granting and certificate programs in urban planning. These urban planning program results were concentrated in the western United States. Key challenges in online learning were identified through a literature review, including pedagogical efforts in skill transfer and multiculturalism. The eight-program curriculum strategies were analyzed through a qualitative case study analysis. A discussion on the tactics during the transition from in-person to online education in the Department of Urban and Regional Planning at California State Polytechnic University Pomona is also presented. This article provides online urban planning program information for educators currently teaching online and for those interested in creating an online program. Online programs in place-specific fields such as urban planning have particular challenges in understanding communities without site visits, ethnography, or robust in-person community engagement. Online urban planning programs must make additional efforts to achieve a social, collaborative learning and practice environment.

Keywords
online degrees; online teaching; online urban planning classes; urban planning education

Issue
This article is part of the issue "Towards Digital Urban Regeneration: Embedding Digital Technologies Into Urban Renewal Processes and Development" edited by Dalit Shach-Pinsly (Technion—Israel Institute of Technology, Israel).

1. Introduction

Urban planning is inherently about the built environment and has largely been discussed, analyzed, and practiced in an effort to adapt physical space to our needs and enjoyment. Place has long been at the center of urban planning and regeneration work, including the fixed economic and social aggregates that constitute the city (Teitz, 2007). Urban planning professionals work to understand the patterns, growth, and change of the city and to respond with effective urban planning solutions (Teitz, 2007). However, Covid-19 has forced all disciplines into online teaching and practice, including the place-making field of urban planning.

This article investigates online urban planning programs to understand their composition and how they address remote teaching and learning in a field based on place-making. After a search for and creation of a database of urban planning programs worldwide, few online programs were in urban planning were found. This article presents three themes of inquiry that were developed from a literature review and scanned for in the curriculum of online urban planning programs including place-based project learning, skills transfer, and cultural competency to work within an online milieu ethically. A search of online programs in urban planning found one bachelor's program, three graduate certificate programs, and four master's programs in urban

planning. The Master of Urban and Regional Planning at the University of Florida was the only accredited online program found.

Many urban planning programs have been forced to pivot to online education delivery due to Covid-19, but now plan to continue incorporating more online learning into their programs in the future. However, the small body of urban planning online programs to learn from is a challenge for educators. This article intends to contribute to the discussion about the increased number of online urban planning curricula by mapping the current provision of online urban planning programs and analyzing their curriculum for themes and courses on place-based project learning, computer skill classes, and classes that address ethics and cultural awareness in urban planning practice. After discussing those curriculum strategies, the case of the Department of Urban and Regional Planning at the California State Polytechnic University Pomona (Cal Poly Pomona) is presented to offer in-class strategies to teach essential skills and cultural competences online in order to be an effective place-based urban planner.

2. The Tension Between Place and Dispersion in Urban Planning Education

Fixed spatial elements of the built environment have been presented as a foundation of urban planning, including firm locations, economic clusters, economies connected by geographic region, and the overall polycentric urban form of contemporary cities (Hall, 1998; Pain, 2016; Reades, 2016). However, Hall wrote about other aspects of cities fundamental to urban planning education and practice, including transport and the movement of people and goods, as well as the creation of sociable cities and zones of hope. The key tension between the dispersed aspects of urban planning with place-specific components of urban planning is the theoretical starting point for this article.

Urban planning and urban regeneration are inherently inter- and multi-disciplinary, as illustrated in Le Play's place-work-family triad (*lieu*, *travail*, *famille*) and Geddes' dimensions of society, "place, work, and folk" (Batty & Marshall, 2017). Geddes' basic components of society were key components of contemporary social science, geography, economics, and sociology. The basis for urban planning might similarly be place, economy, and people (Batty & Marshall, 2017). Greater pluralism in planning versus large top-down planned projects would later be highlighted in the political efforts of Jacobs (1961). Ideas of place in urban planning were challenged by the world of the expanding automobile observed by Melvin Webber (Teitz, 2007). Webber's well-known phrase community without propinquity questioned the concept of place as central to geographic and urban planning work. Webber observed that urban planners were focused on place but at this time there were visible examples of place becoming less relevant (Hall, 2007). However, since Webber's work on urban dispersion, we have also seen intense concentration including the rise of new financial districts in Shanghai, Mumbai, and Moscow, along with rising real estate prices in urban cores (Teitz, 2007).

Urban planning is largely situated within a geographic place, focusing on aesthetics, public spaces, parks, housing, and infrastructure including transport (Alpopi & Manole, 2013). Urban planning solutions themselves involve a synthesis of built, transport, and social issues (Alpopi & Manole, 2013). However, for a long-term sustainable solution, the community must be involved in the diagnosis of the challenge as well as in the formation and ongoing implementation of the solution (Alpopi & Manole, 2013; Deakin & Allwinkle, 2007). In place-specific fields, like urban planning, students commonly learn from real-world challenges and locations, to practice analytical and prescription skills to addressed urban challenges. A large part of the analysis and learning in these project courses comes from dialogue with local stakeholders and site visits. During the Covid-19 pandemic and in online learning, students were removed from their project sites and communities. Interaction and education were reduced to what was available online in the form of satellite imagery, literature, photos, or census data.

Educating future urban planners has always entailed the tensions of remote practice, place specifics, and local knowledge (Moore et al., 2015). In higher education, students often travel for university programs and then take their gained knowledge back to their city of origin or a third location to apply their planning knowledge (Moore et al., 2015). Yet, challenges and solutions in urban planning and regeneration are inherently place-based and many cite local knowledge and context-specific solutions as key to sustainable urban regeneration (Deakin & Allwinkle, 2007; Moore et al., 2015). The responsibility of planning educators is to provide students with the skills to acquire local knowledge and invent solutions on their own. The increasing online or remote aspect of practice adds another complexity by distancing students from each other and their site community. Meanwhile, very little scholarly work has been done in urban planning on teaching and practicing remotely (Myers & Kitsuse, 2000).

Surveys on the future of work and space show that 74% of surveyed companies plan to continue remote work of some kind after covid-19 abates ("Shifting some employees," 2020). Office vacancy rates in the United States are unsurprisingly up to 17%, however, this trend of declining office space occupancy began before Covid-19 (Ryan, 2021). Average lease lengths have also been shrinking since the end of 2018 (Ryan, 2021). These results suggest that urban planning educators need to train students more strongly in online tools, software, and remote work communication for their future practice.

Distance, online, or remote education may be described as an education delivery approach that

replaces face-to-face instruction (Godschalk & Lacey, 2001). This article presents an investigation into online urban planning education programs organized by a faculty member to be delivered asynchronously, synchronously, or in a hybrid manner. Urban planning education in the United States has been dominated by three main phases, from the civic design and master planning era of the early 1900s to the turn to the social sciences in the late 1940s, and more recently the attempt to understand multicultural and interdisciplinary complexity in urban planning (Dalton, 1989, 2001). A large part of the turn to understanding multicultural complexity and consciousness of ethnic and gender diversity came from students and their active role in their education (Dalton, 1989, 2001). Planning for the future must include an increased cultural competency, an understanding of ethics, responsibility, and a thorough addressment of community challenges in education and practice (Agyeman & Erickson, 2012; Dalton, 1989, 2001). Historically, obstacles for increased distanced learning in urban planning have included the lack of compensation for course development and inadequate technical support (Godschalk & Lacey, 2001). Three major themes or challenges have emerged for online urban planning education: (a) the importance of place-based project work; (b) the importance of computer skills to accumulate and analyze data; and (c) the need for a cultural competency within an online practice that is somehow able to empathize and connect with a project site community.

3. Place-Based Learning in Urban Planning Education

Problem-based learning is a key component of urban planning education (Shepherd & Cosgrif, 1998). Problem-based learning blends planning education and practice. Students work on a problem from life, earning skills and knowledge for their future practice as planners. The instructor sets up the problem and then guides the student through strategy and visualization. Problem-based learning and urban planning practice are tied to an envisioned future (Freestone, 2012).

Ethnography is a research method in urban planning based on the premise that phenomena cannot be completely understood outside of its context (Salama, 2008). In urban planning, ethnography is used to understand cultural groups and the perceptions of people within their environment. Ethnography and action, or experiential research, cannot be duplicated by technology and this has implications for how data will be accumulated and how communities in need will be served and allocated resources.

4. Technology and Skills Transfer in Online Urban Planning Education

Distance or online education has evolved from correspondence courses by mail, to universities granting degrees for programs based on broadcasts and teleconferencing to the more recent method of course delivery online relying on classes over video conferencing or recorded lectures and multimedia (Godschalk & Lacey, 2001). Today, online learning programs rely on the internet and multimedia tools, including email, course web pages, and online discussion forums. Students can present their work and discuss it with their colleagues and professors through video conferencing. Yin (2010) states that technological advances are permitting visually detailed, performance-modeled, and geo-referenced representations of urban environments. Computer models provide information on space, communities, energy, and these technologies provide opportunities for communication, collaboration, and understanding (Yin, 2010). However, Yin also states some challenges in GIS education, e.g., that photorealistic models must rely on some data from fieldwork, that students need to stay current on latest technology, and that modeling programs are expensive for planning schools.

Godschalk and Lacey (2001) present a case study and survey data from an introductory planning course at the University of North Carolina. They note several exchange programs and international course initiatives at the University of North Carolina that developed from advances in online instructional tools, user-friendly software packages, training opportunities, and support staff. With information technology, universities can compete for students abroad. Sufficient space at universities can be a challenge due to growing student populations and demand for education. Offsetting some in-person courses with online sessions or courses may alleviate some demands on physical facilities. Online learning also helps meet the needs of employed students, military students, and those that live far away from campus. However, many faculty members are concerned about a decline in the quality and efficacy of education without face-to-face opportunities.

Godschalk and Lacey (2001) also note the importance of a technology instruction center to support faculty and students that teaches not only internet and software skills but also strategies to give tests online, help with course design, and pedagogical resources for online teaching. In the University of North Carolina case, faculty training was supplemented with a support group to discuss and address effective use and monitoring of discussion forums and time management skills for emails, copyright and privacy issues, and ways to develop students' internet skills.

The faculty role has been changing from a sole lecturer of knowledge to a curator and facilitator of knowledge for some time (Godschalk & Lacey, 2001). Online learning offers an opportunity to reach more students and a more diverse population of students (see also Lawhon, 2003). However, online learning must be accompanied by course design, technical support, and instructor training (Lawhon, 2003). Issues to plan for in online courses include how best to present the content of course lectures, how to build community and

collaboration amongst students, and the remote library and technology services that are available to support students (Godschalk & Lacey, 2001).

Challenges in retaining online learners in higher education have included student feelings of isolation, student difficulty in being self-directed, and overall lack of experience of students and faculty with online education (Holder, 2007). A study that asked students to rate in-class versus online discussion found that the online discussions were a useful supplement to the course; however, students preferred the in-class discussions based on sincerity, legitimacy, and comprehensibility (Willson, 2000). Typically, students that thrive and persist in online education include those that are academically prepared, engaged, self-directed, have computer skills, discipline, and time management skills (Holder, 2007). Persistent online learners were found to have emotional support, believe in their abilities, and have time management skills (Holder, 2007).

5. Cultural Competency and Transformative Pedagogy

There have been many efforts to diversify planning curricula, planning schools themselves, and the field of urban planning practitioners (Agyeman & Erickson, 2012). There have also been efforts to reconcile differences, diversity, and heterogeneity within urban planning. Now that there is more physical distance between people without in-person events and with public mixing extremely limited, we must understand that technology use in urban planning is a cultural competency in itself as well as a tool (Agyeman & Erickson, 2012). Data available online does not equally reflect all communities.

Cultural competency includes knowledge and skills to effectively engage in diverse environments. Proficiency in cultural competency demands flexibility and agility, especially in times when planners are removed from direct observation, ethnography, and action research to understand place-based attributes and community needs. Understanding differences and cultural needs to improve disparity is especially challenging when limited to only online data, especially when that data does not reflect certain communities such as migrants or informal economic sectors (Agyeman & Erickson, 2012). Similarly, transformative pedagogy is an approach that encourages students to examine their assumptions, promotes student engagement while investigating social inequalities and posing actionable solutions (Meyers, 2008). This requires effort to create a safe environment for discussion on issues that may be personal to the students (Meyers, 2008). In online courses, this must be done through discussion boards or video conferencing. However, there is a digital divide between those with computer skills and internet availability, and those without (Cummins, 2000).

For accreditation of an urban planning higher education program, the American Institute of Certified Planners requires that a program attracts and retains a diverse student population. In particular, the program must attract and retain a diverse faculty population informed by the characteristics of the served population. Furthermore, professional ethics and values in the curriculum, including equity, diversity, and social justice, are a major component of the accreditation application (PAB, 2017).

A study of 695 research publications on distance learning found that access, equity, and ethics was the seventh most published topic followed by articles on globalization and cross-cultural aspects, as the 11th most published topic (Zawacki-Richter et al., 2009). A study of one hundred syllabi from seventy instructors found that a range of educational goals related to diversity and social justice existed in urban planning education in the United States (Sen et al., 2017). A key point in the study notes service learning as a powerful tool to expose students to different lived experiences, increase awareness of marginalized communities and facilitates, thinking about power relationships, and encouraging tailored approaches in urban planning solutions (Sen et al., 2017). These advantages of service learning depend on ethnography, fieldwork, and collaboration with a community partner or population. However, learning online inserts distance between the student or researcher and the site challenge (Shepherd & Cosgrif, 1998).

Working in contexts of informal development or areas composed of migrant populations is challenging because they are often left out of digital data sets. Internet availability and access are two of the main challenges in low-income and economically developing contexts (Falco et al., 2019). While mapping tools and data are progressing across the world, there are exceptions where there are fewer applications in informal settings due to illegality or illegitimate business and informal housing, lack of education and information, as well as a lack of social and financial resources (Falco et al., 2019). Online tools offer greater participation in urban planning projects, for a more bottom-up process. However, it depends on internet infrastructure provision and training the community on how to use online participation tools (Deakin & Allwinkle, 2007). There has been some progress made using drones or mobile phones including teaching residents to use online mapping tools to map their own neighborhoods in Caracas, Venezuela (Falco et al., 2019). This represents a data gap for researching project areas in an online urban planning program.

6. Methods

A database of 176 higher education programs was created from an internet search using the search terms online urban regeneration programs, online urban planning programs, online urban regeneration education programs, and online urban planning education programs. The Google search engine was used rather than a search engine like Duck Duck Go because Google provided more on-topic results from personalized search results. The first one hundred results of each search phrase were

used. The search result relevance eventually degraded. Thirty-three bachelor or undergraduate degrees were found, seven certificate programs, six diploma programs, 108 postgraduate or master programs, and 22 PhD or other doctorate program websites were found. These results were compiled into a database and reviewed for their degree level offering, their geographic location, the department or college discipline they are housed in, and their subfield within planning and urban regeneration.

Excluded from the analysis were unverifiable programs with little evidence online, including Bircham International University, which had several online degree programs in urban planning and design. One-off classes online via Coursera, FuturLearn, Massachusetts Institute of Technology (MIT) OpenCourseWare, or other online providers were also excluded. Webinars, discrete or short courses outside of a degree, were excluded. While educationally valuable to a wide variety of people especially in reach or spreading awareness of urban planning, these short courses or layperson offerings seemed marketed to a different audience than the degree programs, and it was unclear how to understand their academic impact or involvement. From this database, online urban planning programs were identified. These are planning programs in higher education that are offered, organized, and were created intentionally to be delivered online irrespective of Covid-19.

From the identified online programs in urban planning, a qualitative case study analysis was performed on the program curriculum. The program curriculum was scanned for class offerings in project-based learning, technical computer skills, and ethics in planning. A case study of experiences teaching during the transition from in-person to online learning is also offered. Case study research offers a detailed and nuanced examination of a particular case and is useful for understanding processes and connections (Mukhija, 2010). Case studies offer depth, richness, and particularity rather than generalization (Mukhija, 2010). Case studies and comparative approaches are qualitative research methods that extract substantial detail from the cases (Lauria & Wagner, 2006). Multiple case studies increase the validity of observations and lead to generalization, but they also offer points of contrast to extrude more detailed observations (Mukhija, 2010). Qualitative methods are a reasonable starting point for a discussion on the quality of online urban planning programs.

7. Mapping Online Urban Planning Programs

Of the 176 program websites identified, 117 higher education programs were found in the United States and 34 were found in the United Kingdom. From Australia and New Zealand, six programs were found, six from Canada, 12 from countries in the European Union, and one from Tokyo, Japan. Of the states in the United States, California had the highest prevalence of urban planning courses in this study, with 18 programs found. Internationally, only the United Kingdom had more geographically, with 34 results, due to a combination of Wales, England, Scotland, and Northern Ireland universities. University College London (UCL) had the largest number of planning programs from a single university included in this study, with 13 results. Cardiff University had results for 10 planning programs. The colleges or faculties that the urban planning and regeneration programs were housed in were diverse, with many programs held within their own urban studies and planning schools, architecture and design schools, or public policy schools.

This study developed predominantly upon cases in the United States largely due to the availability of data. There is an English language bias in the search terms that makes a geographic analysis of urban planning and urban regeneration programs partially specious. The analysis of the locations where the programs were found provides a geographic view of the state of urban planning higher education and a body of data for further analysis in the United States.

Further parsing of the 117 United States programs identified 38 programs within colleges or schools with architecture, design, environmental design, or built environment in their names, possibly suggesting an atmosphere and pedagogical approach towards physical planning and built projects. Less common was for urban planning programs to have public service, public policy, or public health in their host college or school names with only 10 results. The University of Illinois at Chicago (UIC) has its own College of Urban Planning and Policy. Four programs were identified at UIC including urban studies, city design, and two programs in urban planning and policy. Trends of urban planning programs within home colleges for the international case collection were limited and dominated by UCL's 13 results, with the School of Planning located within the Faculty of the Built Environment and Cardiff's 10 planning programs being located within the School of Geography and Planning. A search was performed to identify online programs in urban planning. The results of the online urban planning programs are shown in Table 1.

Only eight online programs in urban planning were found during this search. They are all located in the United States. The resulting sample is a diverse set of community planning, design, and infrastructure online programs. The western United States, including Arizona, California, and Washington states, hold the majority of online programs.

8. Case Studies in Online Urban Planning Education

The University of Florida currently has the only accredited online urban planning program in the United States. The online Master of Urban and Regional Planning (MURP) and is similar to the accredited in-person program. The website states that the program was developed for working professionals. The online planning program is located within the College of Design,

Table 1. Online urban planning and urban regeneration programs in higher education.

Degree or qualification	University	Title and discipline(s)
Bachelor of Science	Arizona State University Online	Urban planning
Graduate certificate	Fresno State University	Community and regional planning
Graduate certificate	Northern Arizona University	Community planning
Graduate certificate	University of Florida	GIS for urban and regional planners
Master of Infrastructure Planning and Management	University of Washington	Infrastructure, planning, and management
Master of Urban and Regional Planning	University of Florida	Urban and regional planning
Executive Master of Urban Planning	University of Southern California	Urban planning
Master of Professional Science	Unity College	Urban ecology and sustainable development

Note: Entry requirements for Fresno State's program are unclear but it appears a student must be simultaneously enrolled in a graduate degree program or have achieved a graduate degree.

Construction, and Planning that hosts programs in architecture, construction management, interior design, historic preservation, landscape architecture, and sustainability. The college has both undergraduate and graduate programs, as well as a PhD program. There are three graduate online courses and one online undergraduate course along with the accredited online MURP program. There is also the Graduate Certificate in Geographic Information Systems for Urban and Regional Planners. The college offers study abroad programs in another distance learning strategy. This robust environment provides an opportunity for overlapping support for the online MURP. Curricular, staff, and technical resources can be shared, and help may be found from the in-person urban planning programs or other online programs. The online program requires 52 credit hours from a choice of 22 urban planning courses. Three units of the core requirements and 18 credits of the elective offerings qualify for the online GIS certificate, making it possible to achieve both the certificate and the accredited online MURP. Three credit hours of 34 are required in planning administration and ethics. One three-credit-hour elective course is offered in sustainable community development. The University of Florida online program is heavily weighted towards GIS, visualization, and information systems in planning. The online program does not exactly mirror the in-person program.

There is less breadth of education in the online program versus the in-person program. In the online program, eighteen of the thirty elective choices are geared towards GIS and computer skills. The electives for the online MURP program offer courses not included in the in-person MURP plan of study including a course on sustainable urban development and four courses in information systems and visualization that overlap with offerings from the online GIS certificate for planners. In short, the online MURP program appears to have lost some breadth from the in-person MURP course, including those that may educate planners in social and community issues. The online MURP program relies on the GIS and computer systems courses that overlap with the GIS graduate certificate program.

The University of Southern California (USC) Executive Master of Urban Planning is geared towards mid-career professionals and focuses on urban planning and real estate development. The program is approximately 16 months based on 10 courses, comprising 24 units of coursework. The courses are live online and there are two in-person intensive sessions. The program is focused on politics, collaboration, and building development processes. Key components of the USC program are two intensive in-person sessions with the executive cohort. There is one in-person session per year, allowing for socialization and collaborative work, and may even support social networks during the online portions of the course. These two intensive courses are four days each year of the program and focus on immersive urban planning projects, providing the missing site work and real-world problem-solving work that is difficult to achieve in online urban planning courses. Students collaborate and consider real-world ethical issues and stakeholders of the project place.

Unity College offers a master's in urban ecology and sustainable planning. Unity College has seven online graduate programs and two online certificates predominantly in environmental subjects. The program in urban ecology and planning features personal one-on-one academic advisement. Fieldwork is required at the student's location as part of the course. Similar to the University of Florida and the USC programs, the program allows flexibility for working professionals. The program is organized around a foundation of sustainability and skills courses for the core required courses. A course in ethical practice is required as part of the skills core classes. It is possible to complete the course in twelve months and there are five start dates per year.

The University of Washington holds an online Master of Infrastructure Planning and Management degree. The program is asynchronous, with students taking their courses in the form of podcasts and videos. Courses are organized into core courses, methods courses, and systems courses including infrastructure, food, and public health. The program also requires two capstone courses focused on a real-world problem. The program provides a breadth approach to education in the environment, social equity, and methods or skills.

Arizona State University offers the only undergraduate degree found in this study. The curriculum is entirely online, including undergraduate breadth requirements such as writing composition and mathematics courses typical of undergraduate education in the United States. The urban planning curriculum is slim, composed of an introductory urban planning course, some GIS courses, and some electives. However, this program shows a multi-year and multi-disciplinary undergraduate education can be delivered online.

Northern Arizona University offers an online graduate certificate in community planning. Student learning outcomes focus on analysis, professional development, and geospatial technology. The program requires 12 course units of approximately five courses. The University of Florida provides an online GIS certificate for planners. The program requires three core courses and one elective for 12 credit hours total of approximately 12–15 months. California State University, Fresno, has a Community and Regional Planning Certificate of Advanced Study composed of five required courses that cover a breadth of introductory urban planning topics including community planning, transportation planning, and land use regulation. GIS, technical, and professional skills are absent from this compact online curriculum.

9. Transitioning From In-Person to Online Urban Planning Education at Cal Poly Pomona

After transitioning from in-person to online teaching in the Department of Urban and Regional Planning at Cal Poly Pomona, we have used Zoom, an online video conferencing software provided by Cal Poly Pomona to faculty and students, predominantly for lectures, class meetings, department events, and office hours. I have used the screen sharing feature to demonstrate software online, including AutoCAD and Adobe Illustrator. Students "screen-share" to present their work, usually composed of designs and diagrams, in PDF format. The College of Environmental Design has also made use of Conceptboard, a collaborative online whiteboard software. I have used Conceptboard for classes similar to the way an in-person urban planning workshop might make use of a large sheet of paper where everyone can mark up and add images at the same time to a communal board.

During the summer of 2020, the university provided stipends for classes in online teaching. The Center for the Advancement of Faculty Excellence has provided various resources from webinars to technical support, and source material to support faculty and course design. Students were also provided laptops on loan and software, including the Adobe Creative Suite, which the university provided for free. However, the campus closure disconnected students from essential services. Homeless or housing insecure students depend on the library for study and internet access, the gym for showers, and the food pantry for groceries.

The transition from in-person to online teaching was smoother for lecture courses that could be lectured through Zoom as they were in person. Some lecturers and professors chose to record their lectures so that students could review lectures in their own time. We had three options for course offerings, synchronous over Zoom where the course would meet, similar to an in-person class but online, asynchronous where professors would prerecord lectures or plan activities for students to do in their own time and a third, hybrid approach, with some combination of live online meetings, and some exercises or lectures for students to complete asynchronously.

After initial learning curves, faculty sensed that lectures and analysis courses translated sufficiently online, with many online resources available including Google Maps, Google Earth, and census data for analysis work. The United States provides census data online and, while this is flawed, it is a substantial starting point for educating students on social and spatial issues. California also requires cities to provide land use or zoning maps online, sometimes in the form of a GIS portal, an online tool like Los Angeles City's ZIMAS, or sometimes a PDF map. We were prevented from on-campus or off-campus class meetings, including site visits for class project sites, but Google Street View and other online images partially filled this visual gap. Some efforts at social learning included the use of break-out rooms on Zoom for project groups to work together. The students used the Discord instant messaging communication software on their own for projects, text communication, and sharing media files. I found that socialization must be built through time set aside during class for social activities.

Redesigning urban design studio courses at Cal Poly Pomona required strategizing ways to acquire data, especially to supplement the lack of site visits. Google Street View and searching for photos online was problematic in that the images may be outdated. The Google Street View perspective was also slightly warped and not completely accurate in dimensions.

However, it remains unclear how much was lost through in-person learning in terms of spontaneous or serendipitous learning, and social learning from peers. Urban design project work was particularly different between in-person and online models especially with the prohibition of site visits. Site visits allow for panoramic sensory input well beyond what online images can provide. Things like temperatures cannot be simultaneously

felt in combination with other site attributes such as dust, lack of shade, wind, noise from cars, etc. Showing students how to draw required some awkward camera positioning or holding up of drawn examples. Since site visits were prohibited, I chose sites for the urban design studios that were either further away, including the Salton Sea, which is approximately 136 miles away from Cal Poly Pomona, or normally prohibitive for health and safety reasons including Skid Row in Downtown Los Angeles. I took Covid-19 site visit prohibitions as an opportunity to provide sites for students that we normally wouldn't be able to study in person anyway. Student feedback included an appreciation for working in disadvantaged communities like Skid Row, an intense concentration of the unhoused population of Los Angeles, and a low-population agricultural area that usually does not receive a lot of planning attention like Mecca, near the Salton Sea.

For a lecture course in international planning, I live-lectured half the course, and students worked asynchronously on individual weblogs (blogs) where they reviewed academic articles and online news reports. This prompted students to do their readings and write about them, and had a few added benefits, including a design element for their blog templates and the images they chose. I hoped the blogs would also be a social activity with students viewing and commenting on each other's posts, but this did not come to fruition. Students said they always wanted to create a blog but never had the added motivation. Students also have practiced internet skills and they can host their own portfolios where they can direct future employers.

Fundamental discrepancies or inequality in remote or online education identified while at Cal Poly Pomona this past year during the coronavirus pandemic include many financial and service hurdles for students to overcome. Some students do not have reliable internet or must attend class online via their mobile phones. Many students have suffered job losses due to Covid-19 and subsequently have taken new jobs, even some that were in high-risk situations for contagion including jobs as caretakers or jobs in grocery stores. Students' housing situations changed largely, with many giving up their apartments and moving back to their family homes. This is often a distracting experience due to noisy environments or people nearby within crowded living situations.

10. Conclusion

Covid-19 pushed educators to innovate rapidly to deliver education in urban planning online. Fortunately, there were many online tools available including online video conference platforms like Zoom and Microsoft Teams. These were underutilized in many ways before Covid-19 and we have found that online video conferencing works well for meetings and lectures, without requiring the time and energy for travel. Unfortunately, the fact that there are only eight higher education program degrees online in urban planning disciplines suggests that there is little experience in the field of online learning and remote teaching. This suggests there may be an insufficient market for those interested in online urban planning education.

From a qualitative case study analysis of online programs in urban planning in the United States, several different approaches to the curriculum were discovered. The University of Florida MURP cases show that online programs can achieve accreditation and provide most of the curriculum that an in-person course provides. The Florida case also shows that GIS and computer visualization courses may more easily and more naturally be provided online than community development or social justice courses due to the computer-oriented nature of the work. However, with online learning creating more distance between students and their site communities, more effort must be made to offer social learning, ethnographic site analysis, and collaborative classes than in-person courses to serve site communities beneficially.

The USC Executive Master of Urban Planning is a much shorter curriculum than the University of Florida MURP. The USC program focuses on community engagement and building development, presenting a contrast to the University of Florida case. The USC program eschews a breadth curriculum of planning and only includes one obvious computer data analysis course titled Big Data for Planning and Development. This executive program could be expanded to an MURP program like the University of Florida program by expanding course offerings in urban planning foundations and computer skills. The University of Florida program could incorporate more of the USC-style politics and engagement courses into its curriculum. The USC program includes two in-person intensives that partially bridge the gap between the disadvantages of online learning by providing face-to-face time for students to get to know each other, work together, make real-life social connections, and buoy social support during online learning. These in-person intensive courses also offer students potential experience in workshops and other in-person planning methods as well as the opportunity to gain collaborative project site and community interaction experience.

Other measures that mitigate the loss of social or collaborative learning and in-person site work include Unity College's requirement that their students perform fieldwork, USC's live online course delivery rather than just video or podcast lectures, and Unity College's provision of personal one-on-one academic and professional advisement. Tuition estimates for six of the eight programs were higher for online programs by per-unit costs than in-person programs excepting Arizona State University and Unity College. Some costs are saved for students in online education because they can live wherever the cost of living is more convenient to them, comparatively less expensive, but it is unclear why online education would be more expensive in tuition considering there are savings for the university, including reduced

costs of classrooms, heating, cooling, and other overhead expenditures.

Craig Calhoun states that relationships made through technology foster simplistic or categorical, topic-based, identities and relationships, rather than the multiple and systemic relationships forged in physical life (Calhoun, 1998). Calhoun wrote that the internet matters more as a supplement to face-to-face community and that it doesn't necessarily allow for new things but for doing things that we were already doing or wanted to do more efficiently. Calhoun states that the internet is a most useful tool when building on the capacity of physical life rather than attempting a substitute for it (Calhoun, 1998). Online learning does not provide the serendipitous or social learning inherent in in-person classes. Socialization and collaboration must be formally included and designed into classes through activities or exercises.

Salama (2020) notes that there are ethical considerations in a world less bounded by physical space and with online connections strengthened. In an online learning environment, students must have equal access and provision to the internet and technology for the benefits of dispersed planning education to materialize. Traditionally, distance learning opened up education to more diverse student bodies, including older and working students (Godschalk & Lacey, 2001; Holder, 2007). The current wave of online learning may further open education to working students, students that live far from their university, and possibly a greater economically diverse student population because it takes money to move homes and change jobs to be near the university. However, the Cal Poly Pomona case shows that this beneficial potential for more learners has to be balanced with the knowledge that the internet, mobile technology, and up-to-date computers for online learning include an economic cost for students.

Acknowledgments

The author thanks the other faculty members of the Department of Urban and Regional Planning at California State Polytechnic University Pomona, especially Professor Rick Willson, for our ongoing discussions on teaching and learning. The author also thanks the reviewers for their time and constructive comments.

Conflict of Interests

The author declares no conflict of interests.

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About the Author

Brian Garcia (PhD) is assistant professor in urban and regional planning at the California State Polytechnic University Pomona. Brian teaches urban design, housing, and international planning. His research is focused on sustainable housing and transport. Brian has practiced internationally in architecture and urban design.

Urban Planning (ISSN: 2183-7635)

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