



Compact city planning and development: Emerging practices and strategies for achieving the goals of sustainability



Simon Elias Bibri^{a,b,*}, John Krogstie^c, Mattias Kärrholm^d

^a Department of Computer Science, The Norwegian University of Science and Technology, Saelands Veie 9, NO, 7491, Trondheim, Norway

^b Department of Architecture and Planning, The Norwegian University of Science and Technology, Alfred Getz Vei 3, Sentralbygg 1, 5th Floor, NO, 7491, Trondheim, Norway

^c Department of Computer Science, The Norwegian University of Science and Technology, Sem Saelands Veie 9, NO, 7491, Trondheim, Norway

^d Department of Architecture and Built Environment, LTH, Lund University, A-huset, Sölvegatan 24, 22100, Lund, Sweden

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ABSTRACT

The compact city is one of the leading paradigms of sustainable urbanism. Compact city planning and development has, over the last 30 years or so, been the preferred response to the challenges of sustainable development. It is strongly promoted by global and local policies due to its positive outcomes in terms of contributing to the economic, environmental, and social goals of sustainability. This paper examines how the compact city model is practiced and justified in urban planning and development with respect to the three dimensions of sustainability, and whether any progress has been made in this regard. To illuminate this urban phenomenon accordingly, a descriptive case study is adopted as a qualitative research methodology where the empirical basis is mainly formed by the official plans and documents of two Swedish cities: Gothenburg and Helsingborg, in combination with qualitative interview data and secondary data. This study shows that compactness, density, diversity, mixed land use, sustainable transportation, and green space are the core design strategies of compact city planning and development, with the latter being contextually linked to the concept of green structure, an institutional setup under which the two cities operate. Moreover, at the core of the compact city model is the clear synergy between the underlying strategies in terms of their cooperation to produce combined effects greater than the sum of their separate effects with respect to the benefits of sustainability as to its tripartite composition. Further, this study demonstrates that the compact city model as practiced by the two cities is justified by its ability to contribute to the economic, environmental, and social goals of sustainability. However, the economic goals dominate over the environmental and social goals, notwithstanding the claim about the three dimensions of sustainability being equally important at the discursive level. Nevertheless, new measures are being developed and implemented to strengthen their influence over urban planning and development practices towards balancing the three goals of sustainability.

1. Introduction

Compact cities have, since the early 1990s, been one of the leading global paradigms of sustainable urbanism. In the European Union Green Paper of the Urban Environment, the compact city model was advocated as the most sustainable approach to urbanism (CEC, 1990). A number of recent UN-Habitat reports and policy papers argue that the compact city model has positive effects on resource efficiency, economy, citizen health, social cohesion, and cultural dynamics (UN-Habitat 2011, 2014a, 2014c, 2015). Indeed, according to many studies (e.g., Arbury, 2005; Burton, 2002; Bibri, 2020a, b; Bibri and Krogstie, 2017b; Hofstad, 2012;

Jabareen, 2006; Naess et al., 2011; Newman and Kenworthy, 1999; Williams et al., 2000), the compact city can promote sustainability by reducing the amount of travel and shortening commute time; decreasing car dependency; lowering per capita rates of energy use; limiting the consumption of building and infrastructure materials; mitigating pollution; maintaining the diversity for choice among workplaces, service facilities, and social contacts; and limiting the loss of green and natural areas. This is justified by the fact that the compact city emphasizes the intensification of development and activities, creates limits to urban growth, encourage land use and social mixes, and focuses on the importance of public transportation and the quality of urban design. All

* Corresponding author. Department of Computer Science, The Norwegian University of Science and Technology, Saelands veie 9, NO, 7491, Trondheim, Norway.
E-mail addresses: simoe@ntnu.no (S.E. Bibri), john.krogstie@ntnu.no (J. Krogstie), mattias.karrholm@arkitektur.lth.se (M. Kärrholm).

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in all, the compact city harnesses the advantages of agglomeration and taps into the tremendous variety of environmental, economic, and social benefits it has to offer through proper planning and development.

The benefits of the compact city, as research from around the globe suggests, are far from certain or not guaranteed as desired outcomes. This relates to the issues argued against by the critics of the compact city model that should be addressed so that it can gain in more popularity. By and large, most of these issues pertain to the unforeseen consequences and unanticipated effects of the compact urban form that fall under what is called in urban planning “wicked problems” a term that has gained more currency in urban policy analysis after the adoption of sustainable development within urban planning since the early 1990s. These issues are often overlooked as a result of failing to approach this urban system from a holistic perspective, or of treating it in too immediate and simplistic term. Rittel and Webber (1973), the first to define the term, associate wicked problems with urban planning, arguing that the essential character of wicked problems is that they cannot be solved in practice by a central planner. Wicked problems are so complex and dependent on so many factors that it is hard to grasp what exactly the problem is or how to tackle it.

In addition, in the current climate of the unprecedented urbanization and increased uncertainty of the world, it may be more challenging for cities in developed countries to configure themselves more sustainably. The predicted 70% rate of urbanization by 2050 (United Nations, 2015) reveals that the sustainability of the urban environment will be a key factor in the global resilience to the forthcoming changes. This implies that the city governments in these countries will face significant challenges related to environmental, economic, and social sustainability due to the issues engendered by urban growth. These include increased energy consumption, pollution, toxic waste disposal, resource depletion, inefficient management of urban infrastructures and facilities, ineffective planning processes and decision-making systems, poor housing and working conditions, saturated transport networks, endemic congestion, social inequality, and socio-economic disparity (Bibri, 2019a; Bibri and Krogstie, 2017a). In a nutshell, urban growth raises a variety of problems that tend to jeopardize the sustainability of cities as it puts an enormous strain on urban systems and great demand on natural resources. Furthermore, cities in developed countries are likely to experience an even more rapid decline in average densities through more sprawling patterns, reducing the ability of city-regions to support themselves, unless they adopt and pursue more compact development strategies.

A large body of work has addressed the claimed effects of the compact city model achieved through planning practices and development strategies. More specifically, the discussion has focused on the extent to which this model produces the claimed environmental, economic, and social benefits of sustainability (e.g., Bibri, 2020b; Burton, 2002; Jenks and Jones, 2010; Hofstad, 2012; Lin and Yang, 2006). Here the focus is often on the design strategies of the compact city model (e.g., Bibri 2018a; Bibri and Krogstie, 2017b; Boussauw et al., 2012; Dumreicher et al., 2000; Jabareen, 2006; Kärrholm, 2011; Van Bueren et al., 2011; Williams et al., 2000). This line of research directs attention to their link to the goals of sustainability as to its tripartite composition. As such, it opens the way for cross-domain analyses with regard to integrating environmental, economic, and social aspects (e.g., Krueger and Gibbs, 2007). This paper follows this path by examining how the compact city model is practiced and justified in urban planning and development with respect to the three dimensions of sustainability, and whether any progress has been made in this regard. Accordingly, the main research questions driving this paper are:

- 1 What are the prevalent design strategies of the compact city model, and in what ways do they mutually complement, or beneficially affect, one another in terms of producing the expected benefits of sustainability?
- 2 To what extent does the compact city model contribute to and balance the three goals of sustainability?

To illuminate the phenomenon of the compact city accordingly, a descriptive case study is adopted as a qualitative research methodology where the empirical basis is mainly formed by the official plans and documents of the Cities of Gothenburg and Helsingborg, Sweden, in combination with qualitative interview data and secondary data. We chose these cities for several reasons. First, they are among the largest cities in Sweden’s fastest growing urban landscapes. Second, they are among the Sweden’s most ambitious cities as regards sustainable planning, producing a great deal of planning material and ideas about sustainable urban form.

This paper demonstrates how the compact city model is practiced and justified by the two Swedish cities in their urban planning and development. Forming the basis for the planning and development of the future of these cities, their visions, policies, and strategies are developed along the lines of the argument supported by European Union policy documents that a compact city structure has positive effects on efficient use of resources, economic development, and citizen well-being (CEC 2011); that compact city policies result in reduced energy consumption and emissions in transportation at different spatial scales, in conservation of farmlands and biodiversity, and in reduction of infrastructure cost and increase of labour productivity (OECD, 2012a); and that cultural, social, and political dynamics are promoted by density, proximity, and diverse choices available within compact cities (CEC, 1990).

This paper unfolds as follows. Section 2 provides a relevant topical literature review of the compact city. Section 3 outlines, justifies, and elaborates the research methodology adopted in this study. Section 4 presents the results. Section 5 discusses the results and how they are interpreted in perspective of previous studies. Finally, the paper concludes, in Section 6, by drawing the main findings, providing some reflections, and suggesting avenues for future research.

2. Literature review

2.1. The compact city as an approach to sustainable cities

Rooted in the study of the relationship of urban planning and sustainable development in a rapidly urbanizing world, sustainable urbanism is concerned with the study of cities and the practices and strategies to design and develop them that focus on promoting their long-term resilience and viability through reducing material use, lowering energy consumption, mitigating pollution, and minimizing waste, as well as improving social equity and well-being. The compact city is the central paradigm of sustainable urbanism.

There are multiple views on what a sustainable city should be or look like and thus various ways of conceptualizing it. Generally, a sustainable city can be understood as a set of approaches to practically applying the knowledge about sustainability to the planning and design of existing and new cities. It represents an instance of sustainable urban development, a strategic approach to achieving the long-term goals of urban sustainability. Accordingly, it needs to balance between the environmental, economic, and social goals of sustainability as an integrated process. Such balance has more opportunity to make the city greener, fairer, and more profitable for all stakeholders of the city.

Sustainable cities have been the leading paradigm of urbanism for more than three decades. However, there are different approaches to sustainable cities, which are identified as models of sustainable urban forms, including compact cities, eco-cities, green cities, new urbanism, landscape urbanism, and urban containment. Of these models, compact cities are often advocated as more sustainable.

While there is no definite definition of the compact city in the literature, most of the available definitions tend to share the core dimensions of this model of sustainable urban form. To Burton (2002), the so-called compact city is taken to mean “a relatively high-density, mixed-use city, based on an efficient public transport system and dimensions that encourage walking and cycling.” According to other views (e.g., Jenks, Burton and Williams, 1996a; b; Williams et al., 2000), the compact city is

characterized by high-density and mixed land use with no sprawl. Dantzig and Saaty (1973) provide an explanation of the densification characteristics based on three elements: the urban form, the space, and the social functions (Table 1).

2.2. Compact city dimensions, issues, policies, and perspectives

While many studies have been carried out on the compact city based on a variety of approaches, they share the core dimensions of this model of sustainable urban form, with a slight difference in details as illustrated in Table 2. This serves to inform and guide the selection of the design strategies to be studied with respect to the cases of Gothenburg and Helsingborg. In this context, the term ‘principle’ means a proposition that serves as the foundation for the compact city model, and the term ‘strategy’ denotes an approach that is used to achieve the goals of sustainability.

There is a large body of empirical work on compact cities, especially in the form of case studies. A key strand of this research focuses on a range of environmental, economic, and/or social aspects and the associated policies and planning practices. A set of recent case studies is selected and compiled in Table 3. Generally, studies on compact cities are approached from a variety of perspectives, including urban theory, planning theory, planning practice, design practice, policy, resilience, sustainability, morphology, complexity theory, systems thinking, action net theory, actor network theory, spatial analysis, regenerative design, economics, in addition to comparative and discursive studies. This study approaches the topic of the compact city from the perspective of planning and design practices and strategies through which this model can be realized to support and balance between the three goals of sustainability.

Furthermore, many cities having the highest level of sustainable development practices have been studied on their compact development with the aim to contextualize the outcome to become practically applicable in other cities. Accordingly, lessons can (and should) be learned from other cities around the world. It is well understood that there cannot be a set of rigid strategic guidelines that should be strictly followed and implemented anywhere around the world to achieve sustainable urban forms. Sustainability depends on several intertwined factors that should fit the local context. In view of that, each city should tap into its local opportunities and capabilities as well as assesses its constraints and potentials from a more integrated perspective given the complexity associated with the social, economic, and environmental aspects of the city (Bibri, 2020a, b; Newman and Jennings, 2008). In some instances, cities are evidently incomparable both in scale and in socio-cultural, political, and historical contexts, but the comparison can still be undertaken regarding the relative proportions of density and diversity across urban areas. Yet, even if several attempts have been undertaken to establish ‘compact city’ indexes, the heterogeneity of the concepts of density (Churchman, 1999; Berghauer Pont and Haupt, 2010; Manaugh and Kreider, 2013), diversity (Manaugh and Kreider, 2013), and urban form (Hillier, 1996; Marshall, 2005), coupled with the prevalence of different indexes (Lee et al., 2015), remains problematic for policy implementation. Therefore, the classifications listed in the UN-Habitat’s and other policy documents lack concrete guidelines for global implementation (Lim and Kain, 2016). All in all, each city should deal with its own urban specificities in regard to development agenda and form aspects, applying

Table 1
Densification characteristics.

Urban form features	Spatial features	Social functions
<ul style="list-style-type: none"> • High dense settlements • Less dependence on automobile • Clear boundary from surrounding areas 	<ul style="list-style-type: none"> • Mixed land use • Diversity of life • Clear identity 	<ul style="list-style-type: none"> • Social fairness • Self-sufficiency of daily life • Independence of government

compact city discourse and implementing policies to improve the health of the city and the quality of life for the citizens.

Due to the above inconsistencies in urban research and their effect on practice as to planning policy, the concept “compact city” risks becoming a “boundary object” (Star and Griesemer, 1989) similar to the concept “sustainable development” (Muraca and Voget-Kleschin, 2011). As a means of translation used to connect different, or create intersections of separate, social worlds, a boundary object is interpreted and used differently by various actors or across communities in light of their own experiences, needs, constraints, and/or biases. In this case, the concept of the compact city becomes vague enough to justify any type of urban development (Leffers, 2015).

Table 2
Core dimensions of the compact urban form.

Scholars and Organizations	Focus of Studies	Dimensions
(UN-Habitat 2015)	Strategy of sustainable neighborhood planning	<ol style="list-style-type: none"> 1. Adequate space for streets 2. Efficient street network 3. High density 4. Mixed land uses 5. Social mix 6. Limited land use specialization
Jabareen (2006)	Design concepts of sustainable urban forms and their contribution to sustainability	<ol style="list-style-type: none"> 1. Compactness 2. Density 3. Mixed land uses 4. Diversity 5. Sustainable transport
Kotharkar et al. (2014)	Measuring compact urban form	<ol style="list-style-type: none"> 1. Density 2. Density Distribution 3. Mixed land uses 4. Transportation network 5. Accessibility 6. Shape
Jones and Macdonald (2004)	Sustainable urban form components and economic sustainability	<ol style="list-style-type: none"> 1. Mixture of Land uses 2. Density 3. Transport infrastructure 4. Characteristics of built environment 5. Layout
(Dempsey et al., 2010)	Sustainable urban form components	<ol style="list-style-type: none"> 1. Density 2. Mixed land uses 3. Transport infrastructure 4. Accessibility 5. Built environment characteristics 6. Urban layout
Song and Knaap (2004)	Quantitative measure of urban form	<ol style="list-style-type: none"> 1. Density 2. Mixed land uses 3. Pedestrian access 4. Accessibility 5. Street design and circulation system
OECD (2012b)	Policies of compact city: a comparative assessment	<ol style="list-style-type: none"> 1. Compactness 2. Impact of compact city policies
Bertaud (2001)	Analysis of spatial organization of large cities	<ol style="list-style-type: none"> 1. Spatial Distribution of Population 2. Spatial Distribution of Trips 3. Average density and land use 4. Density profile 5. Population by distance to gravity center

Table 3
Examples of case studies on compact cities.

Country	Issues	Policies
Paris, France (OECD, 2012b)	Urban development Car dependency	Regional development agenda Grand Paris Express connection
Hong Kong, China (Lau et al., 2002)	Loss of green space Urban development Traffic congestion	The Concept of Vertical City The Concept of Compact City The Concept of Sky City
Melbourne, Australia (OECD, 2012b)	Urban sprawl growth High immigration Flat land shortage Decline in economic sectors Rapid urban growth	Revitalization of Central Melbourne Deregulation policies on and conversion of land use
Amsterdam, Netherland (Nabielek, 2012)	Increased car and truck ownership Urban sprawl growth Scattered development Increased congestion	The Structure Plan The National Environmental Policy Plan The National Policy on Spatial Planning
Tokyo and Gothenburg (Lim and Kain, 2016)	High urbanization Urban sprawl growth High immigration Density of built objects Scales of built objects Distribution of the diversity of built objects	The Concept of Compact City Comprehensive Plan for Gothenburg Master Plan for Tokyo Planning by Design Planning by Developmental Control Planning by Coding/ Rule-based Planning
Auckland, New Zealand (Arbury, 2005)	Rapid urban growth Car dependency Transportation system	Regional Growth Strategy for Compact Development Regional Growth Strategy 2050
Toyama, Japan (OECD, 2012b; Suzuki et al., 2010)	Urban sprawl growth Increasing car dependency Population density decline Urban centers decline Agricultural land decline	Master Plan for Toyama City Toyama Compact City Model The City's Density Target and Grant Program

2.3. The Compact city ideal

As widely acknowledged in sustainable urban planning and development, the image of the compact city has proven to be a highly influential translation of what a sustainable city should be, carried by the significance and relevance of the design strategies of this model of sustainable urban form. As a desirable form, the compact city indeed secures a development that is environmentally sound, economically viable, and socially beneficial (Bibri and Krogstie, 2020c; Burton, 2002; Dempsey, 2010; Jenks and Dempsey, 2005; Jenks and Jones, 2010), especially when it is strategically planned and well-designed prior to its development. As such, it can be viewed as an all-encompassing understanding of urban complexities and an all-embracing conception of planning practices and development strategies. Table 4 presents the main sustainability benefits of the compact city, drawing on many theorists and scholars (e.g., Bibri, 2020a, b; Bibri and Krogstie, 2017b; Burton, 2000, 2001; CEC, 1990; Dempsey and Jenks, 2010; Frey, 1999; Hofstad, 2012; Jabareen, 2006; Jenks and Jones et al., 2010a; Jones et al., 2010; Alberti, 2000; Van and Senior, 2000; Newman and Kenworthy, 1999; Williams et al., 2000).

Table 4
The main sustainability benefits of the compact city.

<p>Environmental sustainability</p> <ul style="list-style-type: none"> Lowering per capita rates of energy use and requiring less and cheaper per capita infrastructure provision Lowering energy consumption and reducing pollution due to the proximity to workplaces, services, facilities, and public spaces Decreasing travel needs and costs and shortening commute times Minimizing the transportation of energy, materials, water, and products due to the compactness of the built environment Optimizing the efficiency of the public transport system Limiting the consumption of building and infrastructure materials Reducing car dependency and thus CO₂ emissions through encouraging walking and cycling Conserving energy by combining heat and power provisions made possible by population densities Reducing the pressure on ecosystem services and biodiversity provided by green and natural areas. Limiting the loss of green and natural areas Protecting rural and agricultural land from further development <p>Economic sustainability</p> <ul style="list-style-type: none"> Supporting local services and businesses through population densities, i.e., providing a larger customer basis for commercial activities Revitalizing city centers through the promotion of densely built dwellings, shops, businesses, and accessible infrastructure and facilities Extending and enhancing public transportation infrastructure and facilities Creating proximity between employees and their workplaces Promoting greater diversity among employers and thus greater diversity of job possibilities Increasing the likelihood of workers finding jobs that match their skills, which results in higher productivity Maintaining the diversity for choice among workplaces, service facilities, and social contacts <p>Social sustainability</p> <ul style="list-style-type: none"> Creating a better quality of life through more social interaction, community spirit, and cultural vitality due to the proximity to facilities, services, amenities, workplaces, public spaces, public transportation, as well as the opportunity for walking and cycling Reducing crime and providing a feeling of safety through natural surveillance Improving social equity through better access to services and facilities and flexible design of housing in terms of mixed forms and affordability Enhancing social cohesion through a sense of belonging and connectedness Supporting human, psychological, and physical health through ready access to open green space, walkability in neighborhoods, and social contact Enhancing livability in terms of social stability and cultural and recreational possibilities Healing spatial segregation by forging the physical links and bridging barriers between communities
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2.4. The compact city paradox

Although research and policy argue for more compact cities, referring to higher density, diversity, mixed land use, sustainable transportation, and green areas, this approach to sustainable urban development is associated with some conflicts and contentions.

To begin with, the compact city model produces high levels of noise pollution due to the close proximity between dwellings, transport lines, business activities, and service facilities (De Roo, 2000). Thus, the concentrated impact of dense populations on the environment and the lack of planning for noise pollution control prevent the desired outcomes of this model from being achieved, e.g., direct negative health effects. Moreover, a number of studies (e.g., Breheny, 1992, 1997; Neuman, 2005) argue that compact urban developments can increase land and dwelling prices, cause severe congestion in transport, and create social exclusion. Also, it is argued that neighborhood density might impact negatively on neighborhood satisfaction (Bramley and Power, 2009), sense of attachment, and the quality of public utilities (Dempsey et al., 2012). Breheny (1997) empirically investigates the effects of the compact policies on the population, and concludes that people are unsatisfied about higher-dense development of dwellings. More dense urban areas are, based on research, often responsible for increasing the levels of crime

(Burton, 2000).

Furthermore, arguing against the concept, critics of the compact city highlight increased ecological footprint due to higher consumption, larger income gaps (Heinonen and Junnila, 2011), unfavorable living conditions for low income groups, and lack of accessibility to green space (Burton, 2001). The first two issues might be linked to low income population in dense urban areas, rather than to how the urban form is designed (Glaeser, 2011). They may also be due to a design problem and not necessarily associated with urban compactness given that crowding is a matter of perception of urban space (Kearney, 2006). Similarly, the negative social issues of density may be attributed to the aspects of the urban areas in terms of poverty concentration, rather than to how the urban form is designed (Bramley and Power, 2009). Accordingly, urban problems and urban form are not clearly correlated. Generic problems of urbanization are riskily criticized as being problems of the compact urban form (Bibri 2020b). As Glaeser (2011, p. 9) puts it: “Cities do not make people poor; they attract poor people. The flow of less advantaged people into cities from Rio to Rotterdam demonstrates urban strength, not weakness.”

The debate over the compact city as a set of planning and development strategies is actually between the “decentrists” who are in favor of a decentralised form and the “centrists” who are in favor of a high-densely built form (Bibri, 2020b). Breheny (1996) discusses in more detail the view on the future of urban form in regard to decentrists, centrists, and compromisers. Based on the literature, the main critical arguments of the compact city are advanced by the decentrists who question the environmental benefits delivered by compactness strategies. They claim that the anticipated energy reduction is modest compared to the discomfort inflicted by compactness policies as necessary rigorous measures. They believe that it is impossible to halt the urban decentralization phenomenon that is suited to the majority of the population, which favors the tranquillity of rural and semi-rural areas. In short, the key reason for the heated debate revolves around GHG emissions, energy consumption, and the loss of open green areas in light of the escalating urbanization trend. A key point against the compact city model regards the loss of green spaces in urban areas and the inevitable development of green fields outwards due to high congestion and high density (Breheny, 1996).

As another line of argument, policy makers have been “cherry-picking those aspects of the compact city as a sustainable urban model most attractive to their needs, such as increasing densities and containing urban sprawl ..., which largely reflect dominant economic or environmental interests” (Dempsey and Jenks, 2010, p. 119). However, it is also safe to argue that confronting the hegemony of unsustainable economic development takes time as to creating and establishing robust alternatives within urban planning (Hofstad, 2012).

Worth pointing out is that the above conflicting and contentious issues are still largely associated with the whereabouts of the compact city as to its implementation and development. According to Breheny (1997), the conclusions of many studies are pretty vague and vary from case to case when it comes to the environmental benefits delivered from the compaction strategy. Indeed, urban form attracts growing interest as the spatial concretization of urban sustainability (Oliveira and Pinho, 2010). This pertains particularly to those countries with a high level of sustainable development practices. Besides, as planning occurs in an open urban system with many individual and collective actors with different interests, it is difficult to link planning functions to outcomes (at different spatial scales) in the urban reality (Laurian et al., 2010). Nonetheless, there are highly institutionalized planning approaches that can be applied to raise the likelihood that planning affects the urban reality. Lim and Kain (2016) examine the differences in the outcome of different planning systems in Sweden and Japan in relation to dense and diverse development.

Furthermore, compact cities involve a number of problems, issues, and challenges when it comes to planning, design, and development at the technical and policy levels in the context of sustainability. Bibri (2020a) provides a detailed review of the compact city in terms of

fallacies, deficiencies, difficulties, uncertainties, as well as new opportunities that are being offered by advanced ICT, especially big data technologies and their novel applications. Indeed, it has been suggested that the compact city needs to embrace and leverage what advanced ICT has to offer so as to improve, advance, and maintain its contribution to sustainability. Bibri (2020b) provides a comprehensive state-of-the-art review of compact urbanism as a set of planning and development practices and strategies, focusing on the three dimensions of sustainability and the significant potential of data-driven solutions and approaches for enhancing compact urbanism under what is labelled “data-driven smart sustainable urbanism.”

3. Research methodology

3.1. Case study as an integral part of a backcasting-based futures study

This case study is an integral part of an extensive futures study that is being conducted to analyze, investigate, and develop a novel model for data-driven smart sustainable cities of the future using backcasting as a scholarly and planning approach (Bibri and Krogstie, 2019a, b). Backcasting scenarios are used to explore future uncertainties encountered in society, create opportunities, build capabilities, guide policy actions, and enhance decision-making processes. They allow for new options to be considered reasonable, thereby widening the perception of what could be feasible and realistic in the long-term. The fundamental question of backcasting-based futures studies is: “If we want to attain a certain goal, what strategic actions must be taken to get there?” Accordingly, backcasting starts with defining a desirable future and then works backwards to identify the strategic steps needed to build feasible and logical pathways between states of the future and the present. Developing pathways from this perspective allows to imagine the impacts of alternative scenarios, which are commonly used as a tool for strategic planning, especially in relation to sustainability. Having a strongly normative nature, backcasting is especially well equipped to be applied to sustainability issues (Bibri, 2018c; Dreborg, 1996; Holmberg, 1998; Quist, 2007; Robert et al., 2002).

3.2. Case study research

Case study research has long been of prominence in many disciplinary and interdisciplinary fields. As a research methodology, case study is well established in different academic disciplines. Creswell et al. (2007, p. 245) describe case study methodology as a type of design in qualitative research, an object of study, and a product of the inquiry. The authors conclude with a definition that collates the hallmarks of key approaches and that represents the core features of a case study: “a qualitative approach in which the investigator explores a bounded system (a case) or multiple bounded systems (cases) over time through detailed, in-depth data collection involving multiple sources of information ... and reports a case description and case-based themes” (Creswell et al., 2007, p. 245). In particular, case study methodology entails the use of multiple sources of evidence (Yin, 2009, 2017), e.g., documents, observations, interviews, focus groups, and so on. These approaches provide a more synergistic and comprehensive view of the problem under investigation (Flyvbjerg, 2011; Merriam, 2009; Stake, 2006; Yin, 2014, 2017).

3.3. Case study design categories

According to their design, case studies can be divided into several categories, including descriptive, explanatory, exploratory, illustrative, cumulative, and critical instance, each of which is custom selected for use depending on the objectives of the researcher. Case study research can be used to study a range of topics using different approaches for different purposes (Simons, 2009; Stake, 2006; Stewart, 2014; Yin, 2017). With that in mind, this case study uses a descriptive design, an approach which is focused and detailed, and in which questions and propositions about

the phenomenon of the compact city are carefully scrutinized and articulated at the outset. The articulation of what is already known about this phenomenon is referred to as a descriptive theory, which in this context pertains to sustainable urban forms. Therefore, the main goal of this descriptive case study is to assess the selected cases in detail and in depth based on that articulation. This research design intends to describe the phenomenon of the compact city in its real-world context (Yin, 2014, 2017). It is worth pointing out that the internal validity in this research design, i.e., the approximate truth about inferences regarding cause-effect in relation to this phenomenon is not relevant as in most descriptive studies. It is rather relevant in studies that attempt to establish a causal relationship such as explanatory case studies. Indeed, descriptive research is used to describe some relevant characteristics of certain phenomena, and does not address questions about why and when these characteristics occurred, thereby no causal relationship.

3.4. Descriptive case study characteristics

Descriptive research here involves the description, analysis, and interpretation of the present nature, composition, and processes of two compact cities in Sweden, where the focus is on the prevailing conditions. That is, how these cities behave in the present in terms of what has been realized and the implementation of plans based on the corresponding practices and strategies as associated with compact urbanism. This entails the ongoing and future activities being, and yet to be, undertaken in accordance with the time horizon set in the planning and development documents of the two cities. Moreover, as an urban event based on two instances, the compact city involves a set of indicators of an integrated city system in operation that requires an analysis to allow obtaining a broad and detailed form of knowledge about such system. To achieve this, we adopted an approach that consists of the following steps:

- Using a narrative framework that focuses on the compact city model and its contribution to the three goals of sustainability as a real-world problem, and that provides essential facts about this problem, including relevant background information
- Introducing the reader to key concepts, strategies, practices, and policies relevant to the problem under investigation.
- Discussing benefits, conflicts, and contentions relevant to the problem under investigation.
- Explaining the actual solutions with regard to plans, the processes of implementing them, and the expected outcomes.
- Offering an analysis and evaluation of the chosen solutions and related issues, including strengths, weaknesses, tradeoffs, and lessons learned.

3.5. Descriptive case study as a basis of backcasting

One of the essential requisites for employing case study stems from one's motivation to illuminate a complex phenomenon (Meriam, 2009; Stake, 2006; Yin, 2017). Accordingly, the outcome of this descriptive case study should serve as an input to Step 5 (specifying and merging the components of a new model of urbanism to be analyzed) and Step 6 (performing backward-looking analysis to build this model) of the futures study (Bibri and Krogstie, 2019a, b). By carefully studying any unit of a certain universe, we are in terms of knowing some general aspects of it, at least a perspective that guides and informs subsequent research (Wieviorka, 1992). In other words, descriptive case studies often represent the first scholarly toe in the water in new areas of inquiry. With that in mind, the primary purpose of investigating the cases of Gothenburg and Helsingborg is to identify the compact city strategies that are needed to develop the proposed model for data-driven smart sustainable cities of the future with respect to the first set of its urban components. The second set of its urban components has already been identified through a second case study on the eco-city strategies (see Bibri and Krogstie, 2020a). Similarly, as to its technological components, they have been

identified through a third case study on the innovative applied solutions of data-driven smart cities (Bibri and Krogstie 2020b).

One important use of the case study approach in research is planning, which in turn is at the core of the backcasting approach to futures studies. However, the purpose of analyzing and evaluating the two cases considered here together with the other four cases—two eco-cities (Stockholm and Malmö) and two data-driven smart cities (London and Barcelona)—is to provide a foundation for backcasting the future phenomenon of the data-driven smart sustainable city. In this case, it is necessary first and foremost to define which characteristics of the future state of this phenomenon are interesting and meaningful and should hence be included in the backcasting (see Bibri and Krogstie, 2019a, b for Step 1, 2, and 3 of the backcasting study). Evidently, recent data in this regard are of primary importance as a basis for the backcasting endeavor. Other material needed to make the backcasting depends on how strong the “theoretical and disciplinary framework” we have about the expected data-driven smart sustainable city of the future and its internal relationships (see Bibri, 2018a, 2019a, 2020a for further details). Commonly, quite a strong basis for backcasting is available when there is a framework which underpins and explains the phenomenon in question in terms of its foundation, justification, and expected outcomes as a new paradigm of urbanism. All in all, the results of all the case studies carried out are intended to guide and inform the backcasting-oriented futures study as an overarching scholarly endeavor.

3.6. Selection criteria

The selection of all of the cases to be studied was done in line with the overall aim of the backcasting-oriented futures study being carried out. The cases of Gothenburg and Helsingborg have been selected using a theoretical sampling approach (Yin, 1984). The two cities fall within the category of large cities in Sweden (see Table 5). In addition, the ambition and success of these cities in the field of compact urbanism makes their planning practices and development strategies an ideal sample to analyze. This assertion can be demonstrated considering the international positioning of Sweden in urban sustainability. Sweden is one of the leading Scandinavian, European, and Global countries that have exemplary practical initiatives in sustainable cities, both compact cities and eco-cities, in addition to a number of recent endeavors related to smart sustainable cities. According to several rankings, Sweden, Denmark, Finland, Norway, Germany, the Netherlands, and Japan have the highest level of sustainable development practices (Dryzek, 2005). Another ranking has recently been reported based on 2018 Environment Performance Index (EPI) data: Sweden is one of the world's leading countries in sustainability and has an overall score of 80.51 in regard to environmental friendliness (Buder, 2019). In fact, several empirical studies identify from the mid-1980s onward an increasing ecological disruption in most of the ecologically advanced nations, such as Sweden, Denmark, Germany, and the Netherlands (Mol, 2000).

In the context of this paper, the two Swedish cities selected have been receptive to the compact city ideal. They have chosen the compact city model as the most effective planning system that can go hand in hand with sustainable development in light of the relevance and usefulness of the findings produced by many studies in the field of sustainable urbanism. As such, they may be seen as successful examples of compact city planning and development and critical cases in sustainable urban development. This is due to their long planning traditions and the existence of relatively solid economic resources on the local level, the national focus on sustainability in Sweden, and the wide authorization given to the local authorities (Baldersheim and Ståhlberg, 2002; Kalbro et al., 2010; Rose and Ståhlberg, 2005). Moreover, they express sustainability ambitions in their master and comprehensive plans, support progress and expansion over time, and experience developmental pressure on their landscapes due to rapid urban growth. Additionally, it was important to ensure that there was sufficient information available in the public realm to carry out the analysis of the two cases. All in all, the

selection criteria secured cases where sustainability discourses, planning measures, practical advances, and future goals are present. Gothenburg and Helsingborg illustrate how ambitious cities handle the challenges of sustainability and urbanization, and how different values and interests are weighted and secured through urban planning and development.

3.7. Unit of analysis and data collection and analysis methods

The focus of the backcasting-oriented futures study constitutes the basis for determining the unit of analysis concerning the cases in question. Accordingly, the object of the study on focus in this paper is the design strategies of the compact city and the extent to which they produce and balance the environmental, economic, and social benefits of sustainability. This is essential to focalizing, framing, and managing data collection and analysis. The qualitative data were extracted from multiple sources of evidence identified with a series of searches performed in various online databases. The relevant archive records and documents produced by public and private organizations were considered as primary sources (i.e., master plans, comprehensive plans, visions, strategies, agendas, project descriptions, etc.). In addition, an amount of data was acquired from other documents produced by organizations or researchers not directly involved in the compact city initiatives of Gothenburg and Helsingborg. These sources were considered as secondary (i.e., reports, newspaper articles, journal and online articles, conference proceedings, research project deliverables, etc.).

Another supporting form of the primary data used was face-to-face and telephone interviews conducted with a total of 10 interviewees, including planners, architects, developers, consultants, and administrative servants. These interviewees were mostly involved in those areas associated with the challenging and conflicting issues of the compact city initiatives. These issues were identified based on the previous empirical studies carried out in relevance to this study as well as on the arguments advanced by the critics of the compact city model in the literature. One of the key objectives of the interviews was to corroborate any progress made by the two cities as to the development and implementation of new measures to address the common environmental and social issues of the compact city.

The interviews were mostly unstructured. They were intended to be used in ways that can be adapted to the interviewees' roles and interests. This means that the interviewees were asked different questions. The findings were reported in a form of complementing, substantiating, and conflicting statements. Additionally, a set of face-to-face and telephone conversations were conducted with some researchers and scholars at Lund University and Gothenburg University. They were particularly important in providing further insights into some ongoing projects for strengthening the influence of the environmental and social goals of sustainability over urban planning and development practices in the context of sustainable cities.

To identify, analyze, interpret, and report the case-based themes, a thematic analysis approach was designed and employed. This qualitative analytical approach was deemed suitable given the form of knowledge and insights that we sought to gain from the qualitative data gathered. Thematic analysis is particularly, albeit not exclusively, associated with the analysis of textual material. Braun and Clarke (2006) suggest that thematic analysis is flexible in terms of research design given that it is not dependent on any particular theory: multiple theories can be applied to this process across a variety of epistemologies. Also, thematic analysis is more appropriate when dealing with a large body of qualitative data. As such, it takes as its analytic object meaning by attending to the content of text in its various forms, while keeping in mind how the data are generated, attending to some form of context for interpretation purposes. This pertains particularly to secondary data. Secondary analysis usually involves some degree of distance from the original data as regards to the research questions and place where the data were gathered (see Elliott et al., 2013 for a discussion).

Thematic analysis is an umbrella term for a variety of different

approaches, which are divergent in regard to procedures. Here, we adopted a deductive approach to thematic analysis, which involves handling the data with some preconceived themes that are expected to be reflected in the data based on existing knowledge (descriptive theory).

The main four steps of the analytical approach are as follows:

- Reviewing the multiple sources of the data related to the selected cases. The outcomes of this process are numerous themes that are associated with the compact city model. It is important to have a comprehensive understanding of the content of the documents and multidisciplinary literature and to be familiarized with all aspects of the data collected. This step provides the foundation for the subsequent analysis.
- Pattern recognition (searching for themes) entails the ability to see patterns in seemingly random information. The aim is to note major patterns within the result of the first step. This second step looks for similarities within the sample and codes the results by concepts. Coding involves identifying passages of text that are linked by a common theme allowing to index the text into categories and therefore establish a framework of thematic ideas about it. In this step, the preliminary codes identified are the features of the data that appear meaningful and interesting, and the relevant data extracts are sorted according to the overarching themes. Accordingly, coding facilitates the management of the vast amount of the data that has been collected. It is important to allude to the relationship between codes and themes.
- Revising themes is about combining, separating, refining, or discarding initial themes. Data within the themes should cohere together meaningfully and be clear and identifiable as regards the distinction between these themes. A thematic 'map' is generated from this step. Important to note is that this mapping is informed by the broader concepts of the compact city, namely "compactness," "intensification," "densification," "density," "mixed land use," "diversity," "social mix," "sustainable transport," and "green space," as linked to the goals of sustainability. Subsequently, the theme names are provided with clear working definitions capturing the essence of each theme, as well as highlight the main synergies between the core dimensions of the compact city.
- Producing the report involves transforming the analysis into an interpretable piece of writing by using vivid and compelling data extracts that relate to the overarching themes, research questions, and literature. This is a fundamental step for supporting future comparative research and cross-case analysis (Yin, 1984; Patton, 2012). The report must go beyond a mere description of the preconceived themes and portray an analysis supported with empirical evidence that addresses the research questions.

This analytical strategy has allowed us to analyze the selected cases considering the different perspectives of multiple observers. Moreover, the final description of the process has gained greater strength thanks to the triangulation made possible by the use of multiple sources of evidence (George and Bennett, 2005; Yin, 1984; Voss et al. 2002).

3.8. Brief on the case study cities

Urbanization with its different dimensions is increasingly shaping the urban state of Gothenburg and Helsingborg, Sweden, through population and employment increase and related land use change. These cities are in a phase of expansion with a growing population as a result of increased immigration. Urban planning is seen in these cities as a valuable force to achieve the objectives of sustainable development through compact urbanism as a set of practices and strategies. The two cities are characterized by different levels of compactness and respond differently to its sustainability debate due to the escalating rate of urbanization they are facing. Table 5 provides some key figures about the case study cities.

Table 5

Some key figures about the case study cities.

	Gothenburg	Helsingborg
Land area	447.8 km ²	346 km ²
Population	599 000	135 300
City ranking in Sweden by population and size	2nd	7th
Average age	39	40

4. Results: The compact city strategies and their environmental, economic, and social benefits

In the two cities, compact planning and development entails the promotion and creation of densely developed nodes/areas with a mixture of functions and demographics supported by sustainable transportation and green space. These nodes are termed differently and also overlap: “strategic nodes,” “compact development,” “developed areas,” and “intermediate city.” Despite this variation of names, they are built on the same design strategies of the compact city. As such, they correspond to the ideal of this model as to the tripartite value of sustainability. We now take a closer look at the two cities’ plans and development strategies to identify the key dimensions of the compact city and their link to the goals of sustainability. In this respect, we deem it relevant and useful to include a brief definition of the key design concepts of the compact city.

4.1. Compactness

Generally, compactness suggests efficient land planning, density of the built environment and intensification of its activities, diversity, land-use mix, and sustainable transportation. It is at the core of the Comprehensive Plan for Gothenburg and the Master Plan for Helsingborg with regard to practices through design and development strategies. A denser, more diverse city with a greater mix of uses together with sustainable transportation and green space is what Gothenburg and Helsingborg strive to attain through institutionalized practices by developing and implementing a number of strategies and measures to contribute to the goals of sustainability (Gothenburg City Council, 2009; Helsingborg, 2009a).

As a widely acknowledged strategy for achieving sustainable urban forms, compactness of the built environment also denotes urban contiguity, connectivity, and agglomeration. As such, it suggests that future urban development pertaining to the physical dimension of urbanization (land use change) should take place adjacent to existing urban fabrics and structures. Thus, the potential of the available building zones should be exploited to enable future structural development in the existing urban areas based on inward development strategies. This relates to the intensification of the built form, a major strategy for achieving compactness by means of more efficient land use through the densification of development. This strategy entails developing less or undeveloped urban land, redeveloping previously developed sites and buildings, extensions and additions, conversions and subdivisions (Jenks 2000)—in short, infill, renewal, development, redevelopment, and transformation. The compact city concept is associated with the term “urban intensification,” which “relates to the range of processes that make an area more compact” (Williams, Burton and Jenks, 1996a).

Gothenburg City Council (2014a) and Helsingborg (2010a) state that compactness is supported by the need for development strategies because many people want to live and work in the city based on a recent forecast up to 2035 for both cities. An increasing population needs more housing, more workplaces, more services, more facilities, more public transport and squares, and so on. The focus of compactness in the two cities is on concentrated development in the city center and complementary development in and around the strategic nodes. The Comprehensive Plan for Gothenburg and the Master Plan for Helsingborg have a lot in common when it comes to their clear aim for urban development and their growth

within the already built-up areas. This implies that the continued planning should focus on supplementing the built-up areas in combination with concentrating on the strategic nodes, meaning building the city from the center outwards.

The compact city is the main strategy used for the planning system of the two cities, and aims at the combination of environmental, economic, and social dimensions towards more sustainable development of the city. As observed in the central renewal areas of Helsingborg, a more compact form is evolving through multiple ongoing development projects, which is expanding the center and making it denser, more accessible, and more attractive. Developing from the center outwards can satisfy demand for business sites and service facilities, and increased densities and shorter travel distances give more people the opportunity to walk or cycle (Helsingborg, 2010a). Around the strategic nodes, the aim is to attain a compact building characterized by the diversity of functions (workplaces, housing, facilities, services, etc.) and demographics (age, gender, ethnicity, status, income, etc.) to make urban environments more vibrant and attractive (Helsingborg, 2010a). The financing of place regeneration is argued by Helsingborg to be a positive side effect of the decision to embrace compact development in the transformation areas. Development in relation to the establishment of businesses and services and new dwellings is highly encouraged, particularly when it targets one of the nodes.

According to the Comprehensive Plan for Gothenburg, different planning strategies are adopted with respect to the staged expansion of the city (Table 6).

All in all, Gothenburg and Helsingborg are pursuing three directions to attain the compact city, namely:

- Develop central and renewal areas
- Make use of what already exists: strategic nodes, intermediate city, etc.
- Focus energy and effort where it will make a difference in the context of compactness.

4.2. High density and its relation to multidimensional mixed-land use

Density is a critical strategy in determining the compact urban form. Urban density refers to the ratio of dwelling units or people to land area. In a recent study, Lim and Kain (2016) investigate five urban areas in

Table 6

Planning strategies for city expansion.

Planning Strategies for City Expansion
<ul style="list-style-type: none"> • Build and Develop Centrally: A substantial share of future development is planned to take place in the central renewal areas. A more compact city will emerge, making the city’s center larger and more attractive and accessible, and a mixture of residents, workers, and visitors will create a stimulating environment that draws in new knowledge and service-based companies. Current plan projections indicate that housing and employment growth can be accommodated within the central renewal areas by strengthening them with 30.000 new homes and 40.000 new jobs by 2020. • Concentrating on Strategic Nodes: Compact development brings together both functions and people around strategic nodes, creating places that are alive throughout the day. Gothenburg has several strategic nodes in addition to several interchanges where higher densities are being aimed for together with effective accessibilities. • Complement and Mix: The objective is to complement those areas that both are easy to reach by walking and cycling and have good access to public transport with additional homes and workplaces, leading to greater variety and a more vibrant city by enhancing existing urban structures. New development and re-development are planned to contribute to the increased diversity (social and functional mix) and vitality of the city districts. • Outer Areas Reserved for Future Consideration: These areas have future potential for the development of diverse homes and workplaces and are required to achieve a certain level of density based on the feasibility of high quality public transport. They share a common need for significant investments in infrastructure and services.

Source: Bibri (2020a).

Gothenburg representing the outcomes of the key strategic planning approaches that have been applied historically in the city. Three indicators for compact city form were used for the assessment of dense and diverse built environments: the density of built objects, the scales of built objects, and the distribution of the diversity of built objects. The assessment was applied to three kinds of planning outcomes (urban fabrics) achieved through three types of planning approaches as follows:

- Emergent compact urban form achieved through planning by coding
- Designed compact urban form achieved through planning by design in combination with planning by development control
- Designed dispersed urban form achieved through planning by design

As regards the findings, concerning the density of built objects, the study showed that in Gothenburg the highest density of 37% and 31% is in type 1, the in-between density of 19% and 14% in type 2, and the lowest density of 12% in type 3. These results pertain to five study areas chosen in Gothenburg according to the applied planning approach: rule-based, with 2 areas in Type 1, 2 areas in Type 2, and 1 area in type 3. With respect to the scale of built objects, building footprints of over 750 m² consisted of high percentage of all buildings in Gothenburg, namely <1500, >1500, <2250, <3000, >3000. As to the distribution/diversity of building footprints, larger scale buildings were much frequent in Gothenburg for all urban types. Moreover, the results showed increased density and more diversity in areas designed with a density and diversity oriented approach (Type 2). Important to note is that the focus of the study conducted by [Lim and Kain \(2016\)](#) is on the comparison between Gothenburg and Japan.

However, achieving a compact city is not only about increasing density *per se* or across different spatial scales, but also about good planning to achieve an overall more compact urban form. This pertains to the strategic urban development associated with the potential for higher densities through densification. As stated in the Development Strategy Gothenburg 2035, to be able to plan for a long-term development of the city, it is necessary to analyze the potential for greater density in the intermediate city. “This potential is based on the existing housing forecast that extends to 2022. The work shows that there is potential to build a total of 45 000–55 000 homes in the intermediate city. Of this, around 15 000 homes are included in the forecast up to 2022 and 31 000–40 000 homes after 2022... The intermediate city, the inner city and the central renewal areas are expected to be able to contain development volumes of around 2 500–4 000 homes per year” ([Gothenburg City Council, 2014a](#), p. 7). The intermediate city in Gothenburg is the interlinked city area just outside the city center that has good public transport, good services, and where many of the city’s inhabitants live and work. It covers a large part of the built-up area and contains buildings and areas with very different characters. Part of the intermediate city are also three of the five key nodes targeted by the development strategy.

The key-node strategy is meant to contain the further expansion of new areas, until the empty spaces left in the inner city and the surrounding nodes are developed. Dense settlements are planned to be developed around strategic hubs that bring together functions and people to create living spaces for many hours of the day. Beside the five main nodes, there are several smaller hubs and interchanges with good accessibility which also pursue the high density. Those areas are characterised by a mix of functions as housing, offices, services, cultural facilities, and recreational areas to achieve a vibrant urban environment, combined with a good access to public transport and good cycle paths linked with the rest of the city, meant to facilitate the mobility of people. On the whole, the aim of the densification strategy is to create high-density nodes in order to implement the use of public transport, reduce the car dependency, and to contain the sprawl.

Similar aspects of strategic urban development in the case of [Helsingborg \(2010a\)](#) are associated with what are locally termed as nodes. These correspond to the geographical zone where most of the people live and more than half of the workplaces can be reached by public transport

within less than 1 h, from stop to stop. Indeed, regarding the long-term development of the City of Helsingborg, the potential for greater density is analyzed in regard to the nodes ([Helsingborg, 2010a](#)). This potential as based on the existing housing forecast entails the number of houses and villas that are planned to be built each year, which varies from a node to another. The inner city, the central development and redevelopment areas, and the nodes are expected to be able to contain development volumes of varied number of homes per year. Also, a high density is to be sought for in all nodes, and this development will contribute to strengthening the areas’ central points and thus to achieve a multidimensional form of mixed-use, i.e., physical land-use mix, economic mix, and social mix. Similarly, a high density is to be aimed for in all prioritized development areas, and this development shall contribute to reinforcing the areas’ central points. Density should therefore “be prioritized close to these future central points, as shall supplements to attain a good mix of functions and a good social mix” ([Gothenburg City Council, 2014a](#), p. 33). The multidimensional mixed-use strategy is hand in hand with the high-density strategy.

Urban density is used as a variable in evaluating how livable a city is as to its design. The underlying argument is “that increased population density has a positive effect in several ways for life in the city [Fig. 1], with regard to ecological, social and economic factors. When the built-up city is supplemented with more housing there are more effects that reinforce one another” [Gothenburg \(2014, p. 16\)](#). This relates to the postulation that, at certain densities, generating the interactions needed for the viability of urban functions and activities is determined by the number of people that live within a given area in terms of sufficiency. Following this postulation, Helsingborg aims to secure effective land use through densification and mixed land use within the strategic nodes as well as revitalized city centers with enhanced customer basis and improved transport facilities ([Helsingborg, 2010a](#)). Likewise, one important reason for greater density, and thereby creating the possibility for more people to live and work in the diverse parts of the city, is that it gives a larger base for services, retail trade, public transport, and so on ([Gothenburg \(2014a\)](#)). Therefore, more of mixed uses can become established at more places in the two cities and thus more people will be closer to shops, facilities, bus/tram stops, and so on. Again, there is a clear synergy between density and mixedland use in terms of boosting the environmental, economic, and social benefits of sustainability and their integration.

With regard to the environmental effects of population density, [Helsingborg \(2010a\)](#) argues that the density of built areas and the type of dwellings affect sustainability through the differences in the consumption of resources: energy, materials, and land for housing, transportation, and infrastructure. High density and integrated land use not only conserve resources, but also provide for compactness. However, Helsingborg’s plan clearly states that densification and the building of larger entities can impact the noise level and air quality negatively ([Helsingborg, 2010a](#)).

Gothenburg’s Comprehensible Plan does not make any clear linkage between densification and environmental problems. Nevertheless, in the Development Strategy Gothenburg 2035, the city does take noise pollution levels into consideration when setting restrictions on where densification can occur, as expressed in the following manner:

“Within several of the prioritized areas as part of the intermediate city noise pollution could be an important condition to consider in planning. At present, the municipality is working on producing a new noise pollution policy. This will be an important base for the continued planning” ([Gothenburg City Council, 2014a](#), p.33).

“The intermediate city contains buildings and areas with very different characters... When building additional structures, it is important to take into account potential conflicts such as noise pollution” ([Gothenburg City Council, 2014a,b](#), p. 8).

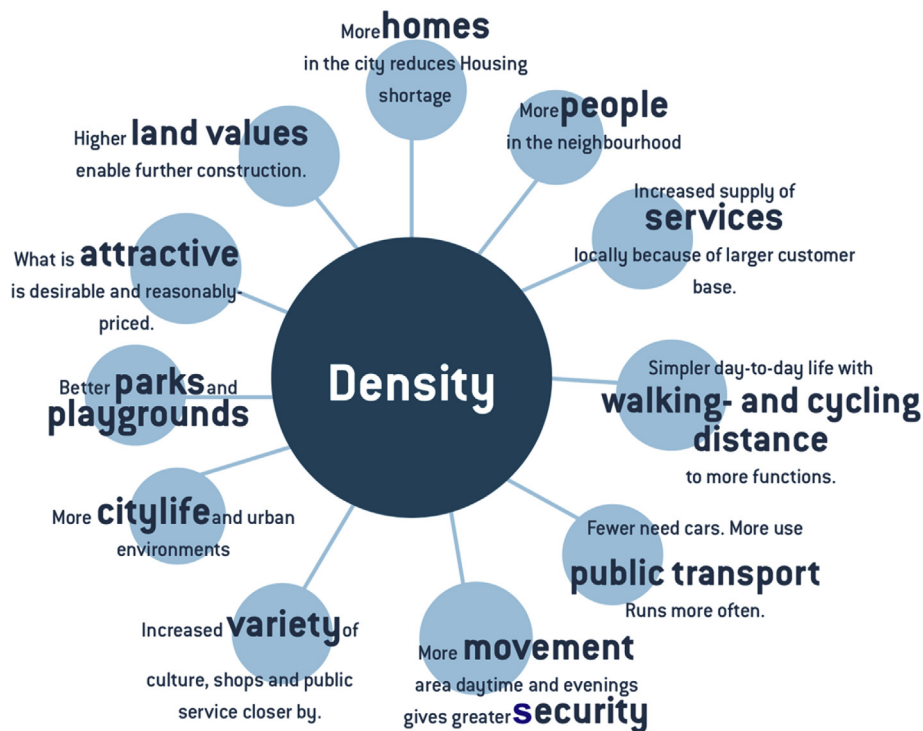


Fig. 1. Multiple positive effects of population density
Source: [Gothenburg City Council \(2014a\)](#).

4.3. Land-use mix and social mix and their relationship to high density

Land use refers to the distribution of functions and activities across space, grouped into different categories. Widely recognized for its important role in achieving sustainable urban forms, land-use mix denotes the diversity and proximity of compatible land uses, a form of cross-sectional residential, commercial, institutional, and cultural infrastructures associated with living, working, and service and amenity provisioning. As a preferred typology in sustainable urban planning and development, diversity, which overlaps with land-use mix as to the variety of land uses, “entails building densities, housing for all income groups through inclusionary zoning, a variety of housing types, job-housing balances, household sizes and structures, cultural diversity, and age groups, thereby epitomizing the socio-cultural context of the urban form.” (Bibri, 2019, p. 231) Indeed, diversity has been used interchangeably with social mix (i.e., housing types and options, demographics, lifestyles, etc.) in the literature. The land-use and social mixes are an important part of the planning and development strategies of Gothenburg and Helsingborg, whose goal is to have a more lively and long-run sustainable city with a balance between social, economic, and environmental factors. In fact, the two cities’s increasing population and high rate of immigration creates a need for more housing and workplaces. And this diverse population, which moves around in the city and uses public spaces—streets, squares, and parks—makes use of the supply of shops, services, and facilities. There is a clear link between the population growth, residential density, and mixed use. The supply of urban businesses and supermarkets increases with greater population density, and this pertains to the inner city, at a few of the strategic nodes and in local centers close to the inner city (Gothenburg City Council, 2009; Helsingborg, 2010a).

An attractiveness discourse prevails in the two cities, with almost the same intensity. It is mostly linked to land-use mix and social mix in dense areas. Attractiveness in this context is distinguished by a complex mix of uses, the ability to bring people together, as well as the multitude of visual impressions. Creating an attractive and safe city with vibrant life is

one of the key aims of the two cities. The compact city model is promoted to provide more attractive and safer streets and districts. Greater compactness gives a city life that attracts more young people and creates a feeling of security (Gothenburg City Council, 2014a). Gothenburg aims to create safe urban areas with a sense of belonging and access to public spaces for meeting opportunities. This can be accomplished by, among other things, designing good public spaces and bridging barriers between different districts. Further, according to the Development Strategy Gothenburg 2035, promoting the mixed-use of functions in the strategic nodes and built-up areas is driven by the attractiveness of the city thanks to the lively areas of the inner-city; moreover, a mixture of functions is associated with proximity in terms of short distances between workplaces, homes, and facilities (Gothenburg City Council, 2014a).

Both attractiveness and safety are intended to be realized by people moving around the city both daytime and evenings—natural surveillance. The mixed land use generates new flows of people and creates opportunities for using places at different times of the day, especially in the evenings when cultural and non-commercial activities are able to supplement the commercial supply. Concerning the economic driving force of the compact city, a mixture of functions, large and diverse population base, short distances, and attractive and secure urban environments, coupled with the proximity to parks and green areas, generate high land values that in turn create a willingness to invest. Indeed, the compact city creates a larger customer base for services, the retail trade, public transport, and so on (Gothenburg City Council 2014a). With respect to short distances, access to everyday commodities within a walking distance is a key issue in the future compact and carless City of Gothenburg, which argues that a distance of half of a kilo-meter significantly increases the number of consumers who walk. In addition, there is a clear connection between density and everyday commodities, the local market base is very important to the supply of everyday commodities. As to the density of the built-up areas under redevelopment, making it denser through new construction (supplementation) is motivated by making everyday life easier for inhabitants by enabling them to live closer to shops, leisure, services, and facilities, as well as to reduce the

need for transport. Thus, it is necessary to have much greater density. Gothenburg strives after a mix of uses, not only as part of transforming central renewal areas, but also as part of developing strategic nodes, as it enriches the city and makes the surrounding development more attractive to people. Important to note is that the conditions for a mixture of businesses, housing, and activities in Gothenburg relate to what they call a “close-knit city” (Gothenburg City Council, 2014a).

Helsingborg aims to be “Sweden’s most attractive city for people and enterprises” (Helsingborg, 2007, p. 2, see also Helsingborg, 2011a). It argues that a mix of housing types and workplaces in the nodes enables a constant flow of people to the city centers, which contributes to improving vitality and safety and providing an environment conducive to human encounters (Helsingborg, 2010a). This is what the city refers to as a ‘mixed city’ (Helsingborg, 2010a, 2010d). Regarding safety, Helsingborg (2010a) argues that the right mix of features and the right content can produce lively environments even during evenings and weekends, which is important for safety. Furthermore, it contends that the compact city gives greater opportunities to manage daily life on foot, by bike, and by public transport thanks to the proximity to shops, services, facilities, and workplaces. This reduces the needs for long distance transports, as more errands can be run by walking, cycling, or public transport, and more people will have an easier day-to-day life and be more attracted to the city (Helsingborg, 2010a). In addition, Helsingborg claims that a housing mix enables people to live in one area throughout different stages of their life (Helsingborg, 2010a). All in all, the notion of compactness frames and sustains the city’s attractiveness ambitions.

Adding to the above is the effort made by the City of Helsingborg to consolidate its position in the regional race to attract young, highly educated people, with the hope that they will create new businesses, including service companies, and provide higher tax revenues. The assumption is that this group wants to be part of an urban environment with a plethora of dwellings, businesses, facilities, services, and amenities with ties to educational institutions. Indeed, people live in the vibrant inner city to enjoy the student life and also the amusement and proximity that the city center offers to them. This applies to Gothenburg as well. A new class is now part of the Gothenburg’s community: “creative class,” which is a symptom of the changes that have taken place over the last decade in Sweden. One planner from the Municipality of Gothenburg stated, “the creative class is represented by those that chose to settle down in the city center as a living-strategy to avoid using cars to go to work so as to save money and time on the commuting and spend more free time at home with the family or for personal interests. In fact, the high-ways are so crowded and stressful to use, which influenced people to decide to live in the city center.” As a token of this, different interviewees from both municipalities asserted to live in the center and to walk, cycle, or use public transport to go to work. They also claimed that the majority of their friends and colleagues live in the city center or the inner city. Further efforts are being made to, as claimed by one interviewee, to build an attractive and safe city center, supported by good facilities, services, amenities, and accessible transportation in order to set up the mind of those citizens that still prefer the countryside life-style in a more sustainable direction.

Regarding the segregation issue, the strategy concerns the enlargement of the core of the city to combine different interest-groups that have the centre as a common public space/meeting point. The aim is to make people integrate in the city centre first, and then try to mix them in the same living areas, by expanding the attractive core.

Regarding social segregation, a number of residential areas and districts in Helsingborg have been segregated in relation to socio-economic status (Helsingborg, 2009a). As observed in several areas of Helsingborg, there is a division into “immigrant” and “native Swedish” populations, coupled with the persistent socio-economic segregation, which is highly problematic. Similarly, Gothenburg has been segregated in several aspects, the different parts of the city differ substantially, and there is an increasing tendency for socio-economic disparities (Gothenburg City Council, 2014a). Problem areas pertain to the city districts associated

with the Million Program, which are ridden with segregation as a problematic issue (Lilja and Perner, 2010). Hence, the two cities’ visions and planning policies promote dense, diverse, and mixed use patterns to reduce socio-economic segregation and increase livability (Gothenburg City Council 2012, 2014a; Helsingborg, 2009a, 2010a). As visible in the Master Plan for Helsingborg, compact city development is seen as a solution for reducing segregation, increased integration, and enhanced diversity, as well as a means of creating identity (Helsingborg, 2010a). Helsingborg focuses even on eliminating what they call “outsiderness,” and the aim is to lift communities with low socio-economic status and decrease unemployment and less qualified people (Helsingborg, 2009a).

By the same token, as stated in the Development Strategy Gothenburg 2035, one way of evening out existing socio-economic differences is to ensure that all parts of the city have good physical links, and new buildings are being used to create and achieve these links (Gothenburg City Council, 2014a). The whole development strategy revolves around developing the intermediate city for a closely connected city using the physical planning as a tool. Additionally, Gothenburg is increasing housing in many areas with insufficient services and shops to attract the population and thus provide conditions for establishing more services in different areas. This contributes to a city that is more closely connected, and where the physical environments of the different districts will give the inhabitants more equal conditions. The mixed-use strategy is used in Gothenburg to promote and obtain social mix as to cultural and socio-economic diversity. One architect from the Municipality of Gothenburg confirmed that the problem of social segregation is mainly caused by the desire of immigrants and people from the same class and/or ethnic group to live in the same areas, thereby avoiding to get mixed with people from other background and socio-economic status. The integration between “immigrant” and “native Swedish” populations proceeds slowly, and the quality of urban life in these areas is less than that in the Million Program areas (Gothenburg City Council, 2013). As a response to these issues, Gothenburg has adopted a strategy based on multi-stakeholder involvement, e.g., by making use of diverse firms to develop new urban areas with a mixture of housing and functions (Gothenburg City Council, 2011, 2012, 2014a,b). As to the segregation issue, the strategy adopted concerns the enlargement of the core of the city to combine different interest-groups that have the centre as a common public space. The aim is to make people integrate in the city centre first, and then try to mix them in the same living areas by expanding the attractive core.

In the two cities, the business areas associated with the activities that are incompatible with housing development, e.g., wholesale retailing, industrial facilities, and port activities, are prioritized with specific transport needs, safeguard good access, and no new housing development. Speaking of the economy, there are different institutional practices used to support economic sustainability in Gothenburg and Helsingborg. Based on the document analysis and interviews, the following institutional practices have been identified in the two cities (Gothenburg City Council, 2009, 2011, 2014a, b; Helsingborg, 2009b, 2011a, 2011b):

- Regional collaboration as a measure to enhance business development.
- Strategic business development plans to guide business and tourist development.
- Arenas where politicians, business actors, and public servants meet to discuss topical questions.
- Collaboration and contact with business actors to enhance knowledge and expertise sharing
- Higher educational institutions doing and integrating research into business development as part of academia and industry collaboration.
- Initiatives for developing competencies in a number of business development areas in relation to sustainability by conducting seminars to improve the level of technological knowledge in this regard.
- Innovation labs for enabling interaction and cooperation between scholars, industry experts, business professionals, and thought leaders

to enhance research opportunities, real-world problem solving, and knowledge creation and dissemination.

- Collaborative projects with other cities in the region and across Scandinavia more generally.

4.4. Sustainable transportation

The term “sustainable transportation” is defined as “transportation services that reflect the full social and environmental costs of their provision; that respect carrying capacity; and that balance the needs for mobility and safety with the needs for access, environmental quality, and neighborhood livability” (Jordan and Horan, 1997, p. 72). It is a major strategy for achieving sustainable urban forms. Indeed, it is by relying on sustainable transportation that the dense, diverse, and mixed-use patterns characterizing the compact city enable it to secure environmentally sound, economically viable, and socially beneficial development. As a key component of sustainable transportation, the public transport system involves both the physical infrastructure as well as the level and quality of services provided to citizens. In Gothenburg and Helsingborg, public transport is seen as a key driving factor for reaching a more sustainable city. In addition, mobility management in the two cities is a kind of a soft measure adopted by the public transport authority to make the existing infrastructure more efficient and effective. This authority is responsible for building, developing, and maintaining the different parts of the urban transport infrastructure, and also creates and keeps the dialogue with businesses, universities, and citizens as to how they should make the choice of travel modes for the everyday needs and what can be done to make travel behavior more sustainable (Bibri, 2020a).

The Comprehensive Plan and Master Plan for the two cities emphasize the important relationship between urban planning and development and sustainable transportation. Both cities aim to improve sustainable transportation through new development in the strategic nodes. These are to be located in proximity to railway stations and to be based on mixed land use development that allows for sustainable mobility, such as cycling, walking, and public transport. One of the objectives of Gothenburg and Helsingborg is to put good public transport in place before new areas are developed. The strategic nodes and the built-up areas have already high quality public transport. Moreover, the two cities argue that to achieve an attractive city requires increasing accessibility through enhancing the transport infrastructure. This is planned by the creation of new links, enhancing existing networks, and building new footpaths and cycle tracks in the strategic nodes concerned with concentrated development. The goal of the two cities is to create an effective sustainable community that has good accessibility and safe traffic through urban form and transport infrastructure.

The K2020 project (Fig. 2) in Gothenburg aims to dramatically increase travel by public transport, which requires new public transport infrastructure (Gothenburg City Council, 2009, 2014b). Specifically, as a long-term strategy for public transport in the Gothenburg Region, this project aims to increase the use of collective modes by 2025, from 25% to 40% (1 million trips per day instead of 450,000). Fig. 3 shows the main principles from K2020.

The transport strategy in Gothenburg for a close-knit city indicates how the transport system needs to be developed as more people live, work, shop, study, and meet in the city, that is, in relation to density and mixed land uses (Gothenburg City Council, 2014b).

Helsingborg emphasizes that compact urban development should be appropriate to efficient public transport, walking, and cycling, which are in turn associated with the close proximity to shops, workplaces, services, and facilities in dense areas (Helsingborg, 2010a). Further, as clearly stated in the Guide to Helsingborg 2035, distances are short and public transport is pioneering, and the city has sustainable transport systems (Bibri, 2020a). As regards the advantages of sustainable transportation, it operates the transport system at maximum efficiency, provides favorable conditions for energy-efficient forms of transport, limits CO₂ emissions, allows equitable accessibility to services and facilities, promotes

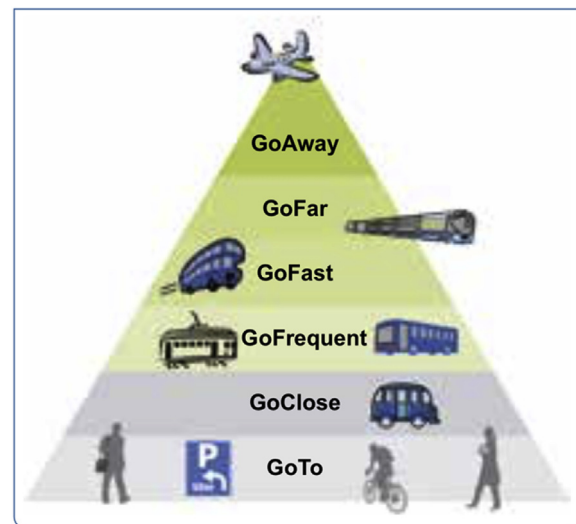


Fig. 2. The K2020 strategy.

Source: Gothenburg 2035 Transport Strategy for a Close-Knit City (Gothenburg City Council 2014b).

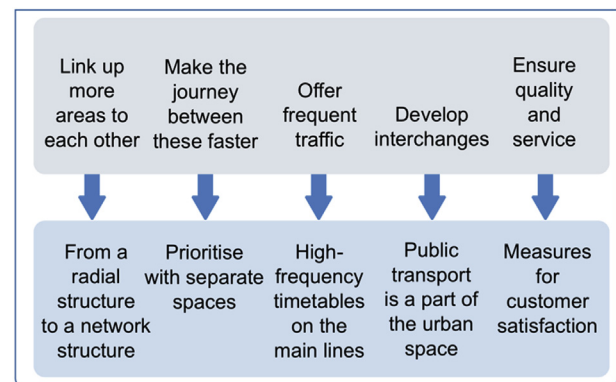


Fig. 3. The main principles from K2020

renewable energy sources, decreases travel needs and costs, minimizes land use, and supports a vibrant economy (Gothenburg City Council, 2009, 2014a; Helsingborg, 2010a). These benefits can be realized within the framework of the compact city as a set of planning practices and development strategies.

4.5. Green structure: green space

Greening is a key design concept for sustainable urban forms. Green space can be defined as the areas of nature found in the urban landscape. It includes trees, grassy patches, water features, flowerbeds, and rock gardens. The Municipalities of Gothenburg and Helsingborg adopt the concept “green structure” in planning. This concept constitutes larger green areas, waterways and streams, shorelines, parks, agricultural land, and natural areas as one common structure (Helsingborg, 1995; 2010a; Gothenburg City Council, 2009, 2014a). Green structure plans emphasize the benefits and losses of green and natural areas.

In the two cities, green space relates particularly to health and recreation for a better quality of life. Gothenburg and Helsingborg will be healthy and able to offer good opportunities for recreation (Gothenburg City Council, 2009; Helsingborg, 2010a). They pursue public health plans (Gothenburg City Council, 2009; Helsingborg, 2010d) and have also attempted to secure a linkage between urban planning and public health goals by developing procedures for the purpose. “Access to

greenery, sports, and play ... shall increase... Planning must have regard to public health" (Gothenburg City Council, 2009, p. 7). In the areas studied in Gothenburg by Lim and Kain (2016), there are larger green spaces and parks in emergent compact urban form. The environmental quality is one of the aims that are of particular relevance to urban planning due to the employed monitoring: ability to enhance the air quality, noise level, and the protection of green areas (Helsingborg 2010d). The issue of air quality can be seen to be keeping pace with the goals formulated. Helsingborg (2010a) promotes the creation of green spaces in the city. One planner from Helsingborg Municipality said, "When people move around in the city, they like to use parks and squares with green features, while green space is highly appreciated in high residential densities. So it is a matter of what people perceive the city life to be and what attracts them to live in it." Nonetheless, there is more to green space than just health and recreation. Greening ameliorates the physical urban environment by removing CO₂ emissions and other toxins from the air, enhances the aesthetics of urban areas and thus make them more pleasant, enhances the urban image and increases economic attractiveness, and helps to control storm runoff (Bibri, 2020a, b). For example, as argued by Gothenburg, "proximity to parks and green areas generates high land values that in turn create a willingness to invest" (Gothenburg City Council, 2014a, p.16).

The protection of large natural, agricultural, and cultural areas is a perceived outcome of the compact city model in both cities. "To use land resources effectively means ... that we have more space left; space for more houses, more green space, businesses, and services that create added value for the areas in question. By prioritizing development in station-nodes the remaining parts of the countryside with high-class agricultural land or important natural or cultural values can be left unexploited" (Helsingborg, 2010a, p. 14). One planner from Gothenburg Municipality said: "We protect natural and cultural landscapes and agricultural areas by setting long-term limits for dense areas, and by the densification of the nodes and the transformation of the existing developed areas. New homes will be built in these areas to avoid the fragmentation of the large natural, agricultural, and recreational areas." As regards the outer and nature areas, the objective is to "have regard to valuable natural and cultural heritage" and to "protect and enhance natural, cultural, and recreational values" (Gothenburg City Council, 2014a, p. 9). On the whole, the two cities perceive densification and transformation as a means to secure the protection of the valuable areas in question beyond the developed and redeveloped areas. They are also clear on the restriction on the development outside these areas—unless there are economic priorities which could enable the green field to give space at the new suburban infrastructure for wholesale retailing, industrial facilities, and large-scale businesses.

Limiting outward urban expansion should be combined with not only more efficient use of land resources through densification and transformation, but also with more effective measures to protect the green areas within the city. Compactness is about ensuring that we make the fullest use of the urbanized land before taking green fields. However, the future of green areas within the strategic nodes is more uncertain. Particularly if green areas are located in the vicinity of a railway node, they risk being used as building ground (Helsingborg, 2010b). While Helsingborg envisions that it will create "more green areas" (Helsingborg, 2010a, p. 14) and "increase the efficiency of green area usage" (Helsingborg, 2010a, p. 30), it is less specific in regard to the green areas located within the strategic nodes. Gothenburg is relatively more explicit about the relationship between green areas and densification. "Both densification and green areas provide good conditions for a variety of qualities: play areas, close to shops, walking areas, public transport, and so on" (Gothenburg City Council, 2014a,b, p. 51). The city argues for the importance of green space as a design feature in a denser city, and all developments and redevelopments should be designed in ways that minimize their impacts on the environment, i.e., valuable green structure is maintained (Gothenburg City Council, 2014a). However, according to Lim and Kain (2016), larger parks in emergent compact urban form in

Gothenburg are distributed less evenly. In view of the above, the main question to raise is to what extent the practices capable of relieving the tension between densification and transformation and the protection of green areas from damage or harm with appropriate measures are detectable in the two cities.

Regardless, green structure plans map the two cities' green resources by assessing their natural and recreational qualities (Gothenburg City Council, 2009; Helsingborg, 2010c). Accordingly, "[l]osses of nature, cultural, or recreation values will be compensated for" (Gothenburg City Council, 2009, p. 7). In the case of densification, "the balance between different interests becomes more difficult, and conflicts of interest must be dealt with at the planning stage of the growing city... It is not possible to avoid values sometimes being lost, but in these cases one needs to compensate for them with new or reinforced values, so the final result is more valuable" (Gothenburg City Council, 2014a, p.16). Helsingborg implements what is called the "balancing principle," a practice which involves a compensation for loss of green areas (Helsingborg, 2010c). Such principle entails an in-depth analysis of the area as a basis for decision-making pertaining to urban development. Although there are no guidelines for what actually functions as to the compensation procedure and what to accept and not in terms of the potential damage or harm to the ecological and natural values, the purpose of such analysis, the value assessment, is to increase the cost of altering the status of the area, of which the value is to be decided through negotiations among the involved stakeholders case by case. Generally, the relationship between urban planning and design interventions and sustainability objectives is a subject of much debate. This means that realizing a compact city requires making countless decisions about urban form, design, and governance, which usually involves complex negotiations and often conflicts. In this regard, one local planner from Helsingborg Municipality said, expressing his concern: "there is weak ground in the balancing principle in that it may be exploited by developers for their own interests by acquiring the right to access green areas for further development." As confirmed by Hofstad (2012, p. 13), "The balancing principle may function as a clause that ransoms developmental interests... Such an alteration of the logic that guides the governing of these areas may make it possible for developmental interests to effectively buy themselves out of this general aim to secure accessible green areas in the city center." In line with this, as stated in the Development Strategy Gothenburg 2035, "[t]here are conflicts of interest in a compact city, but ... it is possible to attain ... both a green and compact city... When building additional structures, it is important to take into account potential conflicts such as ... access to green areas and risk issues" (Gothenburg City Council, 2014a, pp. 6, 8).

4.6. Summary of the results

Table 7 Provides a summary of the results in terms of the core strategies of the compact city for achieving the goals of sustainability.

5. Discussion

The findings showed that compactness, density, diversity, mixed land use, sustainable transportation, and green space are the core design strategies of compact city planning and development as practiced by the two Swedish cities. This is in line with the literature on compact cities in the most essential respects. However, these cities tend to exhibit some differences in the way they develop and implement the compact city strategies to the built form. This is due to their specific physical, geographical, socio-political, economic, and historical aspects. This is consistent with the findings from other case studies on compact cities (e.g., Bibri, 2020b; Hofstad, 2012; Lim and Kain, 2016). Besides, there are great differences between cities in regard to their form (Bibri, 2019a; Van Bueren et al., 2011). Therefore, it is important for cities to make the best use of their local opportunities and capabilities as well as to assess their potentials and constraints from a more integrated perspective when it comes to compact city planning and development. Nonetheless, there

Table 7
Compact city strategies for achieving the goals of sustainability.

Design Principles	Compact City Strategies for Environmental, Economic, and Social Sustainability
Compactness	<ul style="list-style-type: none"> • Build and develop centrally • Concentrate on strategic nodes • Complement and mix • Strengthen public transport • Reserve outer city areas for future development
Density	<ul style="list-style-type: none"> • High density of built objects in designed and emergent compact urban form • Diverse scales of built objects • Distribution of building footprints with frequent larger buildings • Greater density in strategic nodes • Prioritization of density close to the central points of strategic nodes • High-density hand in hand with multidimensional mixed land use
Mixed Land Use	<ul style="list-style-type: none"> • Physical land use mix (horizontal/spread of facilities, vertical mix of uses, amenity, public space, etc.) • Economic mix (business activity, production, consumption, etc.) • Social mix (housing, demography, lifestyles, visitors, etc.) • Greater mix of housing, business, and facilities in strategic nodes • Multidimensional mixed land use hand in hand with sustainable transportation
Sustainable Transportation	<ul style="list-style-type: none"> • Cycling and walking • Public transport (metro, buses, tram, etc.) • Mobility management • Increased accessibility through public transport infrastructure improvements • Sustainable transportation hand in hand with multidimensional mixed land use and high density • Network structure of link areas to connect the major nodes of the transport system • Separate lanes for the public transport for faster journey time and a punctual and reliable system • More services along the main corridors for greater frequency • An easy to understand, safe, and secure system for guaranteeing quality and service • Multi-model travelling in strategic nodes to support their dense, mixed use central points
Green Structure	<ul style="list-style-type: none"> • Green areas and parks • Green areas hand in hand with density • Protection and integration of natural, agricultural, and cultural areas through intensification
Intensification	<ul style="list-style-type: none"> • Increase in population • Increase in redevelopment of previously developed sites, subdivisions and conversions, and additions and extensions • Increase in development of previously undeveloped urban land and buildings • Increase in density and diversity of sub-centers • Investment in and improvement of transport infrastructure and services

are no striking or conspicuous differences between the two cities as to the applications of the theoretical underpinnings of the compact city to the built environment—the way the compact city model is practiced and justified in compact urbanism, just as with many cities across the world as illustrated in Table 2. Especially, both cities are located in Sweden as one of the leading countries in the practice of sustainable development, and where relatively similar land use, institutional, environmental, economic, and social policies are adopted by most of, if not all, the city governments.

In addition, at the core of the compact city model is the clear synergy between the underlying design strategies in terms of their cooperation to produce combined effects greater than the sum of their separate effects with regard to the benefits of sustainability in regard to its tripartite composition. For example, urban greening enhances the presence of the

compact ideas in the urban areas that are targeted by densification and transformation strategies. Also, the availability and quality of the public transport infrastructure is a determinant factor for stimulating urban development projects pertaining to compactness in the strategic nodes as well as the built-up areas so as to boost the benefits of sustainability. In general, urban development policies are supported by the advocates of the agglomeration effects (Glaser, 2011) made by the proximity, contiguity, and connectivity of diverse urban components. This results in a more environmentally sound, economically viable, and socially beneficial form of development through dense, diversified, and highly integrated patterns that rely on sustainable transportation and favor green space (Bibri and Krogstie, 2020c).

Furthermore, the findings showed that the compact city model as practiced by the two cities is justified by its ability to contribute to the environmental, economic, and social goals of sustainability. This corresponds to the results obtained from other studies (e.g., Bibri, 2020b; Hofstad, 2012). In fact, the centrality of the compact city ideal and especially its three sustainability dimensions in urban planning and development is found throughout the western world (Easthope and Randolph, 2009; Healey, 2002; Portney, 2002; Raman, 2009; Vallance et al., 2005). The measures of the compact city provide a series of environmental, economic, and social benefits as they are designed to revitalise existing city areas, increase walking and cycling, enhance the use of public transportation, and preserve recreational and open green space (Jenks and Jones, 2010). The compact city model provides better economic outcome (Quigley, 1998), reduces energy consumption and pollution through densification (Breheny, 1995; Mindali et al., 2004), and alleviates social segregation (Burton, 2001).

Concerning environmental sustainability, the two cities aim to decrease travel needs and thus mitigate GHG emissions through walking, cycling, and public transport; to reduce the pressure on green and natural areas; and to conserve energy through building densities that support combined heat and power systems. Cities as the most compact settlements of people have a tremendous effect on environmental changes (Girardet and Schumacher, 1999), and low population density is the most environmentally harmful form in urban structures (UN-Habitat 2014b). In particular, the planning discourse in the two cities correlate with the compact city ideal as regards sustainable travel. This is at the core of the densification and intensification strategies adopted by the two cities. The main environmental aspects identified, namely sustainable travel and land efficiency, constitute a central part of planning and development practices in both Copenhagen and Oslo (Naess et al., 2011). Newman and Kenworthy (1999) substantiate that the compact urban form involves a less use of energy and a high use of public transportation. In relation to this, most of the public transportation uses electricity to operate, and when electricity is generated by renewable energy (i.e., solar, biofuel, wind, etc), the reduction of emissions can be very significant. The issue of transport dominates the environmental debates on the form of the city (e.g., Bibri, 2020a, b; Bibri and Krogstie, 2017b; Jabareen, 2006; Jenks, Burton and Williams, 1996a). Overall, the intensification of the built form leads to cities which are better suited to sustainable mobility and to energy saving in public transports and district heating (Elkin et al., 1991).

Moreover, the two cities promote green space by means of institutional practices related to green structure. Also, they share the research view that it is possible to attain a city that is both compact and green. The green areas targeted by the strategies of urban development have enhanced the presence of the idea of compactness through the discourse and institutionalization of green structure and the balancing principle and other planning tools applied in Sweden. Especially, natural areas in the two cities are regarded as valuable recreational facilities and a way of making the city more healthy and vibrant, in addition to contributing to the protection of biodiversity and ecosystem services. The health advantages of urban green space tend to be more on focus in research (De Vries et al., 2003; Maas et al., 2006). Green space contributes positively to the objectives of sustainable development in urban areas (Swanwick

et al., 2003). New approaches to urbanism need to incorporate ecological thinking in the forms of human settlement (Beatley, 2000). However, green space is a subject of debate due primarily to the core conception of the compact city. In this respect, the argument that the compact urban form has the ability to reduce the pressure on green areas, ecosystem services, and biodiversity remains less certain. While the goal of protecting open green space outside development areas or strategic nodes finds support in the two cities as manifested in densification and expansion projects, it is not certain when it comes to green areas located in or close to the urban fabric given the potential enticing opportunities offered by new urban development projects to further strengthen the economic goals of sustainability, which indeed is the dominant aspect of the compact city initiatives.

It is worth noting that greening as a key dimension of ecological design is typically associated with the concept of the eco-city, another prevailing model of sustainable urban form. Greening and passive solar design are the key distinctive design strategies adopted by a number of approaches to the eco-city (e.g., environmental city, green city, sustainable city, sustainable neighborhood, sustainable urban living, living machines, and garden city (Bibri and Krogstie, 2020a). Passive solar design entails decreasing the demand for energy by using solar passive energy sustainably through the design measures applied to buildings and urban densities. However, this strategy is not mentioned in the planning and development documentation of the two cities and hence not on focus within the framework of the compact city, despite the intensification of the development and redevelopment projects going on in these cities with respect to densification and transformation. The orientation of buildings and spatial patterns of densities environmentally affects the built form (e.g., Jabareen, 2006; Thomas, 2003). A large body of research has demonstrated and discussed the environmental benefits of passive solar design, notably building heat gains and losses, warming and cooling pressures, heat storage and discharge, emissivity, and air and noise pollution reduction (Bibri, 2020b; Bibri and Krogstie, 2020a).

Another design strategy of the eco-city that is also of high pertinence to the compact city as regards to its environmental health, though missing in the two cities' planning and development documents, is "smart urban metabolism" (e.g., Shahrokni, Lazarevic and Brandt, 2015; Shahrokni et al., 2015) and sustainable systems. As argued by Marcotullio (2007), sustainable systems are a key innovation that the compact city needs to adopt because they create the infrastructure to naturally process sewage waste, grey water, and storm runoff on-site, in addition to preventing flooding on the urban hardscape and utilizing wastewater to fertilize and water gardens. Sustainable systems are commonly associated with the eco-city model (Bibri, 2020b; Roseland, 1997). Nonetheless, there are many overlaps among sustainable urban forms in their ideas and concepts, especially the eco-city and the compact city. While these forms are compatible and not mutually exclusive, they involve some distinctive concepts and key differences (see, e.g., Bibri, 2019a, 2020a; Farr, 2008; Harvey, 2011; Jabareen, 2006; Roseland, 1997). For example, the two models share mixed land use, with the difference being that this strategy in the eco-city model is not hand in hand with, or strongly linked to, the high-density strategy as in the compact city model (Bibri and Krogstie, 2020a). Moreover, the mixed-use strategy as applied to the compact city involves four dimensions: the social mix, the physical land use mix, the temporal mix of social and physical issues, and the economic mix (Evans and Foord, 2007).

With respect to economic sustainability, the two cities aim to revitalize the city centers through the promotion of densely built dwellings, businesses, facilities, and accessible transportation; to create proximity between people and their workplaces, thus making sustainable travel possible; to promote greater diversity among employers and job possibilities; and to improve public transportation infrastructure. This finding is consistent with the results obtained from several studies (e.g., Hofstad, 2012; Jenks and Jones, 2010; OECD, 2012b). Additionally, economic development is found to be a significant force in bringing about densification in studies undertaken in Denmark and Norway (Mace et al.,

2010; Næss et al., 2011). Important to highlight moreover is that proximity, how close jobs, facilities, amenities, and services are to where people live as generally calculated based on the travel time and distance to their homes, adds another dimension to the compact city: self-sustaining. This means that the city has everything that people need within the community, including stores, employers, service providers, energy generation, waste disposal and processing, and small-scale agricultural production (community gardens and/or vertical gardening) (Li, Wen and Yue, 2016). Again, the latter is typically associated with the concept of the eco-city (Harvey, 2011; Roseland, 1997).

As regards social sustainability, the two cities tie its goals to densification together with social, physical land use, and economic mixes. They aim to improve social equity, social inclusion, social capital, and social cohesion, as well as the quality of life through social interaction, safety by means of natural surveillance, and ready access to services and facilities and green space and recreational areas. Compactness promotes the fairness of the distribution of resources, reducing the gap between the advantaged and the disadvantaged (Burton, 2001), as well as social inclusion, social capital, and social cohesion (Jones et al., 2010; Bramley et al., 2010). One of the arguments that supports social equity is the possibility to have a better access to services and facilities (Burton, 2000). Also, there is evidence that compactness promotes social equity through the reduction of social segregation (Burton, 2001) and spatial segregation by means of flexible design of housing in terms of affordability and mixed forms as well as forging the links between communities (Bibri and Krogstie, 2020a). With respect to the quality of life, the two cities' aims highlight the development of an amalgam of dwellings, businesses, shops, and facilities that makes daily life simpler and life-long living possible and creates vital city centers and public spaces for a healthy, vibrant, diverse, and safe city. Mixed use development promotes vitality, diversity, and safety thereby providing significant social benefits (Arbury, 2005; Bibri, 2020a). Currently, the two cities are facing some challenges pertaining to the institutionalization of planning practices capable of improving the goals of social sustainability. The main problems they are struggling with in their endeavor of achieving the status of the compact city are socio-economic disparity and social inequality.

In light of the above, the perceived positive outcomes of the compact city as related to the two cities' plans are broadly associated with the economic, environmental, and social goals of sustainability. However, it can be observed that the three goals identified tend to have unequal position within the compact city. Specifically, it becomes apparent that the economic goals dominate over the environmental and social goals as supported by the underlying design strategies of the compact city. This is in line with the empirical material pertaining to Helsingborg and Gothenburg. The environmental and social goals are not as intrinsically central to the compact city model as the economic goals, thereby the translation of the latter into concrete measures and hegemonic projects and their institutionalization in urban planning and development practices.

Nonetheless, regarding the environmental goals of sustainability, the common ideals of the compact city model: sustainable transportation and the safeguarding of green areas have been institutionalized through the materialization of concrete measures and projects. Urban green qualities are of particular focus in this regard in light of the practice of green structure plans and the introduction of the balancing principle in Helsingborg. Especially, recent studies suggest that the developments pertaining to the compact city are not as green as promised. As far as the social goals of sustainability are concerned, their translation into concrete measures is still slow and their institutionalisation is facing challenges. It is clear that social sustainability has not yet gained full recognition in Gothenburg and Helsingborg, particularly in relation to social equity and social inclusion. Social proposals in this regard seem to be couched in speculative language in terms of investments, ventures, and employments. This in turn means that social sustainability still lacks concrete or strategic guidelines so as to be, as a vision, converted into concrete measures and projects. The assumption underlying social

sustainability is that urban forms cannot be sustainable if they are unacceptable to people and communities.

In sum, the empirical data show the contours of a goal hierarchy between the three goals of sustainability in compact city planning and development. Economic and some environmental concerns are at the top of the goal hierarchy. This is consistent with the conclusion drawn by Hofstad (2012) that the economic goals remain at the core of planning, while the environmental and social goals play second fiddle. Nevertheless, the compact city model has the ability to respond to different socio-economic and environmental challenges. Therefore, new measures are being developed and implemented by the two cities to strengthen the influence of the environmental and social goals over urban planning and development practices towards balancing the three goals of sustainability.

Compact city development should enable to develop a coordinated, institutional framework to make the most of the opportunities offered by the concept of sustainable development. Perhaps most importantly, the citizens should be given a chance to have a voice in the future of the place where they live. Attractiveness does not depend on economic prosperity alone. Rather, to attract people and enhance livability requires a broader agenda entailing a balanced mix of social, environmental, and economic considerations. And for the two cities to fully achieve the ultimate goal of becoming exemplary models of the compact city, the social and environmental goals of sustainability need to be further supported through institutional practices and thus concrete projects. These involve socially-oriented projects that have high environmental performances and reduce social inequality and segregation (see Bibri and Krogstie 2020a).

Regardless, it is inadequate to focus solely on the form of the city in order to achieve and balance between the three goals of sustainability in an increasingly urbanized world. Monitoring, understanding, and analyzing the processes of urban life (living, building, consuming, producing, etc.) as processual outcomes of urbanization require more innovative solutions and sophisticated approaches in order to advance sustainability. In fact, the form of the city as an outcome of evolution emerges from these processes, not only does it shape them as a structure. However, it is of high pertinence and significance to develop and apply more innovative solutions and sophisticated approaches to deal with the challenges of sustainability and to mitigate the effects of urbanization by incorporating them in urban planning, management, and operational functioning. This is due to the dynamic, synergistic, substantive, and disruptive effects of advanced technologies. New circumstances require new responses with respect to sustainable (compact) urbanism and what it involves in terms of wicked problems. Especially, to tackle such problems requires new technology research and development combined with implementation in practice, and the interdisciplinary research alone remains inadequate (Bibri, 2020b).

Worth pointing out is that sustainable cities are complex systems par excellence and thus dynamically changing, adaptive, and evolving; self-organizing social networks enabled by infrastructure, services, and activities; and developed by multitudinous collective and individual decisions from top-down and bottom-up. Therefore, the emerging computational and scientific approaches, especially those enabled by big data analytics, are of high relevance and importance for understanding and dealing with urban complexities (e.g., Batty et al., 2012; Bibri, 2018a,b, 2019a, e, 2020a, b; Bibri et al., 2020; Bettercourt, 2014; Giannotti et al., 2011). And together with socio-political frameworks and solutions, citizen participation and engagement, and deliberative democracy and behavior of agents (Bibri, 2019d; Greenfield, 2013; Kitchin, 2014, 2016; Kitchin et al., 2015), they should play a pivotal role in solving some of the special conundrums, wicked problems, and intractable issues the contemporary city inherently embodies. In addition, Bibri and Krogstie (2020b) investigate how the emerging data-driven smart city is being practiced and justified in terms of the development and implementation of its innovative applied solutions for sustainability. The authors conclude that the data-driven technologies are being highly developed and increasingly implemented in various urban systems and

domains with respect to environmental and social sustainability. This can add a great value to the balance that the compact city is seeking to achieve with regard to strengthening the influence of the environmental and social goals of sustainability over urban planning and development practices. In this regard, different data-oriented competences can be developed and implemented to strengthen the readiness of the compact city to adopt the relevant data-driven solutions and approaches to advance environmental and social sustainability. They include the ICT infrastructure, data sources, horizontal information platforms, operations centers, dashboards, training programs and educational institutes, innovation labs, research centers, and strategic planning offices.

6. Conclusion

Global and local policies on urban planning and development promote the concept of the compact city as a response to environmental integration, economic development, and social justice. The Cities of Gothenburg and Helsingborg should be viewed as successful initiatives in compact city planning and development, on national and international scales. This study has been carried as a demonstration endeavor of what these cities are renowned for in this regard, with the aim of being exposed to both local and general lessons. Most of their practices, strategies, and resulting actions are equally relevant to other cities in the developed world.

This paper examined how the compact city model is practiced and justified in city planning and development with respect to the three dimensions of sustainability, and whether any kind of progress has been made in this regard. Accordingly, it set out to answer these research questions: What are the prevailing design strategies of the compact city model, and in what ways do they mutually complement, or beneficially affect, one another as to generating the expected benefits of sustainability? To what extent does the compact city model contribute to and balance the three goals of sustainability?

This study has shown that compactness, density, diversity, mixed land use, sustainable transportation, and green space are the prevalent design strategies of compact city planning and development, with the latter being contextually linked to the concept of green structure, an institutional setup under which the two Swedish cities operate. Moreover, the underlying strategies of the compact city are not mutually exclusive and thus must take place or exist at the same time in order to guarantee the viability and sustain the performance of the compact city regarding its contribution to the three goals of sustainability. It can be concluded that the compact city is a very complex urban planning and development approach that involves several dimensions that are supposed to work together synergistically.

In addition, this study has demonstrated that the compact city model as practiced by the two cities is justified by its ability to contribute to the environmental, economic, and social goals of sustainability. Hence, these cities are strategically planned to respond to the challenges of urban development in terms of urbanization and its dimensions (physical, environmental, economic, and social) in line with the vision of sustainability. However, the economic goals of sustainability dominate over the environmental and social goals of sustainability, notwithstanding the claim about the three dimensions of sustainability being equally important at the discursive level. Nevertheless, new planning measures are being developed and implemented to strengthen the influence of the environmental and social goals over urban planning and development practices towards balancing the goals of sustainability. The main issues identified that the two cities are struggling with are green space loss, noise pollution, socio-economic segregation, and social inequity.

Providing generalizable conclusions in this study emanates from not only conducting two case studies in a country with a national focus on, and planning tradition for, sustainability on the longest established and most prevalent sustainable urban form, but also from reviewing many other theoretical and empirical studies on this phenomenon. In view of that, it is safe to argue that this study is of a macroscopic nature, and the

outcome is analytically and practically generalizable. Indeed, compact cities are endorsed as a response to critical environmental, economic, and social challenges by turning cities more efficient, equitable, livable, vibrant, and attractive. To put it differently, agglomeration, proximity, and diversity have been demonstrated to promote environmental quality, social equity, accessibility, life quality, innovation, economic viability, and rural land and natural area protection. However, the compact city model involves conflicts when attempting to balance between the three goals of sustainability.

As regards the “so what” strategy, this study suggests that the compact city is not addressing and overcoming the challenges of sustainability based on the most effective approach when they focus exclusively technically on the design of the built form in planning in the face of the escalating scale and rate of urbanization and the wicked problems and intractable issues characterizing cities as complex systems. Indeed, this study illuminates, among others, how emerging planning practices incorporating the environmental and social dimensions of sustainability generate conflicts and contentions within the compact city model. These issues may stimulate new endeavors and opportunities towards finding more effective ways to further enhance and advance this widely advocated model, nevertheless. Regardless, the field of compact urbanism needs to extend its ambit beyond the built form of the city to include more innovative solutions and sophisticated approaches by unlocking and leveraging the potential of advanced ICT.

In that respect, more in-depth knowledge on planning practices is needed to capture the vision of sustainable urban development, so too is a deeper understanding of the multi-faceted processes of change to achieve sustainable urban forms. In this regard, the core questions that would potentially broaden our knowledge on how compact cities can harness their potential through the underlying design strategies and balance the three goals of sustainability in planning and development practices include:

- What is the most effective approach to introducing environmental, economic, and social concerns in the planning process, and what kind of measures are needed to integrate such concerns early on?
- To what extent can advanced technologies support joined-up planning, a form of integration and coordination which enables system-wide sustainability effects to be monitored, understood, analyzed, and built into the very designs and responses characterizing the operations and functions of the compact city?
- What kind of advanced technologies are available that can be implemented to make the planning process more dynamic based on constantly updated information on the operations and functions of the compact city?
- Currently urban dashboards are offering the opportunity for providing an integrated view and synoptic intelligence of the way the modern city is performing and functioning in real time. To what extent can this development aid expert and non-expert users in interpreting and analyzing the visualized information and allow citizens to monitor the city for themselves, all for the benefits of the compact city?
- To what extent can the aggregation of real-time data contribute to dealing with changes in the compact city at any spatial and time scale, especially the current datasets can show the city functioning in real-time and how longer term changes can be detected thanks to the IoT and its ubiquitous sensing network?
- To what extent can short-termism in urban planning, i.e., the process of measuring, evaluating, modelling, and simulating what takes place in the city over hours, days, or months, change the way the compact city functions as to focusing on much shorter term problems and issues than before with respect to the different aspects of sustainability?
- What is the potential of developing and applying urban intelligence functions in the form of innovation labs to capture how the compact

city is changing in its nature on the basis of its real-time functioning, and to generate more effective urban structures, forms, and spatial organizations that improve sustainability, efficiency, resilience, equity, and the quality of life?

- To what extent can emerging technologies leverage the design strategies of the compact city in ways that enhance and optimize its processes and practices by continuously evaluating its contribution to the three goals of sustainability and their integration?

The present study offers insights that can inform future research agendas on sustainable urbanism. More specifically, it provides the grounding for further in-depth research on compact urbanism, not least in the developed countries that support sustainable development practices. We would particularly like to encourage qualitative research to further illuminate the strategies of the compact city model and the assumptions behind the associated initiatives in different contexts. And hence the claims that this model can make urban living more sustainable, irrespective of the context where it is embedded. This is justified by the increasing demand for practical ideas from the ecologically advanced nations about how to achieve the required level of sustainability through compact urbanism from policymakers and practitioners from other developed countries around the world. Further research should focus on providing the knowledge that these actors will need to make informed decisions about how to contribute and support the balancing of the goals of sustainability through compactness in their own national and local contexts. Moreover, as this study has demonstrated that compact urbanism practices, strategies, and goals already exist across the selected cities, it would be useful and interesting to carry out a wider and more varied comparison (involving cities from other Scandinavian and European countries) with a view to revealing more general trends in compact urbanism. Taking up this in future research is indeed justified by the limitation to the present study, which pertains to the case selection that included only Swedish cities. Due to this bias in the case selection, it is moreover conceivable that potentially more strategies of the compact city for particularly supporting the balancing of the three goals of sustainability exist in other cities in Europe. In addition, we would like to draw the attention of future researchers to the tension between the densification of the strategic urban areas targeted by development and the safeguarding of green areas located in such areas, as well as to the extent to which the new measures being developed and implemented to address socio-economic disparities are delivering the expected outcomes. Lastly, a sequel to this work and thus part of our future research is to integrate the compact city, the eco-city, and the data-driven smart city into a novel model of urbanism for the purpose of improving, advancing, and maintaining the contribution of sustainable cities to the goals of sustainability. This is one among many other opportunities that can be explored towards new approaches to smart sustainable urbanism.

Finally, the concepts, ideas, and findings presented in this study for policy makers provide practical clues as well as lessons on the expected benefits of compact urbanism as to its contribution to the three goals of sustainability, in particular the set of measures being implemented to support their balancing through institutional practices. Most of the time, when it comes to compact city development, contradictions, uncertainties, contentions, and even disputes emerge during the cooperation and interaction between policymakers, planners, developers, engineers, government officials, industry experts, and thought leaders as part of a comprehensive team, irrespective of whether the city is badging or regenerating itself as compact or sustainable. This phenomenon is nevertheless common in all urban development projects and initiatives due to the difficulty of aligning and accommodating the interests and expectations of the different stakeholders in the city. Regardless, learning from the experience and knowledge of the emerging or leading cities in their areas of expertise is a common way to formulate and implement urban policies and strategies through drawing positive and negative

lessons. We expect this trend to continue in the future and hope to have contributed our share to improving that practice.

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Author contributions

S.E.B. conceived the study, conducted the literature review, collected and analyzed the data, and wrote the manuscript. J.K. and M.K. reviewed the manuscript. The authors read and approved the final version of this manuscript.

Declaration of competing interest

The authors declare no conflict of interest.

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