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[1] PU = Public,
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Versions

TABLE 0-1: CONTRIBUTIONS & VERSIONS OF THE DELIVERABLE

Version	Person(s)	Partner(s)	Date
V0.1	Emin Selahattin UMDU, Nurdan YILDIRIM, Ebru ALAKAVUK, Duygu ÇINAR UMDU, Arif HEPBAŞLI, Levent BİLİR, Emrah BIYIK	YAŞAR	**February 2024**
VO.2	Duygu ÇINAR UMDU	YAŞAR	**July 2025**

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List of Acronyms

$\bar{X}$	Average
BREEAM	BRE Environmental Assessment Method
BRE	Building Research Establishment
CO_2	Carbon dioxide
°C	Celcius
COP	Climate Change Conference
EC	European Commission
EU	European Union
LCA	Life cycle assessment
N	Number of samples
σ	Standard deviation
SDG	Sustainable Development Goals
SECAP	Sustainable Energy and Climate Action Plan
UN	United Nations
UGS	Urban green space

1. Introduction

City and urbanization have been researched since ancient times. In particular, the discourse of a greener city began to be used between the First and Second World Wars and after the war.[2] Policies aimed at healing the trauma experienced by cities and correcting their negative elements will improve them.[3]

Over time, these improvements became necessary to address not only the effects of war but also different environmental, economic, administrative, and social urban ills. Some of the most decisive of these disturbances today are global warming, climate, energy, and environmental crises. Many other crises can be seen as the results of these crises.[4]

For nearly half a century, global warming, climate change, environmental pollution, and sustainability have been key topics for political, economic, and social leaders. The discussion of environmental issues began in Stockholm in 1972, and the Brundtland Report in 1987 highlighted the significance of sustainability and the scale of the problem. This report emphasized that environmental problems are both regional and global. Following the Rio Agenda 21 in 1992, eco-labels and certification systems have become an integral part of our lives, encouraging third-party involvement in sustainability research and studies by producers and consumers alike.[5,6]

The Kyoto Protocol 2005 established measures to reduce greenhouse gas emissions, while the Paris Agreement of 2015 called for a concerted effort to halt climate change and global warming. The agreement aims to develop strategies limiting global warming to below 2°C or even 1.5°C as part of a collective commitment to environmental action among the signatory states.[7,8]

Various global events and conferences have addressed environmental issues and climate change. These include the United Nations Framework Convention on Climate Change in 1988, the United Nations International Conference on Population and Development in Cairo in 1995,

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[2] Pınarcıoğlu, N. Ş., & Kanbak, A. (2020). Sürdürülebilir Kent Modelleri. London: IJOPEC Publication. ISBN: 9781913809164
[3] Woodbury, C. (1953). The Future of Cities and Urban Redevelopment, Chicago: University of Chicago Press.
[4] Çınar Umdu, D. (2024). An Assessment Model Proposal For Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University
[5] Umdu, D. Ç. & Alakavuk, E. (2020). Avrupa Birliği'nin Sürdürülebilirlik, Enerji Verimliliği ve Akıllı Şehirlere Bakış Açısı In Haner S. (Ed) Mühendislik ve Mimarlik Arastırmaları Teori Uygulama Ve Yeni Yaklaşımlar (pp: 3-30). Ankara: İKSAD. ISBN: 9786257139472
[6] Öztürk S, Tanrısever Yiğit C, Cinar Umdu, D. (2017). Certificates and eco-labels in the context of sustainable tourism, 1st International Sustainable Tourism Congress, November 23-25, 2017, Kastamonu-Turkey, 366-373
[7] Türkeş, M. (2006). Küresel iklimin geleceği ve Kyoto Protokolü. Jeopolitik, 29, 99-107.
[8] Rogelj, J., Den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., ... & Meinshausen, M. (2016). Paris Agreement climate proposals need a boost to keep warming well below 2 C. Nature, 534(7609), 631-639. https://doi.org/10.1038/nature18307

Habitat II in Istanbul in 1996, the Rio+5 Forum in 1997, and the World Sustainable Development Conference in Johannesburg in 2002. Social, political, and economic authorities have studied and discussed sustainable development, smart growth, climate change, and energy efficiency since the 1970s.[9]

Due to their comparable structures, cities worldwide face comparable challenges. These challenges encompass environmental, economic, social, and administrative crises and imbalances, including issues such as emissions, global warming, energy efficiency, drought, overpopulation, pandemics, terrorism, migration, crime, poverty, hunger, famine, resource crises, extinction, and a range of other disasters. Cities must have comprehensive plans to address these issues and ensure the safety and well-being of their residents.[10]

In 2015, the United Nations introduced the Sustainable Development Goals (SDG), comprising 17 primary targets by 2030, as outlined in the Paris Agreement. The SDG aims to improve the quality of life for people worldwide while addressing environmental concerns. While progress has been made towards these goals, 2020 marked a critical turning point in this mission. The United Nations member states' more stringent research will determine the world population's quality of life and environmental concerns in the next decade. SDG 11 outlines the steps for sustainable urban design and encourages social, economic, and political authorities to prioritize urban development. Moreover, smart city indexes, sustainable neighbourhoods, and global city certifications and standards emphasize the growing importance of urban sustainability and smartness.[9]

The EU established The Implementation Working Group in 2018 to develop sustainable, climate-friendly urban areas. The group focuses on creating positive energy districts and neighbourhoods to achieve this goal.[11] Europe has been working towards becoming a climate-neutral, self-sufficient, energy-efficient, and green continent since 2010. The European Green Deal in December 2019 and the European Climate Law in March 2020 have further advanced the mission for sustainable and smart urban spaces.[12] They began supporting climate-friendly

[9] Çınar Umdu, D. (2024). An Assessment Model Proposal For Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University

[10] Moir, E., Moonen, T. & Clark, G. (2014). The future of cities: What is the global agenda?, UKGovernment Office of Science. Retrieved September 06, 2021, from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/429125/future-cities-global-agenda.pdf

[11] EU [European Union]. (2018). SET-Plan ACTION n°3.2 Implementation Plan Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts Retrieved May 8, 2023, from https://setis.ec.europa.eu/system/files/2021-04/setplan_smartcities_implementationplan.pdf

[12] Umdu, D. Ç. & Alakavuk, E. (2020). Avrupa Birliği'nin Sürdürülebilirlik, Enerji Verimliliği ve Akıllı Şehirlere Bakış Açısı In Haner S. (Ed) Mühendislik ve Mimarlik Arastırmaları Teori Uygulama Ve Yeni Yaklaşımlar (pp: 3-30). Ankara: İKSAD. ISBN: 9786257139472

city processes of 112 municipalities selected from the EU and Associated countries in 2022 as part of their mission to establish 100 Climate-neutral and Smart Cities.[13]

[13] Garcia, R. (2022, April 30). The 100 climate-neutral and smart cities by 2030. Eurocities. Retrieved December 29, 2022, from https://eurocities.eu/latest/the-100-climate-neutral-and-smart-cities-by-2030/

2. Methodology

This research project had three primary steps. First, a comprehensive literature review examined existing studies and assessment tools related to sustainable urban development and cities worldwide.

Secondly, a comparative analysis and grounded theory approach were utilized to identify the crucial criteria for sustainable cities. The standards, guidelines, and models, known as third-party authorities' eco-labels, were meticulously analysed. This study's overarching goal is to achieve the criteria necessary for creating sustainable urban concepts in contrast to the usual criteria for the smart city concept.

Lastly, a set of Sustainable City Assessments and Indicators were developed to align with the identified criteria.

3. Sustainability in Urban Areas

Understanding sustainable cities' origins, timelines, and evolution processes is essential. Eco-city, green city, sustainable city, sustainable community, sustainable neighbourhood. Many of these terms are used in today's sustainable urban development process.[14]

Urbanization is defined as the beginning of the first civilization. Humanity's transition to agriculture by leaving hunting and gathering paved the way for urbanization. The first urban areas were selected based on fertile soil and promising natural and environmental conditions. With the Industrial Revolution in the 19th century, the perspective of urbanization changed, and industrialization became the key to urbanization.[15]

Urbanization refers to people's social and economic adoption of the city and its integration. It is integrating a population group by leaving the rural areas and coming to a settlement where they can start an organized social and economic life.[16]

The goal of sustainable development is to live in a socially, economically, and environmentally balanced way by preserving resources for future generations. The concept of sustainable development impacted urban design, Thus birthing the concepts of sustainable cities and development[19].

[14] Umdu, D. Ç., & Alakavuk, E. (2022). Sustainable communities, neighborhoods, cities and their criteria. The European Journal of Research and Development, 2(2), 287-300. https://doi.org/10.56038/ejrnd.v2i2.66
[15] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University
[16] Es, M. & Ateş, H. (2010). Kent Yönetimi, Kentlileşme ve Göç: Sorunlar ve Çözüm Önerileri Journal of Social Policy Conferences, 0 (48), 205-248. Retrieved May 21, 2022, from https://dergipark.org.tr/en/pub/iusskd/issue/890/9892

4. Evolution of the Assessment Tools

In 1992, Agenda 21 (Rio Declaration) highlighted the importance of voluntary involvement from authorities, producers, consumers, and third parties in sustainability research to solve these problems. This led to the global adoption of eco-labels and certification systems.[17] However, eco-label studies date back 15 years before Agenda 21, with Germany's Blue Angel being the first eco-label scheme, followed by Canada's Environmental Choice in 1988.[18] Eco-labels provide guidelines to promote sustainability and higher standards in specific products, industries, geography, or topics.[19]

National or international award programs, certificates, models, or guides that provide environmental and social footprint information to the public throughout a product's lifecycle, including its in-use performance and post-use disposal or reuse, are available to consumers.[20] The BRE Environmental Assessment Method (BREEAM), developed by the British BRE Building Research Establishment (BRE) in 1990, is the pioneer for all sustainable building certifications and is considered one of the leading eco-labels globally.[21]

Building eco-labels led to the creation of sustainable neighbourhood assessment tools, which led to the development of sustainable urban assessment models.

[17] Umdu, D. Ç. & Alakavuk, E. (2020). Avrupa Birliği'nin Sürdürülebilirlik, Enerji Verimliliği ve Akıllı Şehirlere Bakış Açısı In Haner S. (Ed) Mühendislik ve Mimarlik Arastırmaları Teori Uygulama Ve Yeni Yaklaşımlar (pp: 3-30). Ankara: İKSAD. ISBN: 9786257139472

[18] Phillips, C., & Valenzuela, J. (1996). Consumer Labeling Initiative. Retrieved from https://www.researchgate.net/publication/237609050_Consumer_Labeling_Initiative/citations

[19] DEFRA [Department for Environment Food & Rural Affairs] (2007). News releases: 2005 UK climate change sustainable development indicator and greenhouse gas emissions final figures. Retrieved May 13, 2007 from http://www.defra.gov.uk/news/2007/070131a.htm

[20] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University

[21] Reed, R., Bilos A., Wilkinson, S. J. & Schulte K, (2009). An international comparison of international sustainable building tools, ERES, 331, 1-6.

5. What is Sustainable City?

The contemporary world is characterized by its rapid pace, environmental pollution, rising temperatures, technological dependence, and the proliferation of cities. According to Ritchie and Roser's (2018) research, over half of the global population is concentrated in urban areas.[22] This figure is significantly higher in Europe, with urban residents accounting for approximately 75% of the population.[23] Projections suggest that by 2050, nearly two-thirds of the world's population will reside in cities, comprising around 66%.[24]

Despite encompassing less than 2% of the earth's surface, urban areas are a major contributor to environmental pollution and climate change. Cities consume over 65% of the world's energy[25] and generate 60% of global greenhouse gas emissions.[26]

According to research by Umdu and Alakavuk (2022),[27] global issues have a widespread impact. In the 1970s, the Sustainable Development paradigm was introduced to tackle various challenges and continued to evolve in the 20th and 21st centuries.[28,29] This concept is best reflected in the definition of Sustainable Cities (Eco-cities), specifically in the context of urban areas. There are many definitions of sustainable city in the literature. Some of these definitions are shared in
Table 5-1.

[22] Ritchie, H., & Roser, M. (2018). Urbanization. OurWorldInData, Retrieved from https://ourworldindata.org/urbanization, on 20 February 2021
[23] Umdu, D. Ç., & Alakavuk, E. (2020). Understanding of smart cities, digital cities and intelligent cities: similarities and differences. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 44, 173-180. https://doi.org/10.5194/isprs-archives-XLIV-4-W3-2020-173-2020
[24] Bernini, C., & Tampieri, A. (2022). The mediating role of urbanization on the composition of happiness. Papers in Regional Science, 101(3), 639-657. https://doi.org/10.1111/pirs.12671
[25] EU (European Union). (2022a). Commission announces 100 cities participating in EU Mission for climate-neutral and smart cities by 2030. European Commission, Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2591 on 29 December 2022.
[26] UN (United Nations). (2021). The Sustainable Development Goals Report 2021. UN, New York, Retrieved from https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf on 06 October 2021
[27] Umdu, D. Ç., & Alakavuk, E. (2022). Sustainable communities, neighborhoods, cities and their criteria. The European Journal of Research and Development, 2(2), 287-300. https://doi.org/10.56038/ejrnd.v2i2.66
[28] Mensah, J., & Casadevall, S. R. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. Cogent Social Sciences, 5(1), 1653531. https://doi.org/10.1080/23311886.2019.1653531
[29] Nolon, J. R. (2003). Golden and its emanations: The surprising origins of smart growth. The Urban Lawyer, 35(1), 15-73. Retrieved from https://ssrn.com/abstract=1319371 on 09 October 2021

TABLE 5-1. SUSTAINABLE CITY (ECO-CITY) DEFINITIONS

Definition	Author, Date
"Eco-Cities emphasize balanced co-existence of nature-made and human-made environments."	Estevez et al., 2016 30
"An eco–city is a human settlement that emphasizes the self–sustaining, resilient structure and function of the natural environment and ecosystems. It seeks to provide a healthy and livable human environment without consuming more renewable resources than it replaces."	Bibri, 2020 31
"A sustainable city is an ecologically sustainable, socially just and economically viable city."	Blanco & Mazmanian, 2010 32
"Eco-City is designed specifically to minimize its energy, water and food needs, reduce its emitting pollution."	
Sustainable city is a place where to measure and evaluate policies, infrastructure systems, social formations, economic factors, resource use, emissions and other processes that contribute to the city's metabolism, welfare and quality of life and profit from it.	Umdu, 202434
"Eco-City is the urban environmental quality and livability which possess the following characters: compact, mixed-used developments, low-energy transportation, renewable energy generation and a reduced overall ecological footprint."	Fei et al., 201635

[30] Estevez, E., Lopes, N., & Janowski, T. (2016). Smart, sustainable cities: Reconnaissance study. Retrieved Retrieved June 25, 2021 from https://collections.unu.edu/eserv/UNU:5825/Smart_Sustainable_Cities_v2final.pdf
[31] Bibri, S. E. (2020). The eco-city and its core environmental dimension of sustainability: green energy technologies and their integration with data-driven smart solutions. Energy Informatics, 3(1), 1–26. https://doi.org/10.1186/s42162-020-00107-7
[32] Blanco, H., & Mazmanian, D. A. (2014). The sustainable city: introduction and overview. In Elgar Companion to Sustainable Cities (Ser. Social & Political Science, 2014, pp. 1–12). Elgar.
[33] Bhatt, N. (2016). Eco-city - the smart zero carbon cities challenge 2016. Climate CoLab. Retrieved November 17, 2022, from https://www.climatecolab.org/contests/2016/the-smart-zero-carbon-cities-challenge/c/proposal/1329910
[34] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University
[35] Fei, J., Wang, Y., Yang, Y., Chen, S., & Zhi, Q. (2016). Towards eco-city: the role of green innovation. Energy Procedia, 104, 165-170.

6. Sustainable City Assessment Models in The World

There are many sustainable assessment models around the world. Although some of them are spin-offs of building and neighbourhood eco-label or ranking systems, there are also models that focus only on sustainable urban development. In this study, 23 sustainable city assessment models were examined. These models are given in Table 6-1.

TABLE 6-1. SUSTAINABLE CITY ASSESSMENT MODELS

	Model
1	City Clean Energy Scorecard
2	100% RE: / Local Governments for SUSTAINABILITY*
3	2030 Architecture-2030 Palette
4	A Strategic Approach to Climate Action in Cities to 2030
5	CASBEE-City
6	China Urban Sustainability Index
7	ECO-CITY
8	European Green Capital Awards and European Green Leaf Awards
9	Green City Index
10	Guidelines for Sustainable Cities and Communities in China
11	ISO 37120 (37100 Series)
12	LEED for Cities and Communities
13	National Cities Research Program Strategic Agenda (AHURI)
14	One Planet Living (OPL)-Bioregional
15	SPeAR
16	SUDA
17	Sustainable City Indexing
18	The Green City Tool
19	The Place Standard
20	The Reference Framework for Sustainable Cities
21	The Urban Sustainability Framework
22	UN-SDG Goal 11
23	WBCSD Sustainable Cities Engagement Model

7. Criteria of Sustainable Cities

Although sustainable city criteria are not stated as clearly as smart city criteria in the literature, studies on the subject and various eco-city assessment tools have been created so far. For a city to be called sustainable, it must show itself within the framework of five main criteria[36,37] :

- **Social Sustainability:** The interconnectedness of people, society, and life is undeniable. Society forms the texture, identity, and culture of cities. The feature that makes the city a living element is the city residents who make up the urban society. A sustainable society is like an observer and referee of existing sustainability studies for sustainable urbanization because city residents experience these processes. They direct urban development with the management, economic circles, and other partners during experimentation.
- **Economic Sustainability:** A balanced economy is one of the most important elements in the global world.[38] The financial aspect is an essential part of sustainable development. The establishment of employment, businesses, and diverse opportunities associated with this domain benefit the city and, indirectly, the country, representing an economically independent position.
- **Administrative Sustainability:** The management unit is crucial in guiding and directing all aspects of the city towards a sustainable future, particularly in creating a sustainable urban environment. Due to Turkey's complex administrative system, municipalities (local authorities) primarily manage these processes. Local authorities must collaborate closely with relevant institutions, organizations, and directorates under the central authority to streamline bureaucracy. Only through effective cooperation can sustainable urban development be achieved.
- **Environmental Sustainability:** To establish a sustainable and eco-friendly system, it is crucial to integrate an environmental perspective into all sustainable urban models. Considering the ongoing climate change and energy crises, the environmental aspect is a fundamental element of sustainability. Therefore, it is vital to incorporate it into our models to ensure we promote environmental protection and sustainability.
- **Spatial Sustainability:** The built environment plays a crucial role in shaping cities' physical landscapes and is instrumental in defining their unique cultural and social

[36] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University
[37] Umdu, D. Ç., & Alakavuk, E. (2022). Sustainable communities, neighbourhoods, cities and their criteria. The European Journal of Research and Development, 2(2), 287-300. https://doi.org/10.56038/ejrnd.v2i2.66
[38] Singh, A. (2023, May 16). Globalization: Balancing benefits and challenges. Vision Virtuoso Retrieved March 10, 2024, from https://www.linkedin.com/pulse/globalization-abhishek-singh

identities. As such, the spatial dimension of urbanization must be considered when designing for sustainability. This involves accounting for sustainable design practices, green building initiatives, urban green spaces, and transportation systems within the built environment.

Although the indicators determined by many assessment tools, such as EcoCity, GreenCity Index, CASBEE-City, LEED for Cities and Communities, The Reference Framework for Sustainable Cities, and Sustainable City Indexing,[39] are different, sustainable city concepts have been formed considering these five basic criteria. Cities are sustainable to the extent they meet these criteria.

[39] Alakavuk, E., Çınar Umdu, D. & Koyuncu, A. (2021). E-Newsletter of Certifications, Models, Guidelines and Assessments Tools for Smart and Sustainable Neighborhoods and Cities Vol. 2 Retrieved November 27, 2021, from https://arch.yasar.edu.tr/en/wp-content/uploads/2021/12/Vol-2.pdf

8. Indicators of Sustainable City Assessment

The indicators of the Sustainable City Assessment should be determined based on sustainable city criteria. Table 8-1 shows these indicators.

TABLE 8-1. SUSTAINABLE CITY ASSESSMENT INDICATORS

Social Sustainability	
	Health and Well-being
Economic Sustainability	Employment and Productivity
	Cooperation and Globalization
Administrative Sustainability	Services and Infrastructure
	Digital City and Data Management
	Disaster Management
Environmental Sustainability	Water Management
	Waste Management
	Energy Management
	Emission and Pollution
	Landscape, Planting, and Biodiversity
Spatial Sustainability	Mobility
	Community Culture and Space
	Urban Planning and Development

- **Social Partnership and Awareness:** An essential component of community engagement in urban matters is establishing a dependable communication network. This involves keeping neighbourhood management and volunteer representatives informed and involved in local and city-wide initiatives, including councils, meetings, training, and other relevant organizations. The household head, who serves as a volunteer, should maintain regular communication with the neighbourhood administration and volunteer representatives through various digital channels such as email, social media, applications, or phone. This guarantees easy access to communication data and information about these organizations without relying on printed or verbal communication, which can be challenging to track. In times of crisis like a pandemic or natural disaster, this direct communication ensures that

information flows efficiently from households to the city administration, enabling city teams to take prompt action. Figure 8-1 shows the communication model in social partnership.

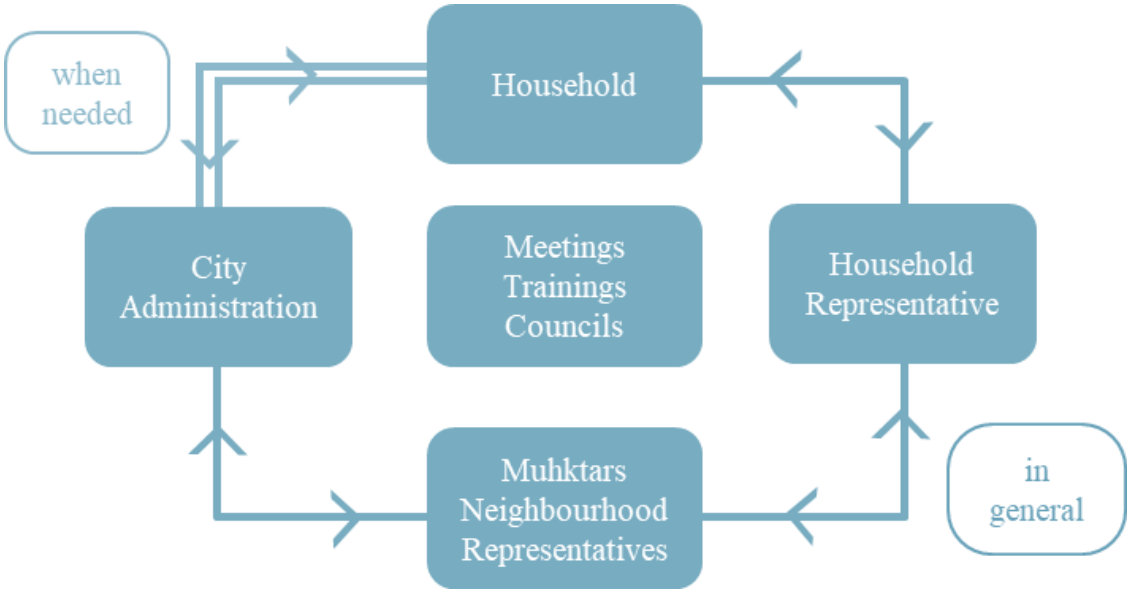

Figure 8-1. The Communication Model in Social Partnership[40]

In addition, social awareness involves assessing society's perceptions and understanding of current topics like sustainability, energy and climate challenges, and innovation. Recognizing that society is a critical component of sustainable development, evaluating citizen awareness levels and the municipality's efforts in this area can assist in measuring this indicator.

- **Health and Well-being:** This refers to providing health and social services that promote physical, sociological, and psychological well-being for all members of society. It encompasses access to healthcare facilities, necessary aid, and communication with local authorities to ensure a healthy and clean-living environment and the protection of people's rights, duties, and freedoms. This applies to residents in both neighbourhoods and cities. A healthy city continually creates and enhances social and physical environments, meets all basic needs, fosters mutual support without undue stress, and expands social resources. Additionally, with the global migration movement, a healthy city must offer opportunities for adaptation and settlement for incoming immigrants. The model includes 11 sub-criteria that support the indicator for health and well-being:

[40] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University

1. Ensuring a high-quality, clean, safe physical environment with good housing and urban green spaces.
2. Encouraging environmentally friendly practices and services.
3. Fostering a cooperative society.
4. Ensuring appropriate and fair payments, penalties, and taxes.
5. Meeting the basic needs of city residents, such as food, water, shelter, security, education, and work.
6. Making all communication types and opportunities accessible to everyone.
7. Protecting cultural and biological heritage.
8. Providing optimally accessible public health and disease care services to maintain high health levels.
9. Encouraging city residents to participate in sustainable and smart city studies.
10. Maintaining a high Human Development Index.
11. Supporting and integrating immigrants into the community.

- **Employment and Productivity:** Urban economies should establish a system that facilitates the manufacturing and processing of regional commodities, assets, and principles. To accomplish this objective, it is essential to leverage the local workforce. The region's inhabitants should be engaged in employment opportunities, which can be provided through vocational factories, training programs, and master classes.

- **Cooperation and Globalization:** The cooperation among businesses, academia, and management partners plays a crucial role in achieving sustainable economic growth at the local level. Nevertheless, fostering partnerships globally to exchange experiences and knowledge is equally important and can pave the way for a balanced and circular economy. Through collaboration, partners can devise enduring solutions that benefit the local community and the global one.

- **Digital City and Data Management:** Establishing a comprehensive system to meet city dwellers' digital and global needs is crucial. This system should provide access to various urban information and services online. Accessibility for all city actors is key to enhancing the quality of their urban and neighbourhood experiences.
  Additionally, the system should be designed to support data collection, analysis, and interpretation to create a sustainable and intelligent understanding of city dynamics. The data collected should be smart and relevant, avoiding redundant or irrelevant data. This data will serve as a valuable indicator to address deficiencies in the city, ensure healthy and sustainable systems, and inform long-term planning forecasts.

- **Disaster Management:** An essential indicator is created through a coordinated work plan among city stakeholders for various natural and human-based disasters and

accidents. This indicator plays a crucial role in facilitating quick and organized response during emergencies, pandemics, and disasters.

- **Sustainable Service and Infrastructure:** The sustainability of infrastructure and superstructure works necessary for all city activities can be determined by various networks such as water, internet, and transportation services. Additionally, central heating systems that are connected to geothermal energy also serve as indicators of sustainability.

- **Water Management:** Our objective is to enhance the management of urban water, encompassing both drinking water and wastewater. The goal is to establish a water network that can effectively allocate rainwater and wastewater for diverse purposes, while guaranteeing the safety of tap water. Grey and black water ought to be directly conveyed to the city's treatment system. Rainwater can be gathered and purified in appropriate neighbourhoods for domestic and park usage. If the rainwater is unfit for use, it should be directed to the municipality's collection system. For a comprehensive understanding of the water management system, kindly refer to Figure 8-2.

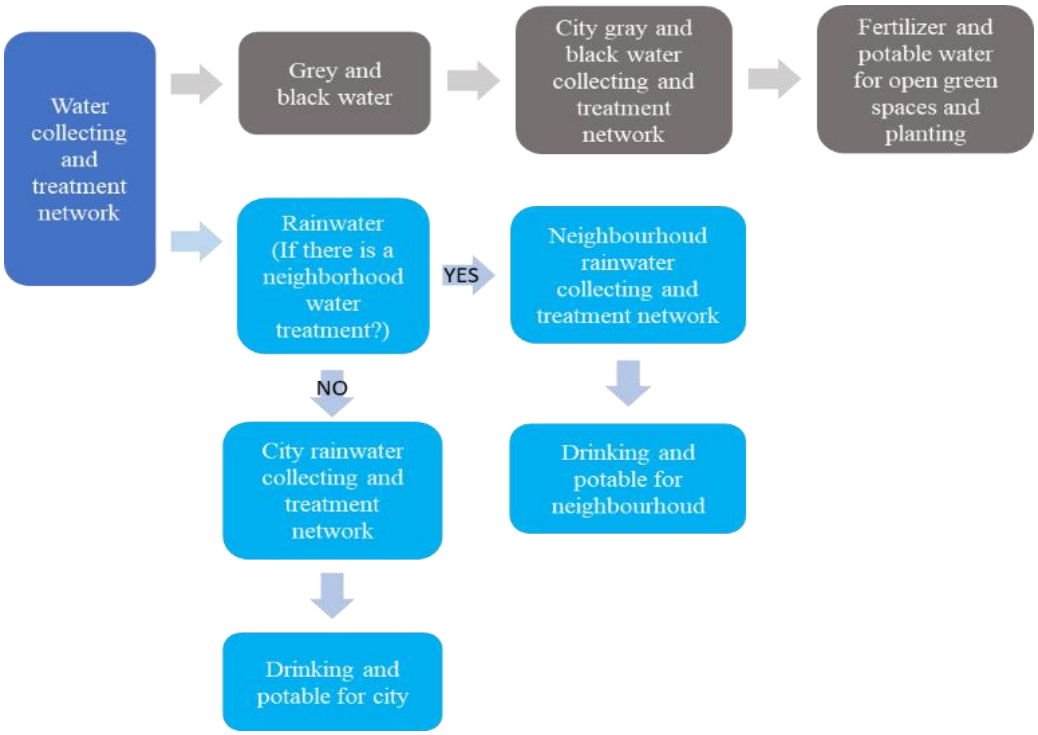

FIGURE 8-2. WATER MANAGEMENT SYSTEM[41]

[41] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University

- **Waste Management:** It is important to have a waste management policy in place that involves all stakeholders in a systematic approach to deal with solid waste. Such a policy helps identify the potential energy source within waste materials. Waste collection can be made more efficient by using automation systems. Residents should be given proper awareness about waste management and recycling. These systems should be designed to control separation, collection, waste occupancy rate, and pressing processes for different types of waste, such as paper, food, and plastic. Basic waste separation containers, including household waste, plastic, batteries, vegetable oil, glass, metal, and paper, should be made available in waste areas in all neighbourhoods. Municipalities should also have waste centres that can separate these 15 waste types.

    - Metal;
    - Packaging (such as biscuit packages, wet wipes packs);
    - All plastics (tires and rubbers included);
    - Domestic waste (food Waste);
    - Construction and excavation waste;
    - Wooden;
    - Paper and Cardboard;
    - Tetra Pak Boxes;
    - Glass;
    - Old Clothing Items;
    - Unspecified Waste ;
    - Medical Wastes;
    - Toilet and Personal Care Waste;
    - Technology Waste;
    - Accumulators and Batteries,

  It is important that these centres remain accessible to the public so that individuals can dispose of their waste responsibly. It is imperative that all waste is properly sorted and processed at these centres before being sent to licensed facilities. Additionally, the municipality may consider creating a platform to facilitate second-hand goods exchange. By establishing designated markets or centres, the community can rely on the municipality's oversight to ensure these items' safe and healthy handling.

- **Energy Management:** Investment in the energy sector is among the highest, with significant funds allocated to support urban and rural operations, construction, production, food, and transportation. As of 2021, energy services are valued at $64.34 billion, while the entire Renewable and Clean Energy Systems sector is worth $613.77

billion.[42,43] The global energy crisis has heightened the need for sustainable energy consumption, with about 71% of energy sources being carbon-based.[44] It is imperative to prioritize effective energy management to mitigate indirect emissions that contribute to the climate crisis. The development of smart and sustainable cities heavily relies on implementing renewable energy strategies, which significantly improve energy use.

- **Emission and Pollution:** In recent years, the impacts of climate change and global warming have become increasingly apparent. Despite the Paris Agreement's goal of limiting temperature increase to 2 °C, or even below 1.5 °C, the COP 26 summit in 2021 revealed that the increase was 2.4 °C in real. Moreover, a report by 55 countries most affected by climate change in 2022 found that their total climate-related losses in the past two decades amounted to $525 billion.[45] These findings underscore the crucial importance of reducing emissions and addressing environmental pollution to combat global warming, climate change, and related economic crises. To minimize these impacts, it is imperative to prioritize emission reduction in cities and neighbourhoods.

- **Landscape, Planting, and Biodiversity:** The purpose of this indicator is to safeguard urban green spaces and promote afforestation and planting activities, while adhering to prescribed square meterage requirements in various scenarios. Additionally, this indicator strives to maintain a healthy balance between green areas (minimum of 15%), roads and streets (minimum of 25%), and grey areas (maximum of 60%) within the city. It evaluates the planning of urban public spaces and open areas, including children's playgrounds, city parks, and outdoor sports facilities (located no more than 400 meters from residential areas). To ensure the proper management of Urban green space (UGS) and other open spaces, there are ten key elements to consider. Helping community health[46];

[42] Fortune Business Insight. (2021). Energy as a service [EAAS] market size, share: Growth, 2029. Fortune Business Insight. Retrieved November 23, 2022, from https://www.fortunebusinessinsights.com/industry-reports/energy-as-a-service-market-101204

[43] Jaganmohan, M. (2021). Global renewable energy market size 2020-2027. Statista. Retrieved November 23, 2022, from https://www.statista.com/statistics/1094309/renewable-energy-market-size-global/

[44] Yıldızoğlu, E. (2022, August 16). Enerji Krizinin Bu Kez Küresel Düzeyde Yaşanması Dünyayı Nasıl Değiştiriyor? BBC Türkçe. Retrieved September 8, 2022, from https://www.bbc.com/turkce/articles/cp6kpy4g4r6o#:~:text=K%C3%BCresel%20%C4%B1s%C4%B1nmaya%20%2Fiklim%20krizine%20yol,elektrik%20%C3%BCretiminde%20canland%C4%B1r%C4%B1lmas%C4%B1na%20yol%20a%C3%A7%C4%B1yor.

[45] Euronews. (2022b, November 22). COP27: 'Kayıp ve Zarar' fonuyla ilgili Bilinmesi Gerekenler. Euronews. Retrieved November 23, 2022, from https://tr.euronews.com/2022/11/22/cop27-iklim-zirvesinde-tarihi-uzlasi-kayip-ve-zarari-kim-odeyecek

[46] Alakavuk, E., & Cinar Umdu, D. (2023). Urban Open Therapy Gardens in EU Cities Mission: Izmir Union Park Proposal. Sustainability, 15(8), 6715. https://doi.org/10.3390/su15086715

1. Easy access;
2. Resilience and park maintenance;
3. Holistic use;
4. Protection of flora and fauna;
5. Space and plant design according to climate and use;
6. Element variety and movement;
7. Harmony with nature;
8. Management;
9. Security and control.

In addition, it is crucial to focus on preserving biodiversity in cities that are limited by neighbourhoods. This involves valuing the variety of plants and animals present and striving to safeguard and encourage the growth of endangered species. It is vital to conduct and endorse research efforts aimed at protecting the local flora and fauna, particularly in green spaces situated in urban areas.[47]

- **Community, Culture, and Space:** A three-stage indicator of society's place and cultural activities.

1. The goal is to seamlessly supply the community with all necessary services and amenities without complications. This includes setting up community centres tailored to the size of each neighbourhood, equipped with courses, indoor sports areas, meeting rooms, and working areas for residents. These centres may also house non-governmental organizations, cooperatives, headmen, and administrative units affiliated with the municipality. This approach will make public services more easily accessible to the public than before.
2. It is important to transfer urban culture and history to the city's residents while preserving cultural heritage and assets to foster a sense of urban identity. This encourages voluntary adoption and cooperation with the city and its unique identity.
3. The third stage will utilize the health and well-being, Planting Management and Landscape, and Built Environment Design indicators. Creating urban green spaces is crucial in the making space approach as it helps society unwind and escape stress while connecting with nature. This allows individuals to find peace in their own natural spaces.

- **Mobility:** Developing a transportation system that is intelligent, energy-efficient, and reduces carbon footprint can simplify urban living and time management.

[47] Çınar Umdu, D. (2024). An Assessment Model Proposal for Smart and Sustainable Neighborhoods [Unpublished doctoral thesis]. Yaşar University

1. To promote the use of public transportation and discourage private vehicles, it is recommended that bus stops be no more than a 10-minute walk away, while rail and sea transportation should be accessible within 20 minutes.
2. The implementation of automated and intelligent parking facilities in neighbourhoods and cities, with 70% of each lot equipped with electric charging stations, can significantly contribute to a sustainable transportation system.
3. A well-structured transition plan that promotes the adoption of electric systems in vehicles as an alternative to petroleum-based fuels is crucial in mitigating transportation's emissions impact.
4. The development of dedicated bike lanes and scooter paths can greatly enhance the mobility of alternative transportation modes and reduce traffic congestion.
5. Establishing clear regulations and guidelines to incentivize scooter users to comply with bicycle rules is a positive step towards achieving a safe and sustainable transportation system.

- **Urban Planning and Development:** This is an indicator that shows linear development targeting specific neighbourhoods each year, starting from the year of entry into the model and continuing until the target year. To achieve this, factors such as land use, green and grey spaces, green buildings, streets and roads, mixed-use urban areas, LCA (life cycle assessment) quality, resource management, and the use of green and sustainable materials are all considered. It is an essential indicator for creating diverse areas and building an infrastructure and superstructure that is suitable for the needs of the community.

9. Last Words:

As we delve deeper into the concept of eco-urbanism, it becomes clear that its associated terms and principles are poised to promote sustainable growth in urban areas. The goal is to identify the inherent value of the city by improving its infrastructure and components, while simultaneously striving to enhance its quality of life and aesthetic appeal.

By the rise of global communication and interconnectivity, sustainability has become a pressing issue for both local communities and governing bodies. Therefore, urban planning must consider multiple perspectives - environmental, economic, spatial, social, and managerial - and analyse them systematically with the aid of technology.