

# Critical appraisal of an example of best practice in urban sustainability

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**Abstract:** Urban centers are key to achieving the global goals of sustainability. Urban sustainability entails having thriving cities that fulfill their needs without impacting the long-term sustainability of the ecosystem. Achieving urban sustainability is, therefore, an important goal as sustainable urban centers portend numerous benefits to the ecosystem. This paper critically appraises Singapore as a best practice in Urban Sustainability. It reviews the literature on urban sustainability and discusses the high and low-performing sectors in Singapore. It finds a gap in contemporary urban sustainability metrics whereby most of the globally acclaimed Urban Sustainability Indicators do not measure universal design for inclusivity as an aspect of urban sustainability. This study, therefore, includes it as a measure and appraises it. High-performing areas highlighted in this study comprise education; universal design for inclusivity; transportation; people-centered approach; water and energy management; healthcare, safety and security; and food security. Areas for improvement comprise self-sufficiency in food production, urban heat island effect, and public participation and social welfare. The aim is to serve as a lesson to cities worldwide as they work towards achieving urban sustainability and provide key information to policymakers as they seek to improve the sustainability of their urban environment.

**Key words:** Urban sustainability, Urban Sustainability Indicators, sustainability, Singapore, Singapore Model

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## 1. INTRODUCTION

In the face of the rising climate and environmental crisis today, urban sustainability has emerged as a very important discourse. This is because urban centers are a major source of pollution that has contributed to the present-day climate and environmental crisis. Half of the global population currently live in urban areas with this number set to rise to 70% by 2050 [1]. Achieving overall global sustainability is, therefore, highly dependent on improving and achieving sustainability of the urban environment [2]. Urban sustainability entails having thriving cities that fulfill its need without impacting the long-term sustainability of the ecosystem. Many urban centers are striving to improve their sustainability while many others have also achieved remarkable improvements in urban sustainability. Notable among them are cities of previously underdeveloped countries like Singapore, the focus of this study, that is now a shining model of urban sustainability.

Singapore is a city-state with a population of 5.6 million people and a landmass of about 722 square kilometers currently (Figure 1), having increased its landmass from about 580 square kilometers at independence in 1965 through land reclamation efforts [3,4]. It was under British colonial occupation for 150 years [5]. Since its independence, it has witnessed a meteoric rise from being an underdeveloped third-world country to a first-world country. Today, Singapore is a gold standard in the sphere of urban

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development and sustainability [6–8], with a model that has become widely known as the ‘Singapore model’ [6].



**Figure 1.** Map of Singapore.

Source: Ontheworldmap.com

Even though some other places/cities have transformed over the years to emerge good examples of urban sustainability, for example, Seoul, Korea, which has also significantly improved its urban conditions and sustainability since its early days as an underdeveloped country in the 1960s [9,10]; Singapore stands out for reasons that will be discussed further in subsequent sections of this work. Also, Korea is not fully urbanized or metropolitan [11,12], like Singapore. Singapore’s status as a fully urbanized city-state, therefore, gives it more capital as a more holistic urban model which contributes to its selection for study in this work, especially in the urban sustainability discourse. In this study, what makes Singapore a model and the areas that need improvement are highlighted. This will serve as a lesson for urban areas seeking to improve sustainability. Highlighting the low-performing areas in Singapore also provides important information to other nations that can enable them to avoid similar issues in the long run and to Singapore as well.

The following sections of this paper discuss the concept of sustainability and urban sustainability which then segues into the section on Urban Sustainability Indicators. The research method and best example selection criteria follow where I discuss/justify the reasoning behind the selection of Singapore. The next section discusses the best practice example of urban sustainability, the strengths of the Singapore model are discussed, and then the weaknesses/areas of improvement. The role of governance and urban planning in Singapore’s success is discussed followed by the conclusion section that discusses the possibilities of the replicability of the Singapore model.

## 2. THE CONCEPT OF SUSTAINABILITY AND URBAN SUSTAINABILITY

Sustainability has emerged as an important discourse in the face of the many problems facing humanity. Even though it became a buzzing topic in the 70s [12], it is not a new concept. Indigenous cultures have always incorporated the tenets of sustainability in their ways of living and had a reverence for the earth treating it with much more respect than is done today [13,14]. There were norms practiced during hunting and agriculture to ensure stock remained for the next generations which is no longer the case today [15-17].

Development and unprecedented environmental pollution, which birthed the environmental movement of the 70s, brought more attention to environmental problems. While there are many definitions of sustainability [18], a common understanding is the need for the current generation to factor in the needs of the future generation in the consumption of resources for development and to protect and preserve the environment. Sustainability is a development goal with integrated social, economic, and environmental dimensions, which needs to be taken into account while meeting our current needs to ensure the ability of future generations to meet theirs is not compromised [19]. Humans face the growing challenge of managing the increased pressure on the environment on which they depend. Such pressures manifest in the form of pollution, resource depletion, mitigation, and adaptation to climate change, etc [20].

Urban sustainability is the concept of having vibrant cities that enhance the quality of life of residents while ensuring the availability of resources for future generations to fulfill their own needs [21]. It is the notion that a city can exist and be run with the least ecological footprint possible and the least impact on climate change. A sustainable city is characterized by compactness, dense mixed-use settlements that promote efficiency, greater innovation and production capacity, and minimal environmental impact [22-25]. In the literature, a sustainable city is characterized by healthy and secure urban space for people and nature to blossom, affordable housing, safety and security, good healthcare, education, jobs, use of clean energy, and a good public transportation system with dedicated cycling paths and active mobility. Well-being, reduced environmental impact, and protection of ecosystems are the hallmarks of a sustainable city. Environmental and physical assets are preserved for future generations while the city's competitiveness is enhanced in a sustainable city. Good local governance and management are practiced to execute urban duties and there is room for citizen participation [26]. While cities are an agglomeration of people and activities and use up a lot of resources, they also produce a significant amount of waste which impacts significantly on the wider urban environment. Opportunities abound for economies of scale and more efficient use of natural resources in cities, for instance, compact settlements use less energy than dispersed ones.

The design and management of cities is the key to achieving urban sustainability and there is a wide consensus among various stakeholders on urban sustainability being central to achieving sustainable development in general [23,27-30]. In this study, I carry out an appraisal of Singapore highlighting the high and low-performance areas to provide an analysis that other cities as well the study city can learn from to improve their urban environment. The overall goal is to contribute to the knowledge needed to achieve global sustainable development and sustainability.

## 3. URBAN SUSTAINABILITY INDICATORS

Urban Sustainability Indicators (USIs) are tools for measuring or ascertaining the sustainability ranking or rating, status, and conditions of an urban area using a mix of factors [31,32]. USIs help in conducting appraisals of cities and provide an overview of areas of strength and improvement. They aim to improve and advance sustainability [33]. As sustainable development anchors on three interconnected pillars- social, economic, and environmental, it is common practice to have sustainability indicators focusing on these three main aspects of sustainability [34,35].

There are currently numerous USIs developed by organizations, universities, countries, and researchers based on various frameworks, principles, categories, indicators, etc [36,37]. Among these sustainability indicators, there is no common agreement on what makes up a category, index, or theme [38]. As the general interpretations of sustainability differ, so also do the features which form the basis of

the design of the various sustainability indicator tools in use today [39]. There have been also arguments that no one knows exactly what sustainable settlements resemble and that only a few places have incorporated the environmental, social, and economic aspects of sustainability in their entire societal fabric [40]. While there are many schools of thought on sustainability and sustainable development, most notably from the beginning of the environmental movement of the 60s and 70s [41,42], the three bottom lines of sustainability comprising the social, economic, and environmental as outlined in the Brundtland [19] report, is the understanding of sustainability that has gained the most traction and acceptance in the mainstream [43].

In brief, there is no single blueprint or outline as to what constitutes indicators of urban sustainability, but there is a wider consensus that there are different pathways to attaining urban sustainability according to the needs and priorities of a community [44–47]. This then implies a uniform USI will be inadequate to apply across all places [40]. Besides, indicators as a set of tools are constantly evolving and what may be relevant today may no longer be relevant tomorrow. In this work, therefore, I focus on the various sectors indicators set out to measure as opposed to using a set of USI to appraise the selected best practice.

#### **4. RESEARCH METHOD AND BEST PRACTICE SELECTION CRITERIA**

This work is an in-depth review that purposefully adopts Singapore as its best practice of urban sustainability based on its consistent positive ranking in various sustainability indexes and studies over the years [48–50]. Singapore was chosen because of its spectacular and noteworthy achievements in its development as a country, and the urban environment. Singapore's selection is aimed to serve as a practical example and inspiration to other countries as a model of what is achievable in terms of growth and urban sustainability, and the numerous improvement possibilities and paths especially as Singapore was not too long ago classed as a third-world country. Today, it has become a fully developed nation. Both developing and developed countries are drawing lessons from Singapore to improve their urban environment including its former colonizer, Britain [51–54].

Dizdaroglu [37] surmises that factors that guide and determine a sustainable urban form comprise sustainable transportation; design; renewable energy and waste management; environmental restoration and protection; economic development; healthy urban planning; and social equity and environmental justice. Ahvenniemi, Huovila [35] studied, refined, and built upon Neirotti, De Marco [55]'s work where various USIs were studied to find out their main focus areas. They subsequently came up with the following as core aspects of sustainable cities: Built Environment; Natural Environment; Water and Waste Management; Energy; Transport; Economy; Well-being, Health and Safety; Education; ICT; Governance and Citizen Engagement. In this work, I further condense Ahvenniemi, Huovila [35]'s core areas of urban sustainability and come up with these core areas which I appraise: education, universal design for inclusivity, transportation, people-centered approach, water, and energy management, healthcare, safety, and security, food security, urban heat island effect, public participation, and social welfare. However, Rebernik, Szajczyk [56] note that despite the myriad of urban sustainability indicators in use today, there are still gaps as measures for inclusion are missing. This key gap was observed and affirmed in this work after a review of 14 USIs where none measured or focused on Universal Design for Inclusivity (see appendix 1). Therefore, it is included as one of the aspects of urban sustainability appraised in this study of a best practice of urban sustainability.

Universal Design refers to the design of spaces and products that facilitate use by everyone to the fullest extent possible [57]. Universal design is aimed at fostering inclusivity. It entails factoring in the different needs of citizens in the design of the city, understanding different accessibility needs and challenges, and ensuring that there are space and opportunities for everyone to blossom, contribute to the city and achieve their potential. It is not just about designing for people living with disabilities [58,59], even as an estimated 15% of the global population live with a disability [60,61]. Incorporating Universal design enhances accessibility and is a practical affirmation that everyone belongs in the city. Accessibility is not limited to physical objects and promotes social participation in the city [62]. It is important to note that even people with no disabilities will have varying abilities as the years pass, therefore, universal

design is for the benefit of everyone [63]. The adoption of various USIs and growing attention to social sustainability is evidence of efforts in recent years to make the city more inclusive, but the lack of attention to Universal design in USIs indicates a shortcoming. Governance is viewed in this work, not as an index/sector but as the fabric that weaves together the different sectors and the most important enabling factor for urban sustainability.

## **5. BEST PRACTICE EXAMPLE OF URBAN SUSTAINABILITY**

Addressing urban sustainability has become a global concern because of the need to support the rising global population while providing a safe, clean, and environmentally sustainable place for life to function [64]. In urban planning and economic development circles, a term known as the 'Singapore model' has emerged which is characterized by the efficient deployment of resources to achieve excellence, growth, and sustainability [6]. Singapore is a nation carefully planned from its birth for long-term sustainability with the understanding that how well a city and the living environment are planned and designed matters [65]. Sustainability was at the core of the country's design far back in the 1960s even before sustainability became a global concern [66]. Singapore just like other countries face urban challenges, but it has succeeded in turning these problems into opportunities and becoming a model of urban sustainability [67]. In this paper, the use of the term 'Singapore model' will refer to its relevance in urban planning and sustainability only.

### **5.1. Strengths of the Singapore model**

All the hallmarks of what makes a sustainable place are present in the Singapore model [68]. Singapore as a model of urban sustainability has a lot of strengths but for this paper, we will be focusing on the key areas of education; universal design for inclusivity; transportation; people-centered approach; water and energy management; healthcare, safety and security; food security; urban heat island effect; public participation and social welfare.

#### **5.1.1. Education**

Singapore understands the centrality of education to its long-term sustainability and has backed this belief by concrete actions. It has a robust compulsory public education system in place with a high literacy rate of 97% [69,70]. The government aimed to have the best and brightest citizens and has invested substantially and intensively in the education sector over the years knowing that its lack of endowment in natural resources can be overcome by innovative citizens [71,72]. Education (both formal and informal) is key to teaching and ensuring sustainability and plays an important role in producing environmentally aware future generations. Sustainability and climate change education forms part of the school curriculum [73]. Singapore ranks among the global best performers in educational excellence and has had consistent high performance in examinations like Programme for International Student Assessment (PISA) over the years [74,75]. This excellence has been attributed to good school leadership, teacher quality, educational reforms, and system attributes [74,76]. Students at all levels are actively encouraged to participate in various forms of research which ingrains in them the spirit of citizen science, for example, the National Science Experiment, a joint initiative by the Ministry of Education, Science Centre Singapore, and National Research Foundation of Singapore was a research initiative in citizen science that involved students at all educational levels. Students designed experiments on sustainable urban features using wearable Internet of Things (IoT) devices that collected climate and environmental data to inform and improve spheres of urban living including physical activity and carbon emissions and transportation modes [77].

#### **5.1.2. Universal Design for Inclusivity**

At the core of the universal design is the understanding that there are special needs and generic needs, and this is factored in while designing and building to foster inclusiveness [78]. Residential town planning takes into account the architecture, physical layout, accessibility of public places like hospitals, schools, shops, parks, offices, etc. Since 2006, Singapore's built environment has been complying with the universal design and accessibility code which ensures accessibility for everyone. Even though buildings

constructed before 1990 are not bound by this code, the government has sought to make every building accessible through active consultations, engagements, and incentives of up to 80% of upgrade costs are offered to homeowners to ensure every house meets up to this standard enhancing accessibility for all [54]. Smart technologies that encourage community access for the aged and people with disabilities are widely deployed in Singapore. For example, the Green Man+ initiative enables the companion of the old or people with disabilities to tap a concession card on a reader that gives them more time to cross the road at crosswalks [79]. Housing is affordable and available for all ranging from high-rise buildings to private properties and up to 80% of the population live in public housing. Public satisfaction with housing has remained high over the years at 90% [78]. Singapore understands that by 2050, the majority of its population will age and has factored that into physical planning to ensure the needs of everyone are met. Building code reviews and standards aimed at establishing suitable homes for all Singaporeans to thrive and age successfully while maintaining independence have been effected and backed by relevant legal instruments and policies [78]. Singapore's moniker is 'city in a garden'. There is ubiquitous lush greenery which can be found from rooftops to the streetscape to parks within 400 m of most homes. Parks are designed to enhance leisure and to be visually appealing. It is no gainsaying that efforts have been made to ensure the city is truly inclusive.

### 5.1.3. Transportation

The transportation sector is a big source of pollution emission that impacts urban sustainability. Achieving urban sustainability and improving liveability depends largely on an efficient public transportation system [80]. Singapore promotes public transport as the most effective and environmentally-friendly way to get around. It is a pioneer in integrated sustainable transport policy and a leader in mobility management [72].

Technology has been effectively deployed to solve traffic problems and provide travel information in real-time. Integrated land use and transportation planning with effective policies as well as a constant improvement over the years, ensured this good transport system. Bike-sharing services which are a zero-carbon means of transport are prevalent in Singapore [81]. Walking is also actively encouraged with its attendant positive environmental and health benefits [82]. Residents are favorably disposed towards active mobility and report satisfaction with the walking infrastructure in place [83]. Homes and amenities are built around major transport hubs to facilitate easier access without needing cars. It was expected by 2020 that the number of rail lines will double to maintain efficiency and cater to the increasing population as well as an increased number of public transit users [84]. As part of efforts to reduce congestion from the traffic flowing in and out of the city center which also has an environmental impact, regional centers were introduced to bring jobs closer to home. Effective Government policies have reduced car dependency, encouraged public transportation, and reduced traffic congestion [85]. Globally, Singapore perhaps has the most technologically sophisticated and comprehensive urban Electronic Road Pricing system which is set to be replaced soon by an even more advanced satellite-based system which will make them one of the first countries to roll out the technology [86,87]. Singapore remains a pioneer in adopting new and innovative technologies to explore new frontiers in the transportation sector.

### 5.1.4. People-centered approach and conservation

To Singapore, sustainable development is not just about preserving the environment or building infrastructure. It is about putting the community first in every developmental decision, building a close-knit community, preserving a unique identity and local character by preserving and conserving the heritage. Citizen participation is enhanced by incorporating big data in urban design where the citizens willingly contribute to the data [77]. The country's ongoing 'Smart Nation' initiative' is people-centric as its success is dependent on citizen participation and also provides another chance for participatory and bottom-up governance [88].

Despite having lost up to 90% of its natural cover, Singapore is committed to biodiversity conservation and has several initiatives, for example, the Singapore Green Plan among others to conserve and sustain what is left of its natural landscape. Laws like the National Parks Act and Park and Trees Act protect nature reserves with the National Parks Board charged with management [50,89,90]. There are

protected nature reserves to conserve tropical rainforests and coastal mangroves despite the desperate need for land. Because Singapore's rapid growth and development mostly occurred at the detriment of natural habitats and loss of important historical buildings [4,91], conservation has been intensified and efforts like the Singapore conservation program have preserved at least 7,000 structures and buildings to date. Planners have often found creative ways of ensuring the viability and relevance of old buildings which is not an easy task with the people involved at every stage. The conservation efforts were not always the case as land was deemed more critical for development than conservation [92]. The shift in position is also a lesson on how unfavorable or poor situations can change in the face of evidence that says otherwise.

#### 5.1.5. Water and Energy Management

Singapore's population to landmass ratio and limited natural water sources makes it a water-stressed country but yet, its water and wastewater management is one of the global best practices [93]. 30% of the country's water demand is met through the recycling of water. Today, it is a pioneer hydro hub, a status built off the success of its NEWater program [94]. The Active, Beautiful, Clean (ABC) Waters program launched in 2006 integrates reservoirs and waterways with the neighboring environment achieving multi-purposes of aesthetics, water quality improvement, and runoff management [95]. Rainwater is collected and stored because freshwater is a scarce resource. Water is recycled and seawater desalinated to provide for water needs. There is 100% recycling of water and wide public acceptance of reclaimed drinking water as well as positive household water conservation attitudes [96]. The country understands its vulnerability to the impact of climate change and has set out plans to improve water conservation, energy intensity, and recycling [97]. It has pledged to reduce greenhouse emissions by 16% by 2020. There are also measures to enhance drainage networks, promote resilience of the water supply system, coastal and natural biodiversity preservation. In its early days in far back 1979, building regulations were enacted to control external heat gain of air-conditioned buildings and regulate the overall thermal transfer value of new constructions. Existing buildings that do not meet the regulated values were surcharged but expenses incurred during retrofitting could be written off in taxes [98]. The country is very keen on using less carbon-intensive fossil fuels and improving energy efficiency. The government is also implementing a range of policies to achieve energy independence. Energy use is not subsidized and fuel and electricity prices are regulated by market forces. Stiff penalties apply for inefficient or excessive use of energy [99]. Singapore sees itself as a living lab and does not shy away from constantly seeking new ways to solve its problems.

#### 5.1.6. Healthcare, Safety, and Security

Singapore ranked second in the 2017 and 2019 safe cities index [100,101]. The report studied the areas of health security, personal safety, digital security, and infrastructure safety. It ranked highest in personal safety which looked at how safe people are from violence and theft. However, there is still room for improvement in the area of safety and quality of the public environment as noted by Stauskis [102]. It also ranked first in the quality of its healthcare and accessibility for all. Digital technologies are infused in many aspects of life in Singapore with residents embracing digital technologies without fear of identity theft or privacy violations because of the security measures in place. The government adopts a holistic and proactive stance to cybersecurity, regularly reviewing and improving measures to improve the resiliency of the smart technologies in use [103]. Singapore has an excellent healthcare system that has been feted as the best in the world both in terms of service delivery and outcomes [104].

However, concerns over rising costs in recent years have led to new measures by the government geared at reducing individual out-of-pocket expenses, expanding coverage, and providing advice on necessary tests and procedures [104,105]. There is a high life expectancy of 83 years and low infant mortality of 2.4 per 1000 live births [106]. Singapore has a robust mix of public and private healthcare systems whereby private physicians handle up to 80% of primary care and 80% of in-patient care is provided by public hospitals which provide subsidized care [107]. Singapore understood the looming challenge posed by its aging population and put in place the 2020 healthcare Master Plan to improve all aspects of healthcare for its population [106]. Guidelines for healthcare professionals in line with the

latest clinical guidelines are provided and regularly updated on the Ministry of Health's website [106]. The health financing scheme is run efficiently with contributions from both the public and private healthcare sectors enabling excellent outcomes [104]. Tele-health services have further reduced the cost of healthcare promoting accessibility for all. Healthcare, safety, and security are areas Singapore performs excellently in.

#### 5.1.7. Food Security

Even though Singapore imports about 90% of its food, it is ranked very highly in the global food security index because it has succeeded in using policies to become a food secure nation by making its food supply system robust [108]. Its strategies like the diversification of supply sources, the food fund, and enhancing food imports have earned it this top spot. However, it understands that its dependence on external sources is subject to forces it has no control over and is intensifying its urban food growing program to achieve self-reliance in food production [109]. To shore up food security, it has some international food production initiatives that allow for portions of produce to be shipped back to Singapore like the Jilin province China agri-food project [110]. A focus on technology-enabled, small-spaced urban farming supplies 10% of its food needs today with a plan to improve self-sufficiency to 30% by 2030 through its 'Singapore Food Story' program [111].

## 6. WEAKNESSES OF THE SINGAPORE MODEL

Despite the Singapore model's strengths, achievements, excellence, and high quality of life, there are still areas for improvement for more sustainable urban living and outcomes. These areas of weakness and improvement are discussed below.

### 6.1. Self-Sufficiency in Food Production/Food Security

Despite Singapore's high ranking in food security, a weakness exists because it is not yet self-sufficient in food production. The country's small landmass of 722 square kilometers with only about 600 hectares available for agriculture makes it hard to produce enough food to feed its people. 90% of food is imported from over 170 countries. Such dependence on foreign sources impacts its resiliency making it vulnerable in the key area of food security and raises sustainability concerns [112,113]. Global events further expose cracks in the system, for example, the post-2007 global food crisis and the Covid 19 pandemic [111,112,114]. To mitigate this problem of food production, urban farming is becoming more intensive with roof-top gardening taking off on bigger scales and agrotechnology parks being established to boost local food supply. Singapore's urbanization has also had opportunity costs that manifest in food production capacity decline. For instance, in 1965, farmlands occupied 25% of land resulting in partial self-sufficiency in food production but by 2014, farmlands made up only 1% of land due to urbanization [114]. Despite Singapore's commitment and deployment of innovative methods like vertical farming, insect farming, meat cultivation, etc, challenges still abound and widespread deployment and acceptance are yet to be achieved [114]. The success and long-term sustainability of these innovations are yet to be ascertained given the novelty of these technologies.

### 6.2. Urban Heat Island Effect

Urban Heat Island (UHI) is a phenomenon whereby built-up high-density urban areas have higher temperatures than surrounding less urbanized areas [115]. Due to Singapore's limited land size, arguments could be made that the city had no choice but to expand/grow upwards. It currently has the least intact original forest area in comparison to its neighboring countries [115]. Being a tropical country with a very dense urban form, the effects of climate change has led to an increased UHI effect [116]. UHI negatively impacts liveability and poses health concerns like heat stroke, cardiovascular stress, etc. More energy is consumed to maintain ambient temperature with attendant feedback climate impacts [116]. The temperature is set to rise more in the coming years as a result of climate change. This necessitates strong mitigation efforts. While the green roofs widely used in Singapore are helping to mitigate UHI impacts and



research endeavours like the 'cooling Singapore' is on-going, more work and action is still deemed necessary.

### **6.3. Public Participation and Social Welfare**

Numerous studies have critiqued Singapore's mostly top-down management style [50], and labeled it semi-authoritarian [117]. There are also critiques of insufficient public engagement but a gradual change has been observed as the public is now more involved in issues like Environmental Impact Assessments where there is a window of 20 working days to make contributions [4]. Despite the general high satisfaction rate of the citizenry towards governance and high happiness levels and quality of life [118,119], a case could be made for a more participative and inclusive planning process as this has proven to yield even more satisfaction. The public expectation for more inclusive participation in governance is also on the rise [120]. There is a need to pay more attention in this area as urban sustainability also entails having engaged citizens. There are still pockets of poverty and inequality has risen [121-123]. The welfare system is not able to sufficiently meet the basic needs of the poor who still battle with feeding and getting adequate healthcare [124,125]. These gaps in the welfare system need to be addressed.

## **7. GOVERNANCE, THE BINDING AND SUCCESS FACTOR**

Innovative and progressive urban planning and governance were wholly integral to the emergence of Singapore as a best practice of sustainability. The Urban Redevelopment Authority (URA) is the central body in charge of planning. It is a government institution that is 100% funded by the government. Their work is built on the foundations of integrated master planning and development. Integrated planning in Singapore entails planning for the very long term, at times as far as a century into the future while building in scalability. Concept Plans and Master Plans guide Singapore's urban planning. The in-built scalability ensures that the plans can be reviewed as needed because change is a constant. From the early days of the country's growth, these plans have been systematically reviewed to meet the changing needs while maintaining a balance between economic and social development (51). The government invests substantially to improve its urban form [126]. Planners in Singapore have almost total power to shape their urban development (6). They see their role as not just building a sustainable and functional urban environment but as bringing citizens together in time and space via urban redevelopment, smart city, and heritage [127]. There are ongoing plans to integrate within a few years, new Virtual Reality and Augmented Reality technologies like HoloLens in urban design and planning [77].

Good leadership is central to implementing urban planning policies and Singapore's leaders have proven dedicated and resolved to build on the legacy of their pioneers who built green Singapore and see it as their duty to ensure sustainability [128]. Planning policies and instruments are deployed as a tool to cater to the needs of the citizenry and foster integration among its different ethnic groups while strengthening the state's political legitimacy [129]. Singapore employs four sets of instruments in its planning: Planning controls, regulatory measures, public participation and awareness, and economic instruments [130]. Stringent regulations guide the management and protection of the city's environment. There are laws covering subjects ranging from clean air to livestock management and strict fines and monitoring to enforce these regulations which ensure compliance. The planning controls are laid out in the concept plan which covers spatial and environmental goals. Public awareness and participation are shaped through the education system, special campaigns, and the 'clean and green week'. There are channels to engage all sectors of the community in consultations on planning issues. The economic tools employed in environmental management include licensing fees especially to limit city traffic, user fees charged for wastewater treatment and collection, fiscal measures like lower prices for unleaded fuel to encourage its use and use of other cleaner technologies, and auction fees [130]. Good governance is thus the strongest factor that ensured Singapore's success as an urban model.

## **8. CONCLUSION**

This work appraised Singapore, the chosen model for urban sustainability, to provide an insight into urban sustainability. Singapore is viewed as a good model as it satisfies most of the criteria assessed by

urban sustainability indicators. As there are many USIs developed by different organizations, countries, and researchers based on different frameworks, principles, and indicators, etc., there is no common agreement on what makes up a category, index, or theme. Indicators as a set of tools are constantly evolving and in this paper, the focus is on the various sectors indicators set out to measure as opposed to using a set of USI to appraise the selected best practice.

There is a gap in the majority of the USIs in use today whereby the universal design for inclusivity is not measured and thus, which this work fills by including and appraising it as a sustainability indicator in this study. Universal design needs to be recognized as a key USI if it is to be believed that the city is indeed, a place for all. It is key to emphasize that the selection of Singapore as a best practice in urban sustainability does not imply it is a utopia or perfect by any means but we focus on urban sustainability, as an aspect where it is a strong performer. Its favorable appraisal in a particular sector does not also imply perfection, for example, in the area of universal design which is appraised positively in this work.

Singapore's excellence is acknowledged and imported by many other cities and countries in both the developed and developing world. The city-state is also constantly seeking to improve its urban environment in line with the tenets of sustainability. When a good understanding of the concept of sustainability forms the backbone of planning, cities will be a step closer to achieving sustainability. Sustainability pervades all aspects of living and cuts across sectors like healthcare, transportation, inclusivity, universal design, food security, ecological footprint to mention but a few. The Singapore example can be replicated by incorporating the main indices of sustainability into the planning framework of a city just like Singapore did. Singapore's success story can be studied and analyzed as a framework that can be tailored to suit other environments. The gaps and weaknesses identified in this study could also guide Singapore in the improvement of its urban form. Critical appraisals of this nature contribute to knowledge and provide important lessons for other countries to learn from.

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## Appendix

**Table 1.** List of Urban Sustainability Indicators Reviewed

S/N	Urban Sustainability Indicator	Developed By
1	China Urban Sustainability Index	China
2	City Blueprint	Waternet Amsterdam; KWR Water Cycle Research Institute
3	Urban Environment and Social Inclusion Index(UESI)	Yale-Data Driven
4	Urban Ecosystem Europe-Informed Cities	International Council for Local Environmental Initiative(ICLEI) Ambiente Italia
5	Urban Audit City Statistics	Eurostat
6	Urban Sustainability Indicators	European Foundation for the Improvement of Living and Working Conditions
7	Reference Framework For Sustainable Cities	RFSC
8	Star Community Rating System	Sustainable Tools For Assessing and Rating Communities
9	Indicators For Sustainability	Sustainable Cities International
10	Global City Indicators Programme	Global City Indicators Facility
11	European Green Leaf Award	European Union
12	European Green city Tool	European Union
13	EEA Urban Metabolism Framework	European Environmental Agency
14	European Green City Index	Economist Intelligence Unit; Siemens

