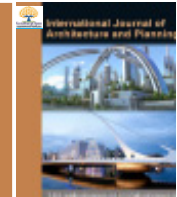




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Compact City as a Tool for Sustainable Urban Development

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Abstract

Over the past two to three decades, the terms “sustainable development” and “urban compaction” have gained popularity in urban planning and policy fields. One of the most influential models of sustainable urbanism is the compact city. Compact city planning and development has been a strategy for sustainable urban development for at least the last 30 years. Due to its benefits in terms of advancing the economic, environmental, and social aims of sustainability, it is strongly supported by both global and local authorities. Many developed countries incorporate urban compaction into their city planning strategies for a variety of reasons, including efficient land use that reduces sprawl, more reliance on public transportation, increased social interaction, a vibrant activity environment, economic viability, and so on. The purpose of the paper is to study the role of urban compaction in sustainable urban development. The approach is based on the literature review of published articles and existing records. This study discusses compact urban development strategies applied to two different cities. The research would highlight the compact form as the most significant sustainable urban form and express the features of compact urban development.

Keywords: Sustainable urban development, Urban compaction, Urban form

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1. Introduction

Worldwide, urban areas are growing at an uncommon rate (UNCHS, 1996). The broad environmental effects of this urbanization, including air and water pollution, the urban heat island effect, greater levels of surface run off and more frequent floods in urbanized watersheds, as well as the loss of natural ecosystems, have been thoroughly reported. In highly industrialized nations, the sprawl of low-density settlements and the growth of ‘edge cities’ along key transportation corridors are of special concern since they increase travel demand while also disrupting the surrounding countryside and having a negative impact on the environment (Pauleit and Golding, 2005). The concept of sustainability has been integrated into urban planning theory through the promotion of the “compact city” model of urban growth rather than “unsustainable urban sprawl” and through a stronger focus on the significance of urban design, known as “New Urbanism” (Arbury, 2014a)

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Sustainability can be achieved in compact cities by reducing the reliance on cars, travel, and commute time, limiting the consumption of building and infrastructural materials, lowering per capita energy use, maintaining the diversity of employment opportunities, and minimizing the loss of green and natural areas (Bibri *et al.*, 2020). Urban form and sustainable development are closely related, although the relationship is not simple and straightforward. It has been proposed that it ‘must be of a form and scale appropriate to walking, cycling, and efficient public transport, and with a compactness that encourages social interaction’ (Artmann *et al.*, 2019).

The study is based on the idea that a city’s form may influence its sustainability and that it may depend on a city’s size, shape, density, and distribution of land uses. This paper is organized as follows. The second segment examines the concept of sustainable urban development, after the introduction of the various issues due to rapid urbanization in the first part. The third section describes urban compaction and its characteristics in detail. The relationship between urban compaction and sustainability is the subject of the fourth section, which covers environmental, economic, and social sustainability. This is followed by elements of the compact urban form. Two case studies are considered in the concluding section to learn more about the policy interventions and implementation.

2. Sustainable Urban Development

The World Commission on Environment and Development (1987) defines sustainable development as development that gives the ability to satisfy the requirements of the present generation while also recognizing the ability of the future generation to meet their own needs. Sustainable urban development may be defined as a user-friendly urban settlement in terms of its design, function, natural and man-made surroundings, and energy efficiency (Dantzig and Saaty, 1973; Kotharkar *et al.*, 2014). Long travel distances, traffic and fuel emissions, environmental degradation, social injustice, health issues, and the loss of nearby agricultural and natural resource land are some of the key issues in many cities across the world. As cities affect the overall environmental performance and management, they should focus on sustainable development agenda (Rod, 2000). Goal 11 of the United Nations SDG demands on cities to be inclusive, safe, resilient, and sustainable (Dantzig and Saaty, 1973). Hence, in order to achieve sustainability, academicians, planners, NGOs, civic groups, and governments have proposed new frameworks for urban rethinking in these areas: (a) at the regional and metropolitan levels; (b) at the city level; (c) the community level; and (d) the building level.

3. Urban Compaction

Dantzig and Saaty (1973) introduced the term “Compact city” which is characterized by high-density and mixed land use development with no sprawl. With this, they introduced the term ‘Densification’ based on three elements: urban form, spatial characteristics, and social functions (Dantzig and Saaty, 1973). As per the widely quoted definition of compaction by Burgess Rod (2000): “Compaction means to increase built area and residential population densities, to intensify urban economic, social and cultural activities and to manipulate urban size, form and structure and settlement systems in pursuit of the environmental, social and global sustainability benefits derived from the concentration of urban functions.” The concept of compact urban development differs based on geographical, institutional, social, economic, and political circumstances, and there is a lack of clarity on definitions, principles, practices, and outcomes (Lim and Kain, 2016).

A compact city includes the following characteristics, according to Neuman (2005): high residential and employment densities, a diversity of land uses, fine-grained land uses, strong social and economic interaction, contiguous development, limited urban expansion with well-defined boundaries, urban infrastructure (notably sewage and water mains), multi-modal transportation, and high levels of local and regional accessibility, high street connectivity (internal/external), including pedestrian and bicycle lanes, high impervious surface coverage, low open-space ratio, unitary or tightly coordinated management of land development planning and sufficient government financial capacity to finance urban services and infrastructure (Neuman, 2005) (Figure 1).

4. Urban Compaction and Sustainability

The concept of the compact city has grown significantly popular in several western nations since the late 1980s and the introduction of the idea of sustainability. In the 1990s, it was heavily debated as a means of achieving urban sustainability, notably in OECD nations (OECD, 2012). Urban compactness is a key component of the Dutch government’s sustainable development strategy. In Norway, the central government has a densification policy. In North America, they introduced

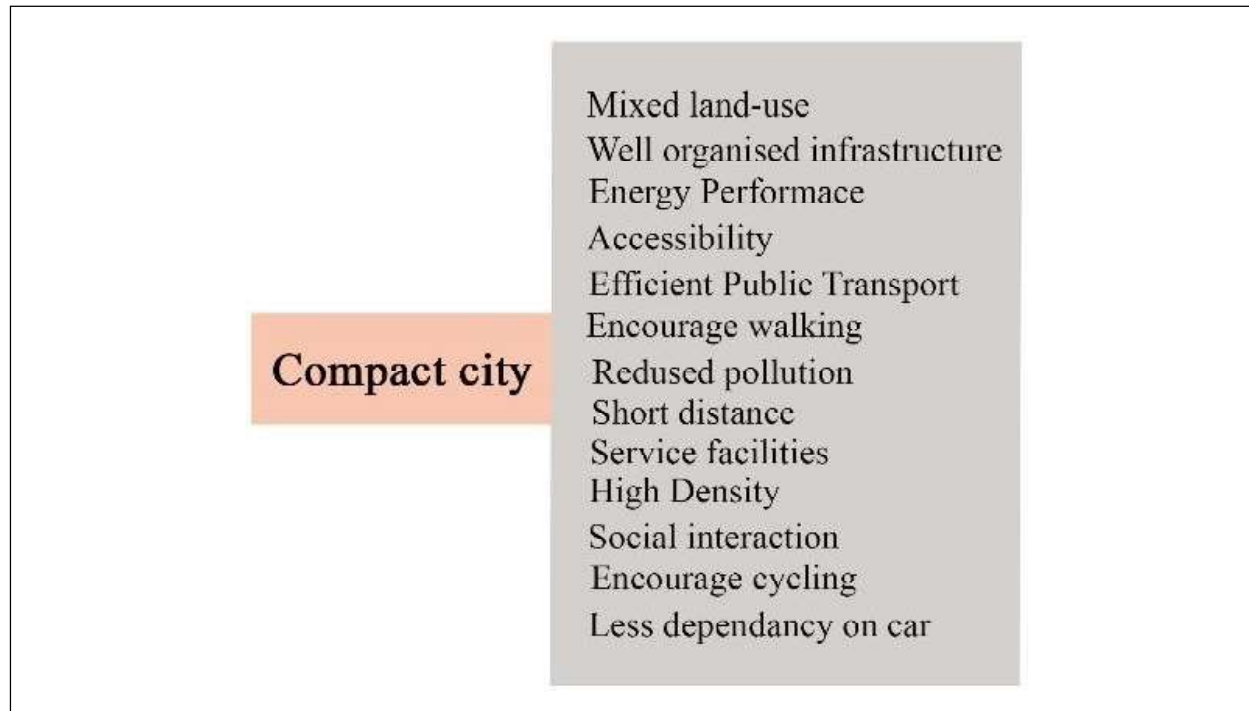


Figure 1: Positive Effects of Compact City

Source: Neuman (2005)

smart growth, alternative transportation, updated infrastructure, housing options, improved environmental protection, and increased investment in urban cores (OECD, 2012).

The compact city, as a desirable form, ensures ecologically sound, economically successful, and socially good growth, especially when it is strategically planned and well-designed prior to creation. As a result, it may be seen as a comprehensive study of the challenges of urban life as well as a complete vision of planning techniques and development plans. Table 1 summarizes the key environmental advantages of compact cities, depending on a variety of theories and academics (Bibri et al., 2020).

Environmental Sustainability	Economic Sustainability	Social Sustainability
• Low energy use	• Supporting local services and businesses (larger customer base)	• Better quality of life
• Short commuting times, thus reducing CO ₂ emissions	• Revitalizing city centers	• Reduced crime rates
• Minimize resource consumption	• High proximity to work place	• Improving social equity
• Energy efficiency	• Higher productivity, with divorce choice of works, service facilities, and social contacts	• Flexible and affordable housing
• Reduce pressure on ecosystem		• Social, cultural and recreational possibilities

Source: Simon et al. (2020)

5. Elements of Compact Urban Form

The urban form is a spatial composition of repeating components that, based on parameters of urban compaction, may help cities in becoming more sustainable. The compact city elements include: (a) compactness; (b) sustainable transportation; (c) density; (d) mixed land uses; (e) diversity; and (g) greening. Jabareen (2006) identified the following four sustainable urban forms: (a) Neo-Traditional Development; (b) Urban Containment; (c) Compact City; and (d) Eco-

City. These four forms include one or more of the seven design elements. Although each of these urban forms makes a different contribution to the sustainability of cities, theoretically, compact cities appear to be more feasible for sustainable development.

a) Compactness: The advantages of compactness, as pinpointed by Burton (2002) are the conservation of the countryside, reduced need to travel by car and thereby reduction in fuel and pollution, support public transport, walking and cycling, better access to services, more efficient utility and infrastructure provision and recreation of urban areas. The compact city concept is linked with the term “Urban intensification” which means the range of processes that make an area more compact (Jenks *et al.*, 1996). Rural protection, which is likely the most well-known and famous counterpart in a compact city planning.

b) Sustainable Transport: According to Jordan *et al.* (1997), transportation services that consider the social and environmental costs, that balance the needs for mobility and safety with access to environmental quality and neighborhood livability can be termed as “Sustainable transportation”. In order to enable movement, shorten travel times and distances, improve efficiency and safeguard the environment, a multinodal transportation system is advised.

According to Newman and Kenworthy (1989), there is a significant negative correlation between urban density and transportation energy use (Jabareen, 2006).

c) Density: It is the proportion of population or housing to land area in which the idea of viable thresholds, also plays a role. The population of a particular region is enough and provides the interactions required to sustain specific urban function at particular densities Typically, density is a factor in sustainable cities (Carl, 2000). Positive effects of density is mentioned in Figure 2.

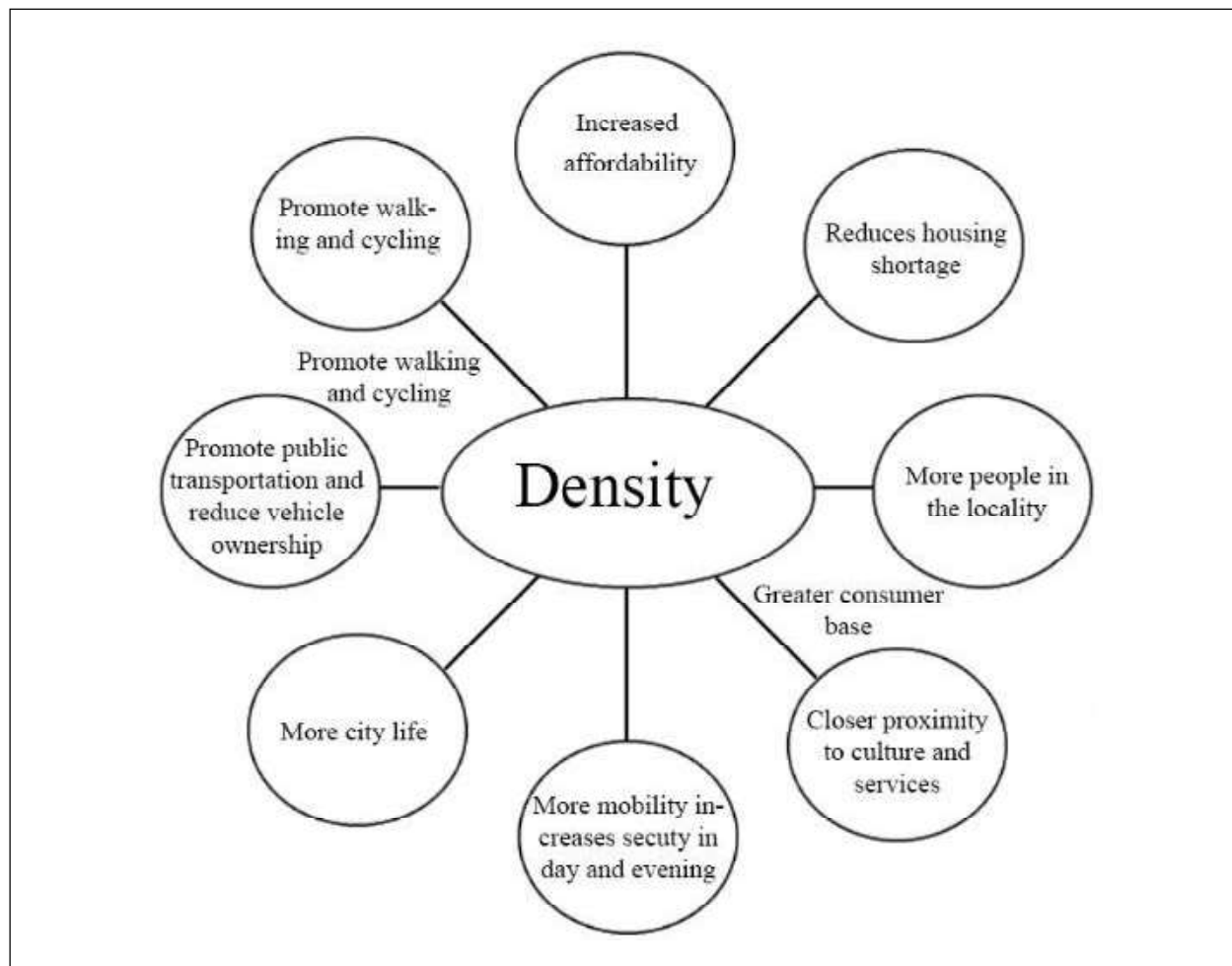


Figure 2: Positive Effects of Population Density

Source: Gothenburg City Council (2014)

d) Mixed Land Uses: It is a critical component, which is focused on the neighborhood having a variety of uses and locations, including institutional, residential, commercial, industrial and recreational strategies. According to Alberti (2000), the probability of using a car for commuting shopping and leisure trips can be reduced with the help of mixed land because jobs, shops, and leisure facilities are located nearby.

e) Diversity: Many planning approaches such as new urbanism, smart growth, and sustainable development have adopted the diversity dimension which was popularized by Jacobs (1961). According to her, people may use their cars for practically all their requirements and in dense diverse urban areas, people still walk which is impossible in suburbs and grey areas. “If development is not diversified, then uniformity of constructed forms frequently results in unappealing, repetitive urban landscapes, a shortage of housing for all income levels, class and racial segregation, and job-housing imbalances that contribute to increased transportation, congestion, and air pollution” (Wheeler, 2002).

f) Greening: According to Beatley’s (2000) opinion, a city is regarded to be green if it meets the following criteria. The first indulge in seeking to live within ecological boundaries. The next one is intended to function similarly to nature. The third one aims to achieve a circular rather than a linear metabolism. The next criteria is to promote more sustainable lifestyle. Lastly, it emphasizes a high-quality neighborhood and community life, improvement of urban image and quality of life. Eventually, Urban Greening aims to preserve and enhance the environment’s natural diversity.

6. Case Studies

Vancouver and Toyama were chosen as case study cities to learn about urban context and policy intervention in implementing the compact city concept.

6.1. Case Study I Vancouver, Canada

The Vancouver metropolitan region is a 2832 km² area situated in southwest British Columbia, Canada. It makes up 50% of British Columbia’s and 13% of Canada’s total population with a total population of nearly 2.4 million. Metro Vancouver is a metropolitan-level authority that is in charge of the area (Metro Vancouver, 2011a).

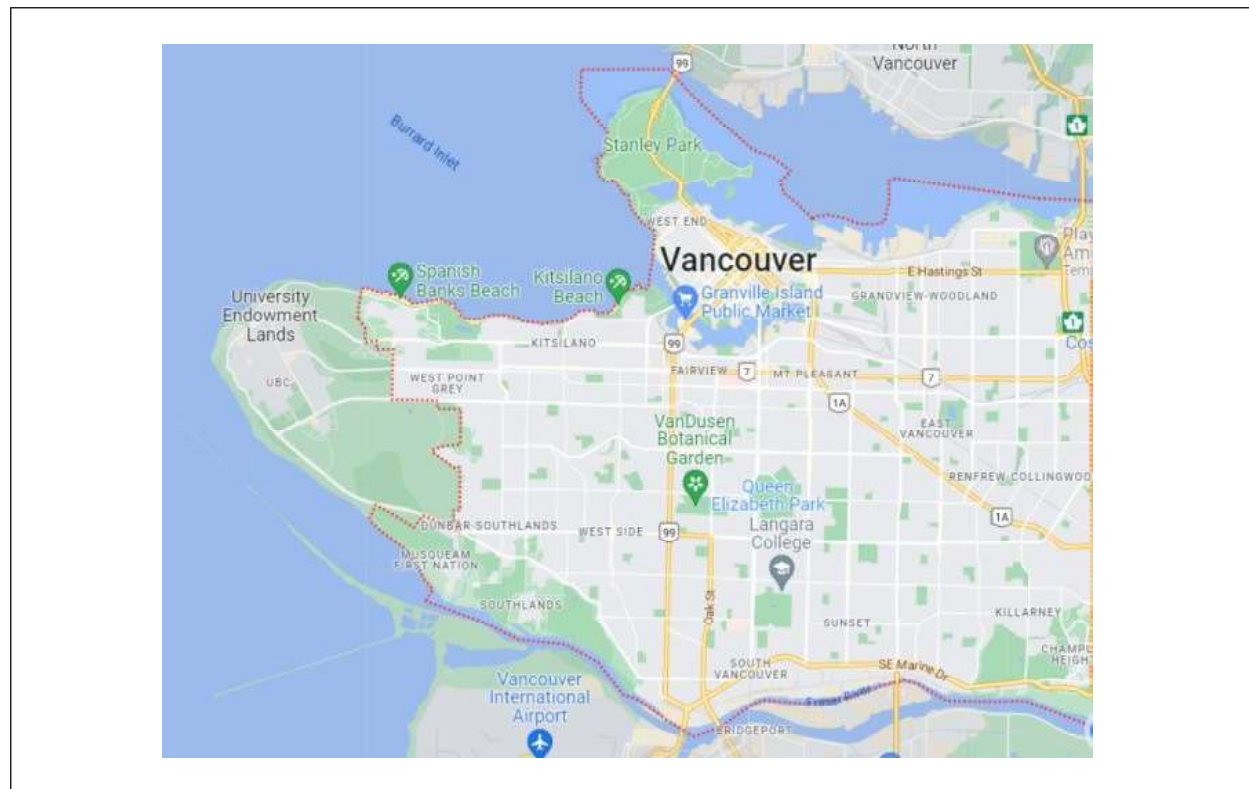


Figure 3: Metro Vancouver

Source: <http://thedirectory.org/cities/BC/bc-westendvan.htm>

Metro Vancouver adopted compact city regulations due to a number of issues. The first is for facilitating the population which will improve sustainability and livability. By 2041, the population of the region is projected to expand by more than 35,000 each year, reaching 3.4 million (Metro Vancouver, 2011b). Second, the development of sustainable transportation networks will become more important. To create healthy, compact, and well-rounded communities, the relationship between land use and transportation must be carefully considered (Metro Vancouver, 2011b). Economic sustainability is the third. The long-term economic viability of urban regions depends on compact growth. Finally, environmental sustainability is required. First, it is essential to safeguard the nation's and the world's natural resources for future generations. Second, it's important to plan for, mitigate, and minimize greenhouse gas emissions related to regional natural disasters including earthquakes, floods, and slope instability. Third, it's critical to preserve the more than 50,000 hectares of fertile agricultural land in the area that enable the production of locally grown, fresh foods (Metro Vancouver, 2011b). The policies they incorporated are as follows:

1) Resource Land Protection: The Province of British Columbia established the Agricultural Land Commission (ALC) in 1973 in order to protect agricultural property as a matter of provincial importance (OECD, 2012).

2) Land Use and Transit Linkages: Transportation service is offered every 15 minutes or more on routes with densities and land uses that encourage maximum passengers every day of the week, from dawn to evening. The Pedestrian Plan also suggested enhancing current facilities for pedestrians and establishing greenways and pedestrian connecting routes. Additionally, via the “four core Es” of engineering, education, enforcement and encouragement, the Bicycle Plan, validated in 1999, seeks to increase riding in Vancouver (OECD, 2012).

3) Densification, Housing Affordability and Quality of Life: Long-term attempts have been made in the Vancouver metropolitan region to create a compact city. Density policies in the city of Vancouver are as follows.

- a) *Secondary Suites:* Permitting a second housing unit along with the main residence is allowed in commercial zones, downtown residential districts, and generally in all new official development plans.
- b) *Basement Suites:* A single-family zoning option is introduced to allow basements to hold a second independent dwelling unit (Jacobs, 1961).
- c) *Laneway Housing:* Besides detached homes of 500 to 750 sq. ft in the conventional garage area of a single-family lot, facing the laneway and keeping backyard open space, supplementary suites are also allowed (OECD, 2012).
- d) *Energy and Emission Policies:* The province of British Columbia passed the Greenhouse Gas Reduction Targets Act, at the provincial level, which entrenched targets for reducing GHG emissions in British Columbia. A climate change plan that will apply to both internal corporate activities and the whole area is being created by the metropolis of Metro Vancouver (OECD, 2012).

6.2. Case Study II: Toyama, Japan

The Toyama metropolitan region is located in the center of the major Japanese island. On a 4 411 km² area, there are 417 322 people living there, making up almost 1.1 million people (as of March 31, 2010). 3000 Meters east of Tateyama Mountain Range; Toyama Bay, a treasure trove of marine life at a depth of 1,000 m, to the north. This area is rich in natural beauty (OECD, 2012).

They implement policies for compact cities as follows: (a) Citizens' mobility without access to a car: Because of population aging, there will be 1.2 times more people without access to a car in 2030. (b) The anticipated reduction in the efficacy and efficiency of public service delivery: It is anticipated that when population density declines, the per capita cost of maintenance and operation for urban amenities would rise. (c) Urban center decline: “doughnut phenomena” The loss of urban center appeal had a direct impact on the region's economic competitiveness, and the drop in land values in the city center had a negative impact on the municipal administration's budget (OECD, 2012).

The “Toyama compact city model” is Toyama's approach to spatial development. To improve the public transportation system by increasing mobility, concentrate city functions along the train and bus lines and in the city center finally, the inhabitants must be attracted to the target location. They enhance public transportation and encourage walking around stations or tram/bus stops to encourage migration. (a) There are six railway lines (including tram lines) and thirteen bus routes. (b) Two departures per hour during the day. The walking distance was set at 500

m for residence promotion areas, ten minutes for train stations, and three hundred meters for bus stops (a five-minute walk) (OECD, 2012).

The city’s density target and grant program: Toyama city has begun a long-term (about 20 years) municipal strategy to boost the number of residents in the home promotion areas.

(a) Bus routes have a population density of 40 people per hectare (the current density is 34). (b) The railways are 50 people per acre (the current density is 44). The city will increase the size of the districts for housing promotion from 2927 to 3489 hectares. The goal population density is to increase from 55.7 people per hectare in 2004 to 65 people per hectare in 2014 (City of Toyama, 2010).

7. Comparative Analysis

Vancouver and Toyama are the sustainable cities of the world, the following table comparatively analyzes the Policy and interventions for sustainable compact urban form in those cities.

Vancouver has established a regulatory development in several city zones as a result of the use of compact urban development tools. Toyama’s transit connections have improved, while spending on infrastructure has decreased substantially.

Parameter	Vancouver		Toyama	
	Issues	Policy	Issues	Policy
Compactness	Core degradation	Regional Growth within the boundary	Urban center decline	The city density target program
Sustainable Transportation	Increasing car dependency	TOD and Frequent transit measures	Increasing car dependency	LRT’s planning in Master for Toyama city
Density	Urban sprawl	Densification in the existing buildup areas (Laneway housing)	Population density decline	Toyama Compact city model
Mixed land use	Decline use of urban areas	Densification in the existing buildup areas with mixed development	Decline use of urban areas	Grant program for polycentric growth
Diversity	Lack of economic development	Incentive- based development in Master plan	Decrease in economic value in the city center	Incentive benefits Master for Toyama city
Greening	Agriculture land degradation	Resource land protection act (1973)	Agriculture land decline	-

8. Conclusion

Compelling arguments have been made linking urban planning with sustainability. The shape, size and density of a city can have an impact on how sustainable it is. In the long run, various goals are attained through sustainable urban forms. The most notable among them are reduced energy use, waste and pollution, automobile use, sensitive ecosystem preservation, and a liveable and community-focused human environment. It is probable that hurdles to achieve sustainable urban growth will be present. The lack of appropriate legislation can lead to overcrowding and environmental degradation. The institutional structure needs to meet the increased demand for compact and high-density areas.

Urban compaction can encourage sustainability by reducing travel and commute times, reducing reliance on automobiles, lowering per capita energy use, limiting the consumption of building and infrastructure materials, mitigating pollution, maintaining diversity in employment opportunities, service options, and social contacts, and limiting the loss of green and natural areas. In this research, six distinct parameters that is categorized according to their sustainable urban form in the development of compact cities. They are compactness, sustainable transportation, density, mixed land use, diversity, and greening. From the above-discussed case studies, it can be inferred that sustainable urban form is concerned with the study of compact cities and the practices and strategies

used to design and develop them. These practices and strategies emphasize promoting the resilience and viability of cities over the long term by decreasing material use, lowering energy consumption, mitigating pollution, minimizing waste, and improving social equity and well-being. The core concept of sustainable urbanism is the compact city.

According to academicians and planners, this idea offers several benefits for the environment, social and economic sustainability. Certain urban patterns seem to be more sustainable than others in terms of compact urban development. It also fosters a better environment and enhances the quality of life. Thus, urban compaction can lead to sustainability in the long run.

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