Politechnika Lodzka
International Faculty of Engineering

EPS PROJECT

SMART ECO CITY

Improving Smart Eco Cities According to Sustainable Development Proposed by the UN and EU Regulations

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Executive Summary

The concept of Smart Eco Cities has gained significant attention in recent years, as nations worldwide strive to achieve sustainable development goals and enhance the quality of life for their citizens. This report delves into the multifaceted aspects of Smart Eco Cities, focusing on their alignment with the Agenda 2030, the measurement of smartness and sustainability, and the crucial decision of adapting existing cities versus building new ones. Furthermore, the report explores the potential of rebuilding Ukraine in line with Smart Eco City principles.

By examining various dimensions, including technology, infrastructure, and governance, the report provides general recommendations and guidelines for the development of these cities. It emphasizes the importance of comprehensive planning, stakeholder engagement, and the integration of innovative solutions to build resilient, inclusive, and environmentally-friendly cities. With the ultimate aim of improving the well-being of habitants and safeguarding the planet, this report serves as a valuable resource for policymakers, urban planners, and researchers invested in creating a sustainable and smart future for our cities.

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Chapter 1

Introduction

Over the past few years urbanization has experienced a significant increase, reshaping the global landscape in profound ways, as we can observe in the Figure 1.1. As rural populations migrate to urban areas in search of better economic opportunities and improved living standards, cities have become hubs of activity and innovation. This rapid urban growth has been driven by various factors, including industrialization, technological advancements, and globalization. Urban centers have expanded to accommodate the number of people, resulting in the construction of towering skyscrapers, efficient transportation systems, and vibrant cultural spaces.

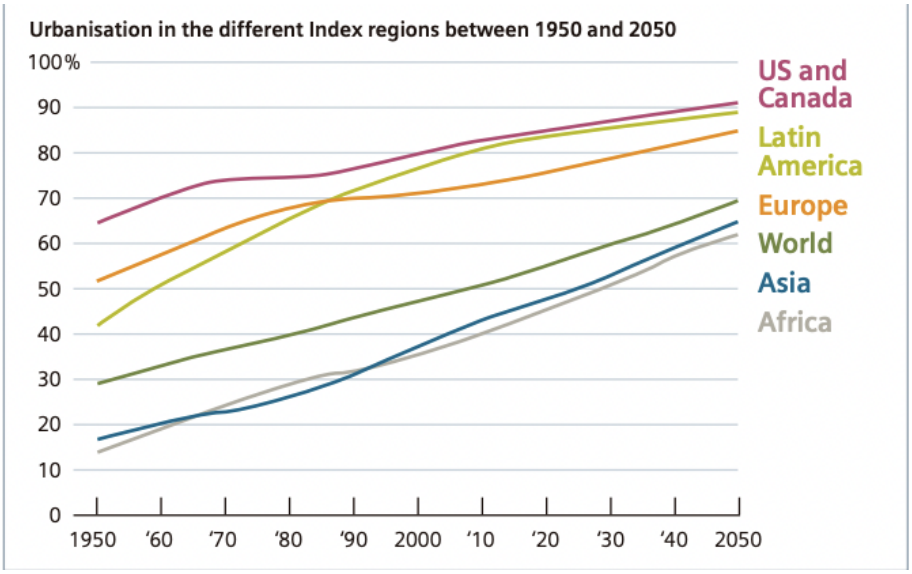

Figure 1.1: Urbanization (Siemens, 2012)

Considering the rapid growth of urban areas, new challenges are coming up, in terms of sustainability and livability of cities. Thus, the concept of a "Smart Eco City" was

born and is becoming more relevant each day. Since it is such a new concept, there can be some misconceptions or abstract ideas when thinking about these kinds of cities. By now, one can define a Smart Eco City as a city that uses cutting-edge technology and data analytics to create a sustainable urban environment.

The first question that arises when thinking about this topic is whether it is possible to develop this kind of such a city and find a balance between progress and sustainability in such a short time. This topic is being heavily researched and discussed, and different solutions and strategies are being proposed, including the Agenda 2030 proposed by the United Nations and "Fit for 55%" proposed by the European Union, which will be used in this project and explained on the following chapter.

Achieving the goals set in Agenda 2030 poses a significant challenge as now is 2023. With a limited time frame, the task of addressing issues such as poverty, inequality, climate change, and sustainable development becomes even more pressing.

Also, it is important to understand the complexity of these challenges and attend to every detail in order to answer these questions and have a wide view of the whole concept. Each Smart Eco City is a unique project with unique conditions that require deep analysis to make the correct decisions.

As one of the last problems that need to be tackled in regard to the sustainable development of Smart Eco Cities are the ones called ghost cities. The examples of existing failures need to be considered in order to avoid them and create spaces where people really wish to live.

In addressing these questions, the importance of defining criteria, frameworks, and standards to measure the smartness and sustainability of cities cannot be ignored. These is one the main goals of this report, develop guidelines provide a common language and indicators for evaluating cities' progress, facilitating comparisons, and identifying areas for improvement.

Chapter 2

Conceptual Background

This theoretical chapter provides a conceptual framework for understanding the terms related to Smart Eco Cities and all the topics discussed in this report.

Smart City

A smart city is an urban area that uses various technologies such as the Internet of Things (IoT), sensors, artificial intelligence (AI), and data analytics to gather and analyze data in real-time and use that data to optimize city operations, improve infrastructure, and enhance services such as transportation, healthcare, and public safety. The goal of a smart city is to use technology and data to create more efficient and effective urban systems, while also promoting sustainability, economic growth, and social inclusion ("Smart Sustainable Cities | UNECE", 2023).

Measuring Smartness

For measuring the smartness of cities one of the most recent studies done by ProptechOS used 10 indicators based on tech infrastructure and connectivity, a tech-driven job market, and sustainability (PropTechOS, 2023). The last ranking can be found in 2.1

- Tech, Infrastructure, and Connectivity
  - Free WiFi hotspots
  - Broadband download speeds
  - Availability of airports

  - Number of IoT companies (plus the number of IoT companies per 100,000 of the population)
  - Number of 5G network towers

— Green Infrastructure

  - The number of public-access EV charging points
  - The number of public access EV charging points per 10,000 of the population
  - The number of 'green certified' buildings

— Tech-Driven Job Market

  - The number of tech jobs
  - The number of tech jobs per 10,000 of the population

	City	Technology infrastructure	Green infrastructure	Tech job market	Score (out of 100)
1	London, UK	89	95	36	73.7
2	Amsterdam, Netherlands	86	88	27	66.9
3	Berlin, Germany	82	77	26	61.6
4	Paris, France	91	68	25	61.6
5	Lisbon, Portugal	78	64	29	56.9
6	Oslo, Norway	76	83	11	56.4
7	Budapest, Hungary	80	74	15	56.3
8	Dublin, Ireland	76	63	27	55.2
9	Madrid, Spain	87	54	22	54.3
10	Helsinki, Finland	77	62	19	52.4

Figure 2.1: Top 10 European cities best prepared for a 'smart city' future (PropTechOS, 2023)

Eco City

An eco city is an urban area designed with a focus on sustainability and environmental conservation. It aims to minimize the impact on the environment while improving the quality of life for its inhabitants. Eco cities typically feature green buildings, renewable energy sources, public transportation systems that reduce reliance on private cars, waste reduction and recycling programs, and the preservation of natural spaces. Additionally, eco cities prioritize social equity and community engagement, ensuring that all residents have access to basic services and amenities, regardless of income level or background. The

overall goal of an eco city is to create a livable and healthy urban environment that meets the needs of both present and future generations, while minimizing the impact on the natural environment ("Smart Sustainable Cities | UNECE", 2023).

Measuring Sustainability

For measuring the sustainability of the cities there is the "Green City Index" which is a research project conducted by the Economist Intelligent Unit (EIU) and sponsored by Siemens. This series of research started in 2009 and covers more than 120 cities in Europe, Latin America, North America, Asia, and Africa. The last results can be found in Table 2.2 .This Index series uses 30 indicators across eight categories (Siemens, 2012). The indicators are as follows:

Overall Results

Rank	City	Score
1	Copenhagen	87.31
2	Stockholm	86.65
3	Oslo	83.98
4	Vienna	83.34
5	Amsterdam	83.03
6	Zurich	82.31
7	Helsinki	79.29
8	Berlin	79.01
9	Brussels	78.01
10	Paris	73.21
11	London	71.56
12	Madrid	67.08
13	Vilnius	62.77
14	Rome	62.58
15	Riga	59.57
16	Warsaw	59.04
17	Budapest	57.55
18	Lisbon	57.25
19	Ljubljana	56.39
20	Bratislava	56.09
21	Dublin	53.98
22	Athens	53.09
23	Tallinn	52.98
24	Prague	49.78
25	Istanbul	45.20
26	Zagreb	42.36
27	Belgrade	40.03
28	Bucharest	39.14
29	Sofia	36.85
30	Kiev	32.33

Figure 2.2: Eco City Ranking (Siemens, 2012)

— Environment Governance

  - Green action plan
  - Green management
  - Public participation in green policy

— CO2

  - CO2 intensity
  - CO2 emissions
  - CO2 reduction strategy

— Energy

  - Energy consumption
  - Energy intensity
  - Renewable energy consumption
  - Clean and efficient energy policies

— Buildings

  - Energy consumption of residential buildings
  - Energy-efficient buildings standards
  - Energy-efficient buildings initiatives

— Transport

  - Use of non-car transport
  - Size of non-car transport network
  - Green transport promotion
  - Congestion reduction policies

— Water

  - Water consumption
  - System leakages
  - Wastewater system treatment

  - Water efficiency and treatment policies

— Air quality

  - Nitrogen dioxide
  - Sulfur dioxide
  - Ozone
  - Particulate matter
  - Clear air policies

Smart Eco City

A smart eco city is an urban area that combines the principles of a smart city and an eco city to create a sustainable, livable, and technologically advanced urban environment. Smart eco cities utilize advanced technology and data analysis to optimize urban services and operations, while also prioritizing environmental conservation and sustainability. The ultimate goal of a smart eco city is to create a harmonious and balanced urban environment using technology to improve efficiency and reduce environmental impact ("Smart Sustainable Cities | UNECE", 2023).

Agenda 2030

The Agenda 2030 2.3, also known as the Sustainable Development Goals (SDGs), is a transformative global framework adopted by the United Nations in September 2015. It outlines a comprehensive set of goals, targets, and indicators to guide countries toward sustainable development over a 15-year period, addressing social, economic, and environmental dimensions. The Agenda 2030 encompasses 17 interconnected goals that aim to end poverty, protect the planet, and ensure prosperity for all (Samaan, 2023).

Figure 2.3: Agenda 2030 SDGs (Samaan, 2023)

Smart eco cities, with their focus on leveraging technology and sustainable practices, align closely with the principles and aspirations of the Agenda 2030. These cities recognize the need to address the pressing challenges of urbanization, resource depletion, climate change, and social inequality. By embracing the Agenda 2030, Smart Eco Cities can act as key drivers of sustainable development, demonstrating innovative approaches to achieving the SDGs at the local level. This can serve as tangible examples of how these goals can be translated into action at the local level. By aligning their strategies and initiatives with the SDGs, these cities can contribute significantly to the global pursuit of a more sustainable and inclusive future. It is through the integration of technology, innovative practices, and collaborative partnerships that Smart Eco Cities can effectively address the challenges of the 21st century and pave the way towards a more sustainable and resilient world.

Fit for 55%

The "Fit for 55%" concept is a key component of the European Union's comprehensive climate and energy policy framework. It sets an ambitious target of reducing greenhouse gas emissions by at least 55% by the year 2030, compared to 1990 levels. This target is a crucial step toward achieving the EU's long-term objective of becoming the world's first climate-neutral continent by 2050 (United Nations, 2023c).

The "Fit for 55%" package is a set of proposals to revise and update EU legislation and to put in place new initiatives with the aim of ensuring that EU policies are into line

with the climate goals agreed by the Council and the European Parliament. To achieve this target, the EU adopts a comprehensive approach that encompasses various sectors of the economy, including energy, transport, industry, buildings, and agriculture. The initiative emphasizes the need for transformational changes in these sectors to enable a sustainable, low-carbon future.

Smart eco cities play a critical role in realizing the objectives of the "Fit for 55%" initiative. These cities serve as test stands for innovative technologies, policies, and practices that facilitate the transition to a decarbonized society. By implementing energy-efficient measures, embracing renewable energy sources, promoting sustainable mobility options, and adopting circular economy principles, smart eco cities contribute to the overall emission reduction targets.

C40 Cities

C40, also known as the C40 Cities Climate Leadership Group, is a network of the world's largest cities committed to tackling climate change. Established in 2005, C40 brings together mayors and urban leaders from around the globe to exchange knowledge, share best practices, and collaborate on innovative approaches to climate action. The organization focuses on driving meaningful and measurable progress toward achieving some objectives.

Its primary objective is to accelerate urban action on climate change by supporting cities in their transition towards low-carbon and resilient urban development. The organization recognizes the crucial role cities play in mitigating greenhouse gas emissions and adapting to the impacts of climate change. C40 provides a platform for member cities to collaborate, learn from each other, and implement effective strategies that align with global climate goals (C40 Cities, 2023).

Chapter 3

Research Methods

In this report, a combination of research methods was employed to gain a comprehensive understanding of this complex topic. The following research methods were utilized:

Desk Research

Desk research played a crucial role in collecting existing information and data related to Smart Eco Cities. Extensive literature review was conducted by accessing academic publications, reports, and online databases. The research team critically analyzed and synthesized the gathered information, exploring topics such as new technologies, sustainable practices, and case studies of successful eco cities. This process provided a solid theoretical foundation and informed the research objectives.

Survey Research

To collect primary data, a survey research method was employed. The target population consisted of individuals within a variety of ages and nationalities. A well-designed questionnaire was developed to gather insights on Agenda 2030 and quality of life. The collected survey responses were analyzed and interpreted to draw meaningful conclusions.

Data Visualization and Analysis

Data visualization techniques were employed to present and interpret research findings effectively. Utilizing tools such as Python and its data visualization libraries, the research team visualized the EU data in the form of charts. Through comprehensive analysis and interpretation of the visualized data, key findings and conclusions were drawn.

Interview

One extensive interview was conducted with a key stakeholder specialized in economics. This interview aimed to gather qualitative information and perspectives on the costs and economic challenges involved in this report. The participant was selected based on his expertise and experience.

Attending to a congress

To enhance the understanding of current developments and discussions in the field of Smart Eco Cities, the research team attended to the International Congress of Energy Regeneration of Cities on 31st of May. Attending the congress provided valuable exposure to the latest innovations, research findings, and practical experiences shared by experts and practitioners. Insights gained from the congress influenced the research approach and provided additional context for the study.

Problem-Based Learning

Problem-Based learning was utilized as an active learning approach to explore real-world challenges faced by Smart Eco Cities. The research team engaged in problem-solving activities, working on specific case scenarios and practical problems related to smart eco city initiatives. This approach facilitated a deep understanding of the complexities, interdependencies, and practical implications of implementing smart and sustainable solutions within the urban environment.

Project Management

Project management techniques were employed to ensure the proper execution of the research. A well-defined project plan was developed, including a timeline and its needed milestones. Effective project management helped the efficient coordination of the team and the resources in order to accomplish the report.

Chapter 4

Presentation and Discussion of Findings

4.1 Challenges and Limitations

The idea of creating or adapting cities into smart eco cities inspired a lot of people to be a part of this conversation, but there are still several challenges and limitations that need to be addressed and taken into consideration.

One major challenge is the integration between different technologies and systems, to make sure that everything can work together. Achieving compatibility among these different technologies, such as IoT devices, data analytics platforms and communication networks, can be very complex, time-consuming and requires extensive coordination of the stakeholders (Baldi et al., 2022).

Additionally, privacy and data security concerns arise as cities collect and analyze vast amounts of personal data to optimize operations. Balancing the potential benefits of data-driven decision-making with privacy protection measures requires careful consideration and robust governance frameworks (Cui et al., 2018).

Another significant challenge is ensuring equal access to smart services and addressing potential social inequities. The success of a Smart Eco City is directly related to the active citizen participation and engagement. The technology can enable efficient services but it is essential to ensure that the benefits of these advancements reach all segments of the population (I., 2023).

Moreover, with the idea of ensuring equal access to essential services, one concept that has been gaining more visibility is the 15-minute city concept, which promotes the idea of creating self-sufficient neighborhoods where residents can access their daily needs within a

15-minute walk or bike ride. This model offers a promising vision for creating sustainable, walkable and accessible neighborhoods, but also comes with its own sets of challenges to be implemented ("[eBook] Four Ways Data Supports a Resilient Smart City", 2020).

The challenges begin with the existing urban infrastructure and zoning patterns. Many cities are built around centralized commercial and business areas, causing a mismatch between residential areas and essential services. With that, the adaptation of existing urban structures to accommodate this model may require significant changes in zoning regulations and land use patterns, which can be costly and time-consuming.

Furthermore, it needs to be taken into consideration the difficulty of scalability and affordability of this type of model. While it is feasible to create self-sufficient neighborhoods in compact urban areas or newly developed communities, replicating the model in larger cities with sprawling layouts can be more challenging. And as the cities and population grow it gets harder to achieve equity and social inclusivity. Ensuring that every neighborhood has access to high-quality services and amenities requires addressing existing disparities in resource allocation and prioritizing underserved communities. By overcoming these challenges in an inclusive manner, cities can move closer to realizing the vision of the 15-minute city and create more vibrant, livable, and accessible urban environments.

Another of the biggest challenges in Smart Eco Cities is the urban growth. As the cities continue to witness rapid urbanization, the challenges associated with urban growth are becoming increasingly evident and inadequate planning and management of urban development may not lead to sustainability. There are a lot of factors that can be considered to face this problem, but there are some solutions and tools that can help us with this.

In the article (Tsagkis et al., 2023) it was developed a tool using a Machine Learning Artificial Neural Network (ANN), another classic method called Cellular Automata, and public data from the EU involving various impact factors such as social, economic, biophysical, neighboring-related, and political driving forces. It provides a useful tool for urban planners, policymakers, and stakeholders in Smart Eco Cities to analyze, predict, and manage urban development in a sustainable and efficient manner.

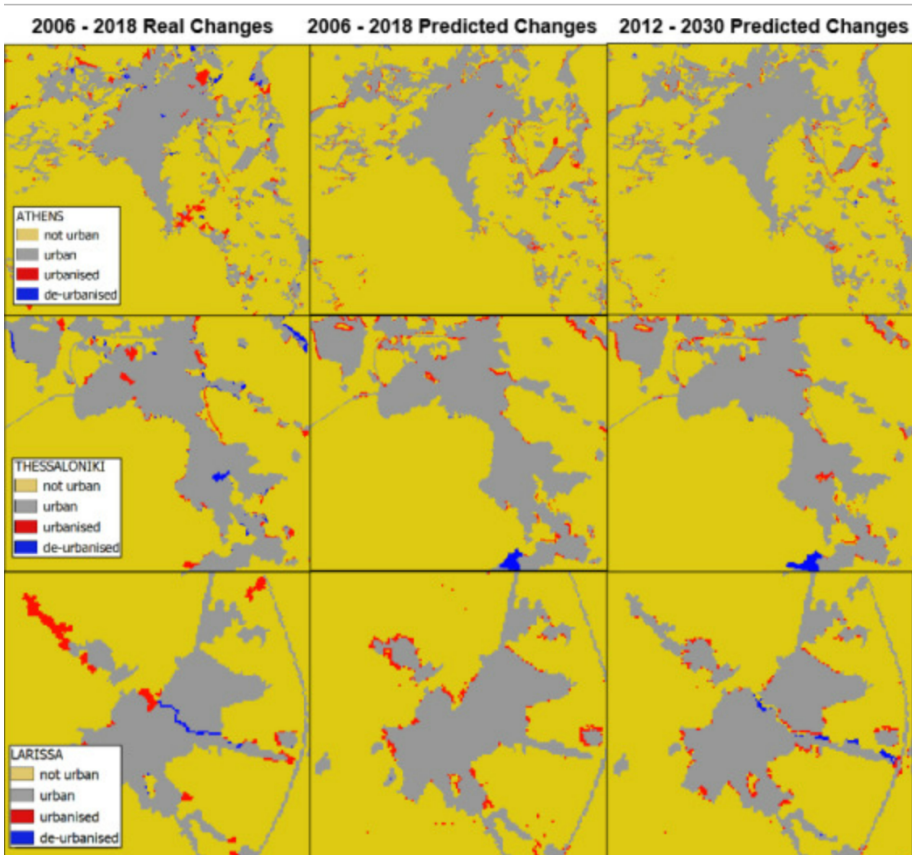

Figure 4.1: Urban Growth prediction for Greek cities (Tsagkis et al., 2023)

In Figure 4.1 the results of the tool are presented for three Greek cities: Athens, Thessaloniki and Larissa. For each city there are three maps, the first one with the real changes occurred between 2006 and 2018, the next one the predictions for the same years, and the last one with the predictions from 2012 to 2030. The yellow surface is not urban area, the gray urban, the red the new urbanized area and blue de-urbanized area.

As can be seen, the results of this tool are not perfect and have to be interpreted carefully as the area of study of urban growth is unpredictable, but it shows the possibility to start finding some patterns and an important advance in the topic.

Another helpful data available is in the Eurostat Database (Eurostat, 2023b), a public data source made by the EU. Analyzing the database of "Population on 1st January by age, sex and type of projection" there are some predictions made about the population until 2100. There is the data plotted of the 27 countries part of the EU 4.2.

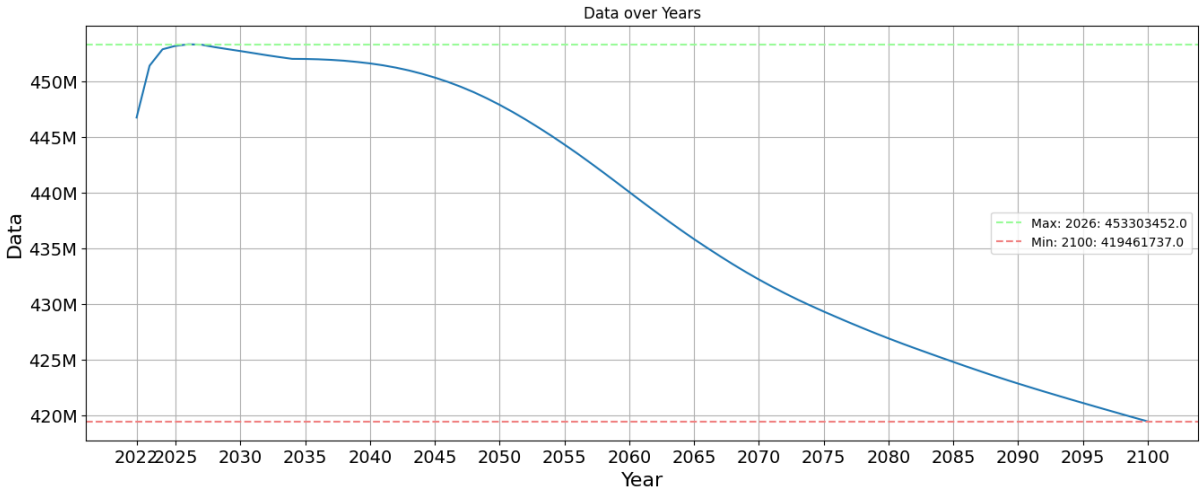

Figure 4.2: EU Population prediction

In the Figure 4.2 there is a population decrease of almost 35 million habitants in Europe. The reason for that is the combination of below-replacement fertility rates, the impact of the COVID-19 pandemic on mortality, and the complex dynamics of migration. It is important to note that population projections are subject to uncertainty and can be influenced by various factors that may change over time.

4.2 PEST Analysis

The PEST analysis is a tool employed to examine the macro-environment in which a company operates. This analysis was done in order to identify and delimit the fundamental spheres that significantly influence Smart Eco Cities. By conducting this analysis, some insights were provided into the current state and helped to get a wide overview of the challenge.

The first stage is identification of significant factors relating to individual segments of the environment. In this step the goal is to identify the most important factors of individual segments of the environment (political, economic, socio-cultural and technological) that significantly affect or may affect the city. For example, for a company providing transport services, a very important economic factor will be the increase in fuel prices and the introduction of road tolls and their amount. A manufacturer of expensive, exclusive furniture should take into account an important social and cultural factor, which will be the low interest of the public in its products, caused by low earnings. Finally, companies

producing mobile phones or computers will pay special attention to technological factors, such as the use of the latest technological or scientific achievements (I. Penc-Pietrzak 1998, p. 143).

The second stage is determining the impact of each factor on the functioning of the organization when the company assesses the impact of each factor on its functioning. It is necessary to assess, which factors affect the company the most today and which will affect it in the future. In this way, a list of factors is created, divided by strength (the greatest and the smallest impact) and by the duration of the impact (whether the company is dealing with them now or will have them in the future).

Finally, the last stage is determining the relationship between the organization and the macro-environment. This step is to define the relationship between the company and its macro-environment. The organization summarizes how a given factor affects or how it may affect its operations in the future. For example, a training company will consider the possibility of receiving funding from the European Union and the consequences of this (e.g. lowering training prices, because competitors may also have access to funding). On the other hand, a manufacturer of exclusive furniture will determine what to do to increase public interest in its products (for example, spread the price of furniture in installments to expand the group of its customers).

The PEST analysis is useful for analyzing Smart Eco Cities as it provides a comprehensive evaluation of the political, economic, social, and technological factors that impact the development and success of these cities, helping to identify opportunities and potential challenges in their implementation. Here is the PEST analysis of the project:

Political factors

This group is often called as "Political and legal" factors, as they include system of regulations to economic activity. Political factors include European integration, stability of power, environmental protection regulations, labor law, taxes, concerning foreign trade (A. Stabryla 2000, p 146).

— Government support: The level of support and commitment from the government towards the development of smart eco cities can significantly influence the project's success.

— Regulations and policies: Existing regulations and policies related to urban development,

sustainability, and technology adoption can impact the implementation of the project.

— Agenda 2030

Economic factors

Economic factors will include i.e. trends in GDP, economic cycles, interest rates, inflation, money supply, availability and cost of energy carriers, unemployment, budget income, level and pace of economic development (I. Penc-Pietrzak 1998, p. 123), economic policy. It is also worth taking into account such factors as the standard of living of citizens or the average salary in order to be able to adjust one's offer to the financial capabilities of the society (A. Stabryła 2000, p. 146).

— Funding and investment: The stability of the political environment is crucial for long-term planning and investment in the smart eco cities project.

— Affordability and costs: The cost of implementing and maintaining smart technologies in eco cities can be a barrier to widespread adoption. The economic feasibility and affordability of the project need to be assessed. Chronology adoption can impact the implementation of the project.

— Green investment

— Inflation

Social factors

In the third group of factors, which are socio-cultural factors, we examine population demography, level of education, income distribution, consumption lifestyle, social mobility, awareness of threats, customs, ethical and moral standards and changes in lifestyle. For example, when introducing a new product to the market, the entrepreneur should get acquainted with the preferences of consumers to whom it is addressed (A. Stabryla 2000, p. 146).

— Public perception: The acceptance and perception of the local community towards smart eco cities play a significant role. Education and awareness programs may be required to ensure public understanding and participation.

— Lifestyle changes: The project may require individuals to adopt new habits and lifestyles, such as energy conservation practices or using public transportation. The level of acceptance and willingness to change among residents can impact the project's success.

— Social equality: Ensuring that smart eco cities are inclusive and benefit all sections of society is essential. The project should address issues of affordability, accessibility, and social equality.

— Smart education

— Community empowerment

Technological factors

The last group is technological factors, which include: state spending on research, obsolescence of technology, focus of the authorities and the industry on technological effort, speed of technology transfer and new discoveries in technology.

— Technological infrastructure: Availability and reliability of necessary infrastructure such as high-speed internet connectivity, data centers, and communication networks are crucial for the implementation of smart eco cities.

— Research and innovations: Continuous technological advancements and research in areas like renewable energy, Internet of Things (IoT), artificial intelligence (AI), and data analytics can enhance the project's capabilities and sustainability.

— Data privacy and security: The collection and utilization of vast amounts of data in smart eco cities raise concerns about privacy and security. Implementing robust data protection measures is crucial to gain public trust.

— Open-source collaborations

— Digital inclusion

4.3 Stakeholders

A stakeholder of a project refers to any individual, group, or organization that has an interest or concern in the project or is affected by its outcomes. Effective stakeholder

management involves identifying and understanding the needs, expectations, and potential impacts of each stakeholder group, to make sure their interests are appropriately addressed. The stakeholder analysis can be found in Figure 4.3.

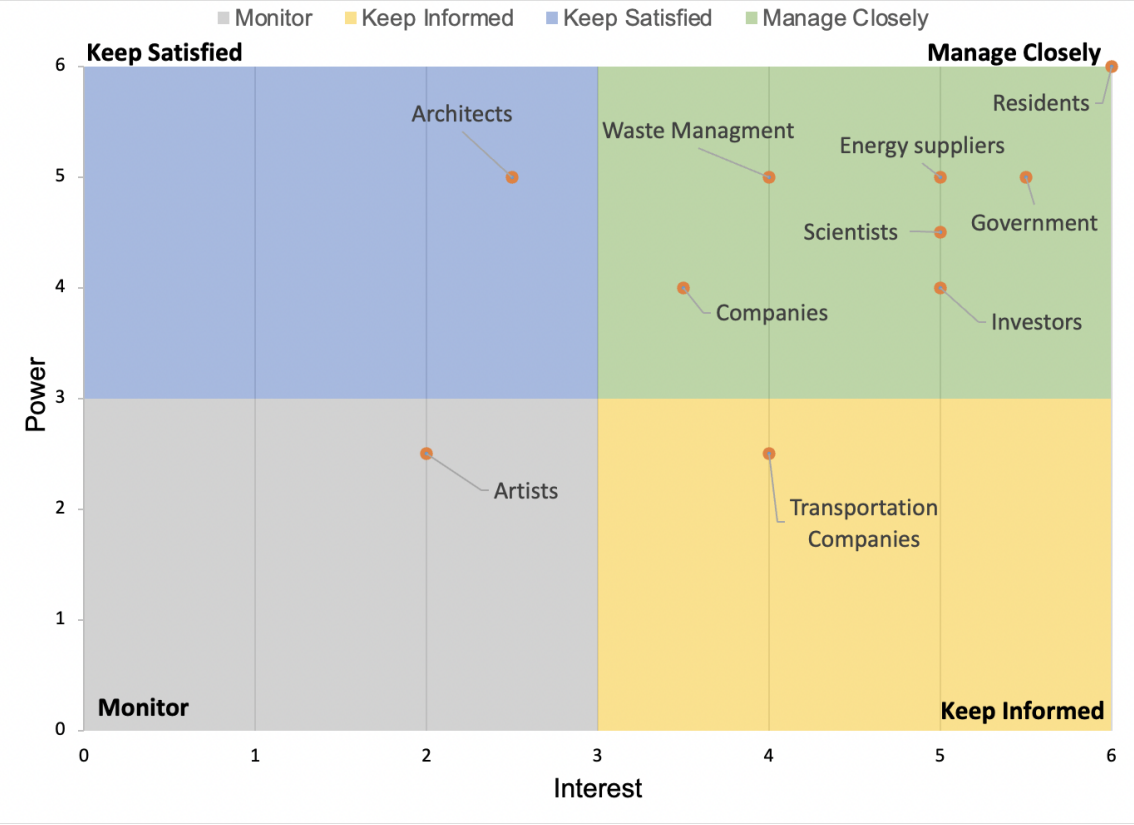

Figure 4.3: Stakeholder analysis basing on the authors

With the purpose of developing this analysis and make some meaningful but small conclusions, the team chose a short but significative list of stakeholders. It is important to note that this is a general analysis and it should be replaced with real entities when addressing a real project.

The most important stakeholders are the residents, and it is very important to keep their interests and demands in mind when planning the development of a city. Ultimately, it is the people in Smart Eco City that will be the pillar of its operation, and it is necessary to keep them happy and satisfied.

Moreover, the government and its involvement are crucial to the development of a smart eco city. They have authority, resources, and influence, so it is important to guide them towards sustainability and well-being of residents.

Another key stakeholder are the investors, bringing with them innovation and funding of

projects. Their support makes it easier to transform urban areas and foster collaboration between different people, also managing risks and promoting long-term solutions to different problems.

This stakeholder analysis provides valuable insights into stakeholder interests, power dynamics, collaboration opportunities, and risks. It enables effective stakeholder management and engagement, contributing to the successful implementation and long-term sustainability of the project.

4.4 Cities all around the world

In this chapter, there will be some highlights of initiatives done by cities in order to become a more sustainable and smarter city

Starting with Warsaw, Poland, and its strategy to ensure sustainability and improve quality of life. A great pride for the residents of the city is the green area, which covers almost 40% of the city land mass (European Environmental Agency, 2023). To continue and improve the green areas, the Warsaw City Council, in 2017, created a mobile app called "One Million Trees". With this application, citizens can plant trees and log it into the app, so later other people can find the trees that are planted and nurtured. Creating a network of trees' locations to increase the awareness and importance of tree planting, while also, making the citizens involved and part of the change (Baker, 2022).

Another accomplishment of the Warsaw City Council is creating a smart city network to optimize energy use. It is a joint investment with Veolia Energia Warszawa S.A. By improving the existing network and installing appropriate equipment, Warsaw's CO2 emissions got reduced by 14.5 tones which equates to planting of 1 million trees (Baker, 2022).

Another example of city is Curitiba, Brazil. It is a big city known for the great rates of recycling. Curitiba recycles around 70% of its garbage due to a program that exchange bus tokens, notebooks and food in return for recycling. This program protects the environment and it also increases food access, facilitate transport and boosts education for the city's poor people (Philipp, 2020). Another big innovation for Curitiba was the bus rapid transit system. That consists of express lanes for buses for quick boarding, and this has helped Curitiba with low-emission transit systems and cheap ticket prices.

Furthermore, the city Barcelona, Spain, has done some investments in smart waste disposal systems. With this system, citizens deposit their household waste into smart bins, which suck the waste into underground storage using vacuum. This reduces noise pollution from collection vehicles and the smell of rubbish waiting to be collected, and allows the city to monitor the level of waste coming from different areas to optimize waste collection. Afterwards, the incineration of waste is used to generate energy for heating systems (Glasco, 2022).

At last, there are some initiatives from Lisbon, Portugal. To develop a map of consumption and production of energy, smart meters were installed to limit maximum electricity flow and allow building and homeowners to better understand and control their energy consumption. Additionally, the city is using monitoring systems to be able to better control traffic flow. Through smart mobility tools, Lisbon is adapting street lighting based on pedestrian and vehicle flows, so that lighting can be dimmed when no traffic or pedestrians are detected (Tomás, 2017).

This demonstrates the global commitment of cities worldwide to prioritize sustainability and smart city development. While the examples discussed in this report are specific to the countries represented by the authors, it is important to acknowledge the abundance of initiatives and ideas implemented across the globe. Each city adopts a unique approach based on its specific challenges and priorities. However, commonalities can also be observed. Over time, these collective efforts can yield significant progress and it is crucial to continue striving for the most effective solutions, thereby bringing us closer to achieving the sustainable development goals by 2030.

4.5 Ghost Cities

In the area of urbanization, a contrasting phenomenon has emerged: ghost cities. These abandoned or underutilized urban areas serve as cautionary examples that highlight the challenges and complexities associated with the development of sustainable urban environments. By examining the following examples, valuable insights can be gained into the multifaceted nature of building successful urban environments that are both smart and sustainable.

4.5.1 Fordlândia, Brazil

Fordlândia was an ambitious industrial town project initiated by American automaker Henry Ford in the late 1920s. Located in the Amazon rain forest of Brazil, it aimed to secure a stable supply of rubber for Ford Motor Company's production lines. The project was intended to be a self-sufficient community that would produce its own rubber, generate hydroelectric power, and provide a healthy and productive environment for workers.

In 1927, Ford purchased around 2.5 million acres of land in the Tapajós River region, located in the state of Pará, Brazil. He envisioned Fordlândia as a model American town, complete with houses, schools, hospitals, libraries, recreational facilities, and even a golf course. The town was designed in a grid pattern, resembling an American Midwest city. However, the project faced numerous challenges and difficulties. The tropical climate, unfamiliar to the American engineers and workers, made it difficult to adapt to the harsh conditions. The rubber trees planted by Ford's team were vulnerable to diseases and insect attacks, resulting in low-quality rubber production. Additionally, clashes with indigenous tribes and labor issues added to the project's troubles.

Cultural clashes and Ford's insistence on imposing American customs and practices on the local Brazilian workers created tensions. The diet, work schedules, and living conditions imposed by Ford were often met with resistance from the workers. The American-style housing and food were incompatible with the local culture, leading to discontent and protests.

Ultimately, Fordlândia failed to achieve its intended objectives. By the late 1930s, the rubber project was considered a financial disaster for Ford. The rubber production never reached the expected levels, and the town's infrastructure deteriorated over time. The Brazilian government took over the project in 1945, and Ford eventually abandoned Fordlândia.

Today, Fordlândia is a small town in the Brazilian Amazon, with a population of around 2,000 people. The remnants of Ford's failed experiment can still be seen, including abandoned buildings, empty streets, and the deteriorating rubber plantations. Fordlândia serves as a reminder of the challenges faced by ambitious industrial projects in the Amazon rain forest and the complexities of merging different cultures and practices. (Macintyre, 2009)

4.5.2 Hashima Island, Japan

Hashima Island, also known as Gunkanjima or Battleship Island, is a small deserted island located off the coast of Nagasaki in Japan. The island's nickname, Battleship Island, comes from its distinct shape, resembling a battleship when viewed from a distance. Hashima Island is historically significant and has gained international attention due to its unique industrial heritage.

In the late 19th century, Mitsubishi Corporation purchased Hashima Island to establish undersea coal mines. The island's coal reserves played a crucial role in Japan's rapid industrialization during the Meiji period. Over time, the island was heavily developed, and to accommodate the growing population of workers, large concrete apartment buildings were constructed, making it one of the world's most densely populated areas.

During World War II, due to its strategic importance as a source of coal, Hashima Island became a forced labor camp where Korean and Chinese prisoners were made to work under harsh conditions. After the war, the island continued to operate as a coal mining facility, contributing significantly to Japan's post-war reconstruction efforts.

However, with the decline of coal as an energy source and the increasing availability of petroleum, Hashima Island's coal mines became unprofitable. Mitsubishi officially closed the mine in 1974, and the island was abandoned, leaving behind a ghost town-like atmosphere. (JapanWonderTravelBlog, 2020)

4.5.3 Teufelsberg listening station, Berlin, Germany

The Teufelsberg listening station is a former Cold War intelligence facility located in Berlin, Germany. It is situated on top of Teufelsberg, a man-made hill built from the rubble left over after World War II. The site played a significant role in the intelligence operations of the United States and its allies during the Cold War. Construction of the listening station began in the 1950s by the U.S. National Security Agency (NSA). Its primary purpose was to intercept and analyze communication signals, particularly those from the Soviet Union and Eastern Bloc countries. The strategic location on Teufelsberg provided an advantageous vantage point, as the hill offered a clear line of sight over the surrounding area.

After the fall of the Berlin Wall and the reunification of Germany in 1990, the listening

station became obsolete. The withdrawal of U.S. forces from Berlin led to the abandonment of the facility. Since then, the site has changed hands multiple times and has undergone various transformations.

Today, Teufelsberg and its abandoned listening station have become a popular tourist destination and a hub for urban exploration. The buildings, including the iconic radar domes, remain standing, albeit in a state of decay. Street artists have covered the structures with vibrant graffiti, adding to the unique and surreal atmosphere of the site. Guided tours are available, allowing visitors to explore the remnants of the Cold War intelligence gathering operations and learn about the history of the facility. (Walsh, 2018)

4.5.4 Detroit, USA

Detroit, once renowned as the 'Motor City,' epitomized American industrial might in the 20th century. This was largely due to its thriving automotive industry, with giants such as General Motors, Ford, and Chrysler making the city their home. A peak population of 1.8 million was recorded in the 1950 Census, demonstrating the city's vibrancy and economic strength.

However, the city's fortunes began to change in the second half of the century due to a combination of socio-economic factors. One notable change was the 'White Flight' that took place during the 1950s and 1960s, a mass migration of white individuals to the suburbs. This mass exodus led to a significant decline in population and subsequently, a reduction in tax revenues.

Simultaneously, deindustrialization took a heavy toll on Detroit. Many manufacturing jobs, especially those in the automotive industry, began moving overseas or to other parts of the U.S., further aggravating the city's economic predicament. Racial tension, which was prevalent during this period, culminated in the 1967 Detroit riots, contributing to the city's issues and accelerating its decline.

These series of events left Detroit with a deteriorating infrastructure and a growing debt. In 2013, with the city unable to meet its financial obligations, Detroit filed for the largest municipal bankruptcy in U.S history.

Post-bankruptcy, Detroit has embarked on a slow path to recovery. Efforts have been focused on urban renewal and attracting businesses to invigorate the local economy. Yet, many areas of Detroit still bear the scars of its turbulent past. The cityscape is marked

by abandoned houses and buildings, earning Detroit as a ghost city. (Weber, 2015)

In conclusion, these examples serve as warning stories for the development of Smart Eco Cities. These "ghost cities" highlight the importance of avoiding key errors in urban planning and development. To learn from these mistakes, future projects should prioritize comprehensive research and planning, adapting to local conditions, diversification of industries, sustainable manufacture maintenance and community engagement and empowerment. By acknowledging and learning from the mistakes made in past urban development attempts, future Smart Eco Cities can avoid the pitfalls that lead to the creation of "ghost cities".

4.6 Adapting existing cities vs. Building new ones

In the discussion of Smart Eco Cities, the choice between building new cities from scratch and adapting existing ones is a complex decision that involves a range of factors. Building new cities offers the advantage of a clean slate, enabling designers and planners to integrate cutting-edge technologies and sustainable practices right from the outset. It allows for careful consideration of urban layout, zoning, and infrastructure placement, facilitating the creation of efficient transportation networks, optimized energy grids, and innovative waste management systems. New cities can be designed with a focus on walkability, green spaces, and smart building designs that promote energy efficiency and reduce carbon emissions.

However, building new cities comes with its challenges. It requires significant investments in land acquisition, construction, and establishing basic amenities and services. Moreover, developing a new city from scratch often means displacing existing communities and disrupting natural habitats, which raises ethical and environmental concerns. Additionally, it may take years, if not decades, to fully develop a new city, making it a long-term commitment with uncertain outcomes.

On the other hand, adapting existing cities offers a more practical and potentially faster path towards sustainability. Retrofitting existing infrastructure with smart technologies, renewable energy systems, and eco-friendly solutions can bring about immediate improvements. Upgrading transportation systems, enhancing energy efficiency in buildings, and implementing

intelligent systems for water and waste management are among the possibilities. Adapting existing cities leverages the investments already made in infrastructure and utilizes the existing resources and communities, minimizing the ecological footprint associated with new construction.

Adapting existing cities may face constraints and challenges. It can be more complex and costly due to the need to integrate new technologies into an already established framework. Compromises may be necessary, as some adapting solutions might not be feasible in certain urban contexts. The process of adapting existing cities also requires careful urban planning and community engagement to ensure the changes align with the needs and aspirations of the residents.

Another huge and unique challenge is adapting old cities with historical background and infrastructures, like Toledo in Spain. With its rich historical heritage and intricate urban fabric, striking a balance between preserving the city's cultural identity and implementing modern sustainable technologies becomes crucial. Adapting existing buildings with energy-efficient systems while respecting architectural integrity and heritage protection regulations can be complex and costly. The narrow streets and limited space pose challenges for the installation of smart infrastructure, such as sensors or data networks. Additionally, engaging with the community and obtaining support from residents, businesses, and local authorities to embrace sustainable practices and adopt new technologies can be a significant challenge. Balancing the preservation of cultural heritage with the integration of smart and eco-friendly solutions requires careful urban planning, innovative approaches, and collaboration among stakeholders to ensure that this cities retains its charm while becoming a sustainable and intelligent city of the future.

As an example of an initiative for this kind of city, there is a project called "CinToledo" (ESMARTCITY, 2018) aims to transform the city of Toledo into a smart city. This project focuses on two main areas: applications and services for residents and tourists, and tools for improving city management and decision-making processes. Tourists can enjoy augmented reality experiences and guided tours through a mobile application, which showcases historical sites and monuments. Additionally, a mobility planner provides users with information on transportation options and routes, including accessibility features like escalators. The project also incorporates a communication channel for citizens to report issues and participate in municipal decision-making. A city management platform acts

as the "brain" of the smart city, gathering data from various applications and providing real-time information to improve decision-making and identify trends. The project aims to create a modern and participatory administration while leveraging smart tourism technologies to stimulate economic growth and employment in the city.

Ultimately, the choice between building new cities or adapting existing ones depends on a careful assessment of factors such as available resources, environmental impact, community involvement, and long-term sustainability goals. Both approaches have their merits and limitations, and a balanced and context-specific approach may involve a combination of both strategies to create smart eco cities that effectively address the challenges of urbanization while minimizing their environmental footprint.

4.7 Costs

The cost of building a Smart Eco City can vary greatly depending on several factors, such as the size of the city, its location, the level of technological integration, and the specific sustainability features included in the design. However, constructing a Smart Eco City typically involves significant upfront investments. Here are some cost considerations to keep in mind:

Land Acquisition: Acquiring suitable land for the eco city is one of the initial expenses. The cost will depend on the location, availability, and size of the land.

Infrastructure Development: Developing the necessary infrastructure for the city, including roads, bridges, utilities (water, electricity, sewage), and waste management systems, can be a substantial cost. Implementing smart technologies for efficient resource management and monitoring will add to the expenses.

Building Construction: Constructing residential, commercial, and public buildings within the smart eco city requires funding. The construction costs will depend on the type, size, and design of the buildings, as well as the chosen materials and technologies for sustainability.

Renewable Energy Systems: Incorporating renewable energy sources, such as solar panels, wind turbines, or geothermal systems, is a key feature of an eco city. The costs associated with designing, installing, and maintaining these systems can be significant but offer long-term benefits in terms of reduced energy consumption and carbon footprint.

Smart Technologies: Implementing smart infrastructure and technologies, such as smart grids, intelligent transportation systems, sensor networks, and data analytics platforms, requires investments in hardware, software, communication networks, and ongoing maintenance.

Green Spaces and Recreation Areas: Creating green spaces, parks, and recreation areas within the eco city helps enhance the quality of life and environmental sustainability. Designing and developing these areas will involve landscaping, planting trees, installing irrigation systems, and building recreational facilities.

Water Management: Implementing efficient water management systems, such as rainwater harvesting, wastewater recycling, and smart water meters, can contribute to water conservation efforts. However, the costs associated with implementing these systems and ensuring a reliable water supply should be considered.

Maintenance and Operations: Over the long term, ongoing maintenance and operations costs should be factored in. This includes the upkeep of infrastructure, smart technologies, green spaces, and utility systems.

It is challenging to provide an exact figure for the costs of developing a Smart Eco City from scratch as it depends on numerous variables. However, it's not uncommon for such projects to involve billions of dollars in investment. Additionally, securing funding from various sources, including public-private partnerships, government grants, and international financing, may be necessary to cover these expenses.

4.7.1 Costs of new cities

Building new cities, from empty spaces to tall buildings, is an extremely costly challenge. The natural and slow development of cities is a much more sensible process. To substantiate these conclusions, we performed simple calculations that allowed us to estimate the cost of building a new city.

In general, building new cities is very expensive. Costs are highly variable and depend heavily on site-specific conditions, but mostly depend on the ultimate success of the city. The development of a new city is as high as $1 million per prospective resident, although more often it can be done for around $100,000 to $500,000 per resident. In general, these numbers decline as the city's population increases over time. In order to get an estimated cost of building the city, we obtained information on the cost of building Brasilia - a city

built in accordance with the 15 minutes city rule.

To perform this task the following formula is going to be used. It is a vague approximation that can help to get a wide overview.

$$\frac{\text{building city cost}}{\text{people living in the city}} \text{ x amount of citizens planned}$$

In this case the building costs were 1.5 billions dollars for 500,000 people, and it is going to be calculated for 50,000 people.

$$\frac{1,500,000,000}{500,000} \text{ x } 50,000 = \$150,000,000$$

Using this method is found that the price per habitant is $150,000,000. It is still not a precise way of calculating it. Another way of doing it is done by UN-Habitant (Kamiya et al., 2020) using the example in table 4.1.

Table 4.1: Expenditure (in million $) on Different Categories (Kamiya et al., 2020)

Country	**Housing**	**Transport**	**Solid Waste**	**Public Space**	**Governance and Planning**	**Total**
Bolivia	18.81	29.13	0.63	4.36	1.36	54.29
India	4.71	9.38	1.69	17.82	0.84	34.43
Malaysia	0.06	16.43	0.18	0.09	1.72	18.48
Colombia	15.44	19.26	0.38	2.79	1.09	38.96

Within this method, the results are between 18,48 and 54,29 $ millions per habitant, which gives a much precise and bigger amount of money than the previous one, as this is done based on statistical and actual research while the previous one is done based on old historical data and a non realistic formula.

4.7.2 Costs of adapting

Adapting existing cities into Smart Eco Cities entails a range of costs, both financial and logistical. The transformation requires significant investments in upgrading existing infrastructure, implementing advanced technologies, and integrating sustainable practices. These costs can vary depending on the size and complexity of the city, as well as the extent of the desired smart and eco-friendly interventions.

Upgrading the infrastructure to support smart systems and services is often a major expense. This includes installing sensor networks, upgrading communication and data

management systems, and integrating renewable energy sources. Additionally, adapting existing buildings with energy-efficient technologies, such as smart meters and automated systems, adds to the overall costs.

Another factor to consider is the cost of acquiring and deploying advanced technologies. This may involve investing in smart grid systems, intelligent transportation systems, waste management systems, and other innovative solutions to enhance the sustainability and efficiency of the city. Furthermore, training and educating the workforce to operate and maintain these technologies can be an additional expense.

In addition to the financial aspects, the process of transforming existing cities into Smart Eco Cities often requires careful planning, collaboration, and coordination among various stakeholders. This may involve engaging with local government bodies, community organizations, private sector partners, and residents to ensure a successful transition. The costs associated with project management, feasibility studies, public consultations, and change management initiatives should also be considered.

While the costs of adapting existing cities into Smart Eco Cities can be substantial, it is essential to recognize that these investments often yield long-term benefits. These benefits include improved energy efficiency, reduced carbon emissions, enhanced quality of life for residents, increased economic opportunities, and a more sustainable future. Governments, private entities, and communities must weigh the initial costs against the long-term advantages and work together to find innovative financing models to support the transformation into smart eco cities.

The "Smarter Together" project in Lyon-Confluence (European Commission, 2017), France, focuses on transforming the area into a zero-carbon urban environment through various initiatives. The project includes retrofitting 35,000 m^2 of existing buildings to reduce energy consumption and developing local renewable energy generation, such as a wood-fired cogeneration power plant and photovoltaic systems. The total investment for the project is €37.5 million, with €7 million funding from the EU. The primary energy savings are projected to be 5,477 MWh/year, and the CO2 emissions reduction is estimated at 3.534 t CO_2/year.

Another example is the case of Valladolid (European Commission, 2017). In this case the DIRECTION project in Valladolid, Spain, aimed to achieve very-low-energy new buildings through innovative and cost-effective energy-efficient technologies. The

project resulted in significant reductions in energy consumption, cutting thermal energy and electricity use in the CARTIF III building by half compared to the reference building. This led to annual energy savings of 163 MWh and a CO2 emissions reduction of 101 tones. The total investment for energy efficiency and renewable energy interventions was €544,660.

In terms of cost, the "Smarter Together" project in Lyon-Confluence involved a significantly higher investment compared to the DIRECTION project in Valladolid. Lyon-Confluence required a total investment of €37.5 million, reflecting the extensive scope of the project and the implementation of various sustainable infrastructure and technologies. On the other hand, the DIRECTION project in Valladolid had a lower investment of €544,660, indicating a more focused approach targeting very-low-energy new buildings.

The contrasting costs can be attributed to several factors, including the scale of the projects, the complexity of interventions, and the specific goals and objectives pursued. These cost variations highlight the importance of considering the scale, scope, and specific objectives of each project when analyzing investment requirements.

Overall, the choice of adapting existing cities should take into account the available resources, project goals, and the potential return on investment. The prices can appear to be lower than building new ones from scratch, but it need to stick to much more strict existing requirements, and spend more money on planning.

4.8 Survey Research

Looking at Agenda 2030, there are many goals that need to be achieved. Therefore, it was decided to conduct our own survey to find out people's opinions on the issues of the Agenda 2030. There were 80 participants in the survey and their answers are presented in the following section.

The first questions in this survey were related to gender (Figure 4.4), age nationalities (Figure 4.5), and age (Figure 4.10). The target group was young adults of different nationalities.

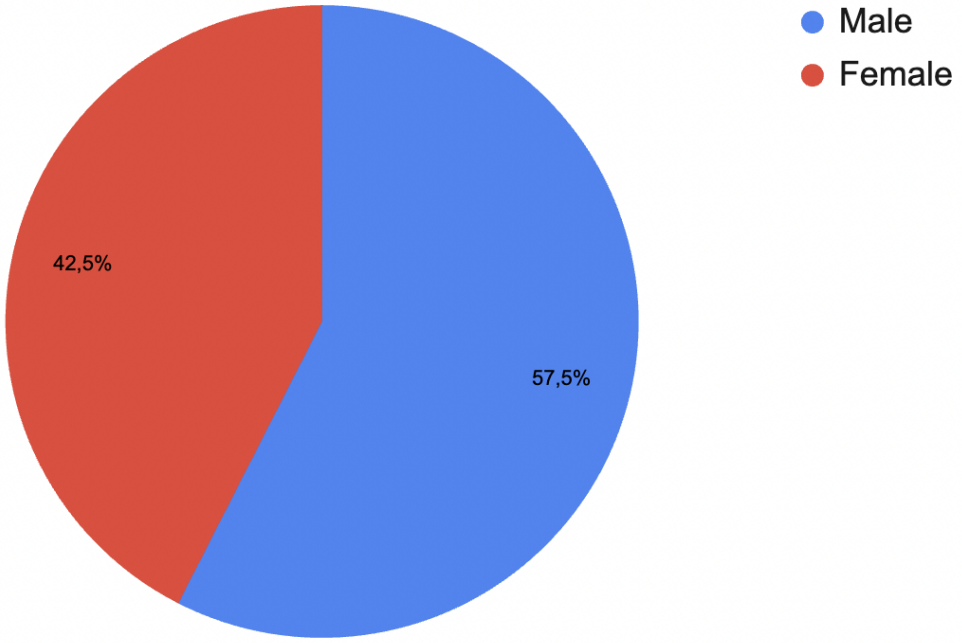

Figure 4.4: Gender

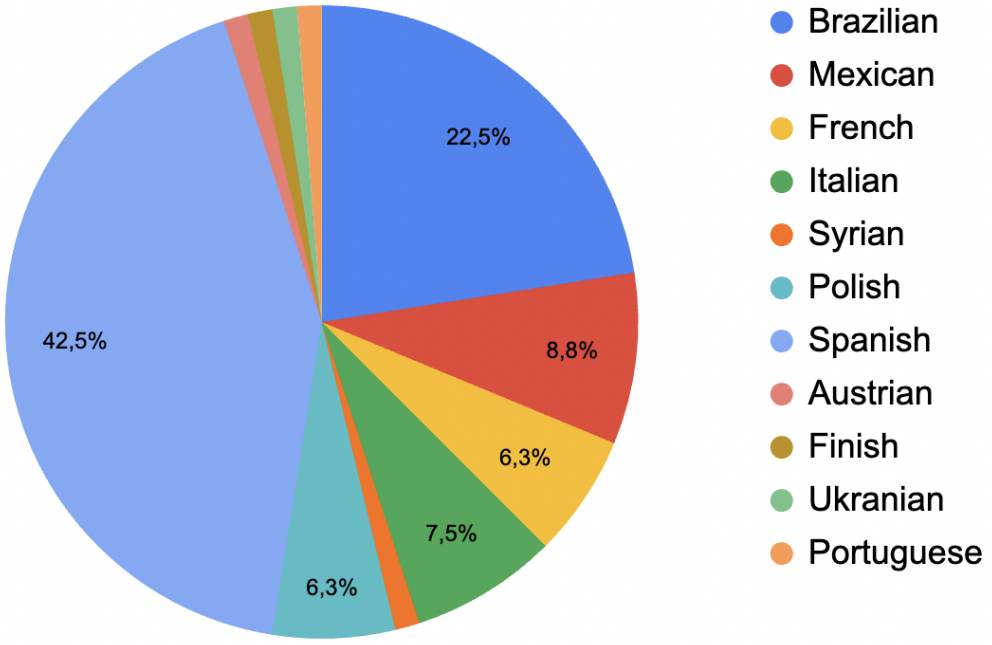

Figure 4.5: Nationality

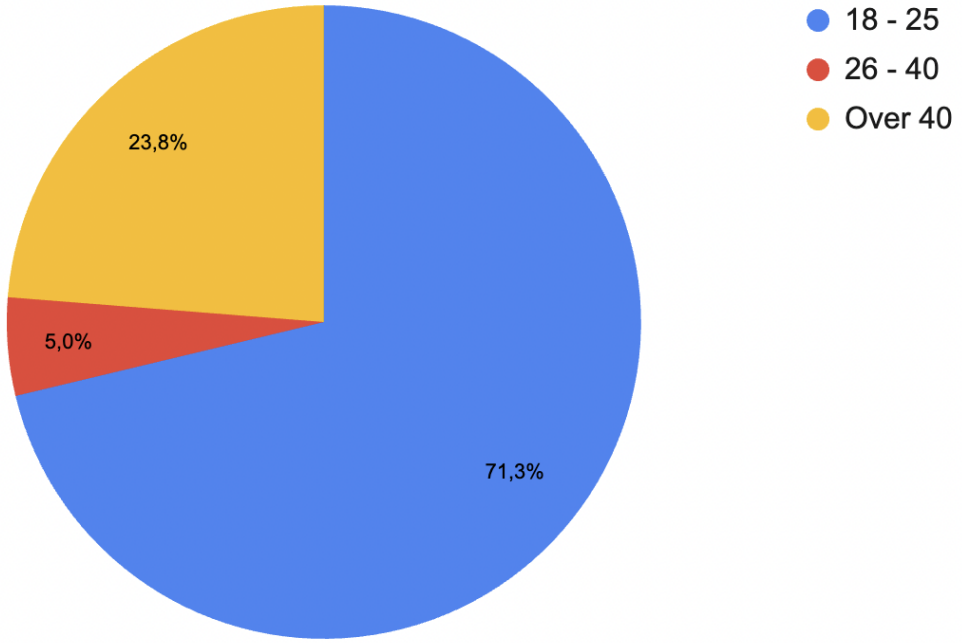

Figure 4.6: Age

Afterwards, the question was "When thinking about the quality of life in a city, which aspects do you consider most important? (Select 3)"

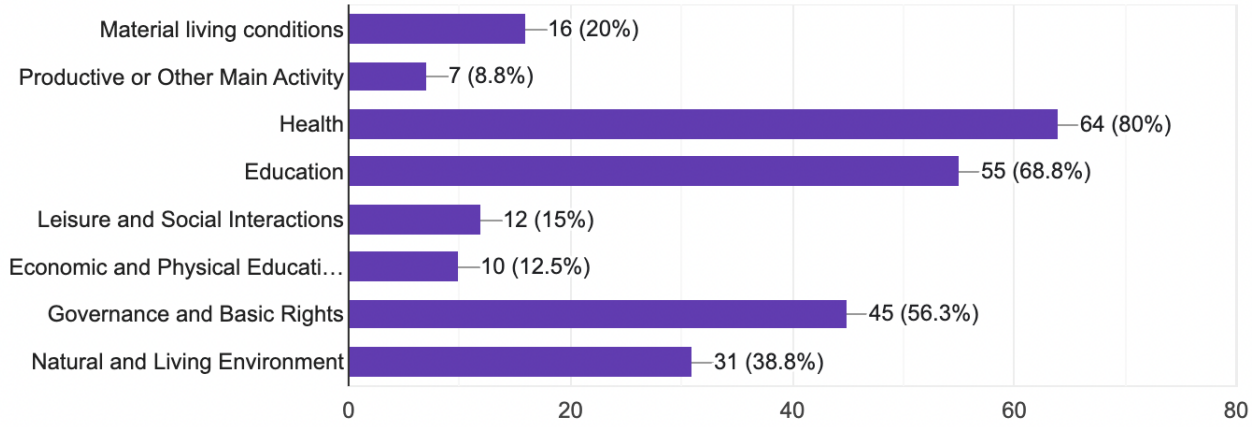

Figure 4.7: Quality of life pillars

These findings suggest that priorities for improving quality of life should include health care and healthy living conditions, quality education and learning opportunities, and good governance and protection of individual rights.

The following questions were about the agenda 2030 goals. "Which one of this goals of agenda 2030 do you think it's most important to achieve as a society? (Select 3)".

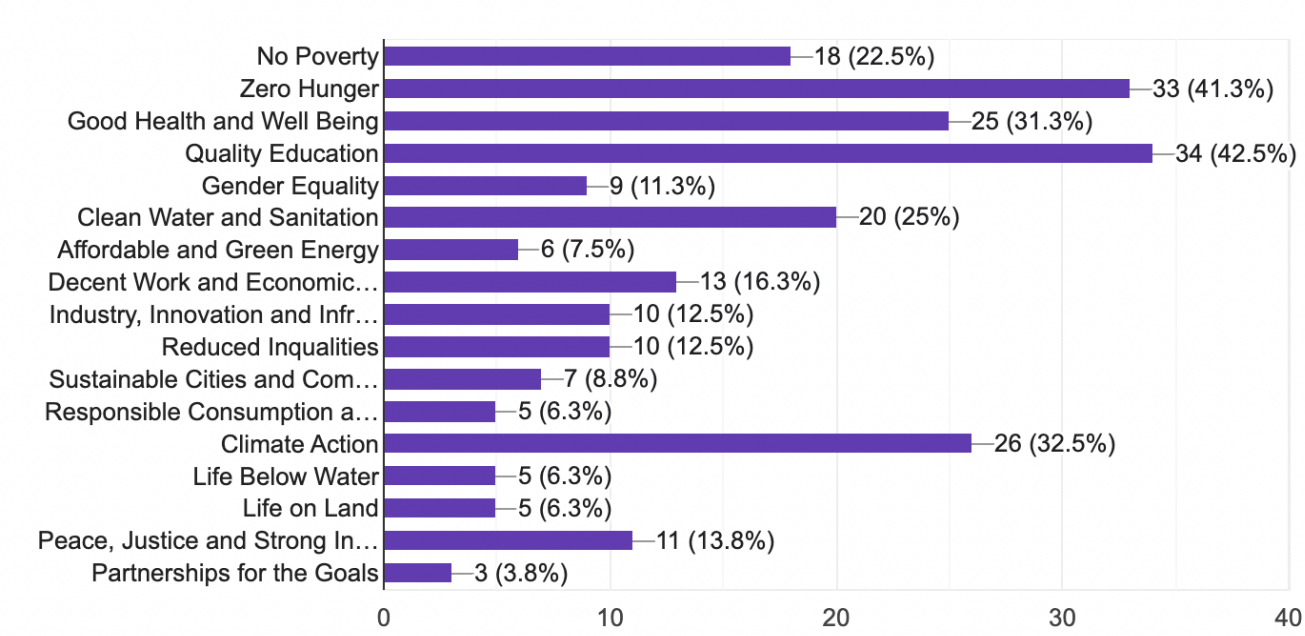

Figure 4.8: Most important goals of Agenda 2030

And, "Which one of these goals of agenda 2030 do you think it's least important to achieve as a society? (Select 3)"

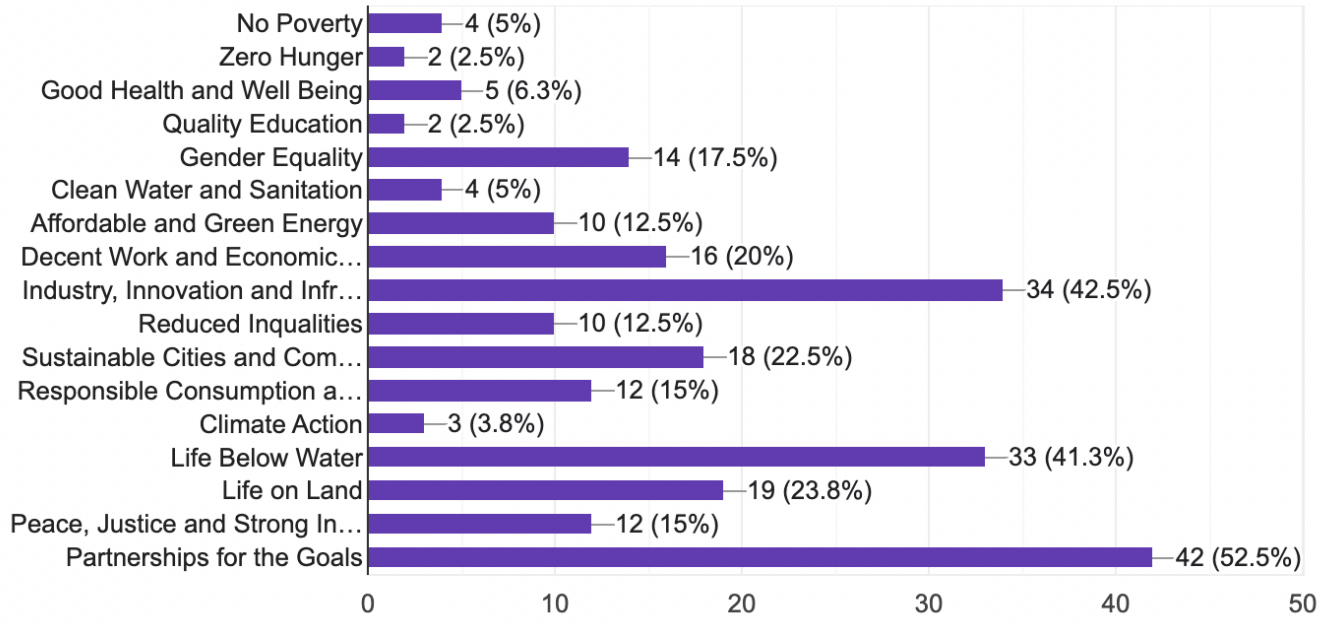

Figure 4.9: Least important goals of Agenda 2030

The goals voted more important to achieve were "Quality education" (42.5%), "Zero Hunger" (41.3%), "Climate action" (32.5%) and "Good health and well being" (31.3%).

Moreover, the goals voted less important were "Partnership for the goals" (52.5%), "Industry, innovation and infrastructure" (42.5%) and "Life below water" (41.3%).

These results can be used as a starting point on how to allocate the resources as these topics are seem as most important to the people living in the cities, however, it is also important to highlight that the goals of agenda 2030 are interconnected and should be pursued collectively to achieve sustainable development.

Finally, the last question was "Which one of these goals of agenda 2030 do you think is not possible to achieve until 2030? (Select 3)"

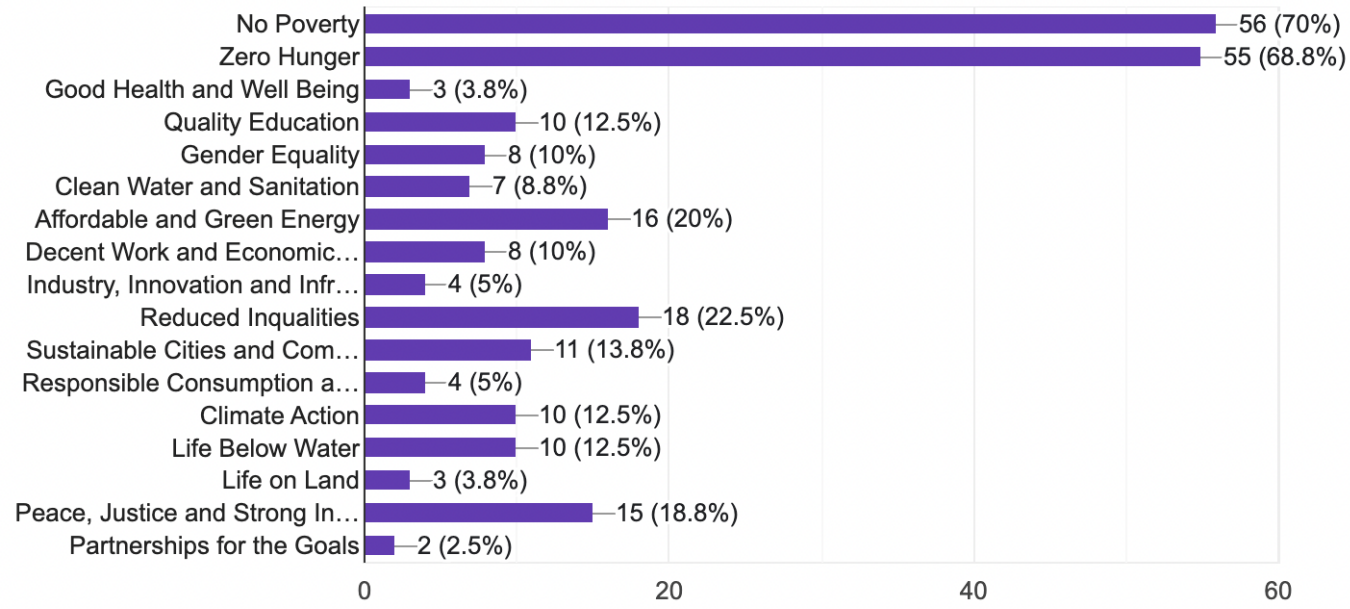

Figure 4.10: Most difficult goals to achieve of Agenda 2030

The top results were "No poverty" (70%), "Zero hunger" (68.8%) and "Reduced inequalities" (22.5%). The high percentages assigned to the first two, indicate the recognition of the complex and persistent nature of these global challenges. Eradicating poverty and hunger will require a lot of effort and it may not be possible to achieve in such little time. "Reduced inequalities" received a lower percentage then the other two, but it is still acknowledged as a challenging objective.

4.9 Quality of Life

Quality of life is a multifaceted concept that includes various aspects or components that can be evaluated using specific sub-dimensions and corresponding indicators. It encompasses both objective factors, such as access to resources, health, employment, and living conditions, as well as subjective perceptions of these factors. The subjective perception of quality of life is influenced by individuals' priorities and requirements. Comparatively assessing the quality of life across different populations and countries is challenging and requires a comprehensive set of indicators covering diverse dimensions. In this reports there are going to be presented a set of frameworks and tools used to measure quality of life, an essential need for Smart Eco Cities.

4.9.1 The 8+1 dimensions of quality of life

Efforts to evaluate societal progress and well-being beyond traditional economic measures have led to significant initiatives. One of these initiatives was the establishment of The Sponsorship Group on Measuring Progress, Well-Being, and Sustainable Development by the European Statistical System. This group aimed to develop specific indicators that would provide a more comprehensive understanding of quality of life. Eurostat, in collaboration with an Expert Group consisting of experts from national statistical offices, scientists, and representatives from international organizations, created a set of 8+1 Quality of Life Indicators. These indicators take into account multiple dimensions of well-being and offer a broader perspective on the situation of households and the sustainability of societies. The indicators can be found on the table 4.2

Table 4.2: 8+1 Indicators for Measuring Quality of Life (Eurostat, 2023c)

Dimension	**Indicator**
1. Material Living Conditions	Median income S80/S20 (inequality of income) Severe deprivation rate
2. Productive or Other Main Activity	Employment rate Job satisfaction
3. Health	Life expectancy Self-perceived health status
4. Education	Tertiary educational attainment
5. Leisure and Social Interactions	Satisfaction with time use Help from others
6. Economic and Physical Security	Inability to afford unexpected expenses Homicide rate Perception of crime, violence, or vandalism in the living area
7. Governance and Basic Rights	Trust in the legal system
8. Natural and Living Environment	Urban pollution Perception of pollution, grime, or other environmental problems in the living area
9. Overall Experience of Life	Life satisfaction

In general, the 8+1 indicators provide a comprehensive view of the quality of life in a society. They cover various dimensions, including economic well-being, work, health, education, leisure, social interactions, safety, governance, and the environment. By measuring these indicators, policymakers and researchers can identify areas of strength and weakness within a society and develop targeted interventions to improve the well-being of individuals and communities. However, it is important to note that these indicators are

not exhaustive and may not capture the full range of factors that contribute to quality of life. Nonetheless, they provide a solid foundation for assessing and improving quality of life in a society.

4.9.2 Happy City Index

The ranking of cities in the Happy City Index (Happy City Index, 2023) is a yearly study based on thousands of indicators developed by researchers. These indicators directly relate to the quality of life and the sense of happiness of the residents. The ranking takes into account objective information, open data, and interviews conducted with residents. It evaluates cities against 24 different areas of activity, divided into 5 key categories: Citizens, Governance, Environment, Economy, and Mobility. Table 4.3 presents the list of the indicators used in the last ranking in 2023.

Table 4.3: Areas and Categories in the Happy City Index (Happy City Index, 2023)

Category	**Areas**
Citizens	Educational system
	Social inclusion of residents
	Innovation and creativity of residents
	Access to culture, including libraries
Economy	Gross Domestic Product and Productivity
	Innovation and creativity of enterprises
	Entrepreneurship
	Labour market flexibility and unemployment
Governance	Involvement of residents in decision-making processes
	Transparency in operation and openness of data
	Accessibility of public e-services
	Conscious strategies
Environment	Management of natural resources, including renewable energy sources
	Anti-pollution
	Waste, wastewater management and recycling
	Availability of green areas
Mobility	Use of information and communication technologies in transport
	Accessibility and efficiency of public transport
	Safety of the transport system
	Openness of transport data

The aim of the ranking is not to determine the single best city in terms of ensuring the happiness of its citizens in the long term. Instead, it aims to discover and promote good trends that contribute to the happiness of people around the world. Therefore, the ranking identifies a group of cities that form a class of the happiest cities on the planet, known as the Golden Cities. The cities included in this group may vary each year based

on the indicators and point values from the reports. This is the top 10 cities of 2023 including the score in each section.

Table 4.4: Top 10 Happy Cities Ranking

City, Country	CIT.	GOV.	ECO.	ENV.	MOB.	TOTAL
Aarhus, Denmark	364.4	302.2	324.7	325.3	297.6	1614.2
Amsterdam, Netherlands	348.7	307.8	306.4	323.0	292.2	1578.1
Bergen, Norway	324.8	302.2	326.4	321.2	293.5	1568.1
Brisbane, Australia	375.5	306.5	308.8	321.8	272.6	1585.2
Canberra, Australia	363.5	295.0	308.2	313.7	275.4	1555.8
Eskilstuna, Sweden	374.7	300.0	311.1	309.6	270.8	1566.2
Geneva, Switzerland	393.1	299.0	327.0	284.1	296.7	1599.9
Helsinki, Finland	345.1	312.2	297.6	324.1	294.4	1573.4
Jonkoping, Sweden	386.7	311.9	311.7	257.4	288.1	1555.8
London, United Kingdom	392.2	309.7	276.4	326.4	282.2	1586.9

Is summary, Happy City Index recognizes that happiness is determined by many factors, and each person has different needs influenced by historical, geopolitical, or traditional conditions. It acknowledges that a city is an ever-changing landscape shaped by its inhabitants' social, political, and economic activities. It provides a comprehensive assessment of cities based on various factors that contribute to the happiness and well-being of their residents. It aims to promote positive trends and highlight successful cities in creating a happy and fulfilling environment for their citizens.

4.10 Agenda 2030

In this report Agenda 2030 is considered as one of the biggest basis on how we approach the cities, what are our goals and needs. After reading in detail Agenda 2030 research was carried out on the topics it raised, drawing its own conclusions. There is a list explaining how any of these topics should be treated. (Samaan, 2023)

4.10.1 No Poverty

Preventing poverty in a smart eco city requires a comprehensive approach that addresses social, economic, and environmental factors.

Accessible Education and Skill Development: Provide accessible and quality education at all levels, including vocational training and skill development programs. This empowers individuals to acquire the necessary skills for better employment opportunities and entrepreneurial ventures.

Promote Economic Diversity and Job Creation: Encourage a diverse range of industries and job opportunities within the smart eco city. Foster innovation, entrepreneurship, and investment to create a vibrant economy that offers a variety of employment options.

Social Safety Nets: Establish social safety nets such as welfare programs, unemployment benefits, and healthcare services to provide support to those in need. Ensure these safety nets are easily accessible and well-targeted to assist individuals and families at risk of poverty.

Affordable Housing: Develop policies and initiatives that promote affordable housing options within the smart eco city. This includes rent control, subsidized housing, and housing assistance programs to ensure that individuals and families can access safe and affordable housing.

Digital Inclusion: Ensure access to affordable and reliable internet connectivity and digital infrastructure throughout the smart eco city. Bridge the digital divide by providing training and resources to enable residents to leverage digital technologies for education, employment, and entrepreneurship.

4.10.2 Zero Hunger

Preventing hunger in a smart eco city requires a comprehensive approach that addresses both the immediate needs of the population and the long-term sustainability of food production and distribution.

Sustainable agriculture: Promote urban farming, vertical farming, and hydroponics to maximize food production within the city. Utilize smart technologies such as sensors and automated systems to optimize resource usage, increase productivity, and reduce waste.

Efficient food distribution: Develop smart logistics systems that minimize food wastage

and ensure timely delivery of fresh produce. Implement intelligent routing and tracking systems to streamline the supply chain from farm to table, reducing transportation costs and environmental impact.

Community gardens and allotments: Encourage the establishment of community gardens and allotments in residential areas. These spaces can provide individuals and families with opportunities to grow their own food, fostering self-sufficiency and a sense of community.

Food waste management: Implement effective waste management systems that include composting, recycling, and food recovery programs. By reducing food waste and diverting it to productive use, more resources can be conserved and made available for those in need.

Food education and awareness: Promote education programs on nutrition, healthy eating habits, and sustainable food choices. Encourage citizens to make informed decisions about their food consumption patterns, which can lead to reduced food waste and improved health outcomes.

4.10.3 Good Health and well-being

Health care in smart eco cities combines advanced technology, sustainable practices, and innovative healthcare solutions to provide efficient and accessible healthcare services to residents.

Telemedicine and Telehealth: Smart eco cities leverage digital technologies to enable remote consultations, diagnostics, and monitoring. Telemedicine platforms allow residents to consult healthcare professionals through video calls, reducing the need for in-person visits. Remote monitoring devices can track vital signs and send real-time data to healthcare providers, enabling proactive interventions and personalized care.

Electronic Health Records (EHRs): Smart eco cities adopt electronic health record systems that store and manage individual's health information securely. EHRs enable seamless sharing of patient data among healthcare providers, ensuring coordinated care and reducing medical errors. Integrated EHR systems also support data analytics for population health management and disease surveillance.

Wearable Devices and Health Sensors: Residents in smart eco cities can utilize wearable devices, such as smart watches or fitness trackers, to monitor their health and

well-being. These devices can track physical activity, heart rate, sleep patterns, and other health parameters. Health sensors integrated into the city's infrastructure can also provide real-time data on air quality, temperature, and pollution levels, enabling proactive measures to promote public health.

Emergency Response Systems: Smart eco cities incorporate advanced emergency response systems to enhance public safety and reduce response times. Integration of smart surveillance systems, automated emergency alerts, and location-based services helps emergency responders reach the scene quickly. Furthermore, connected ambulances equipped with telemedicine capabilities can provide immediate medical assistance during transit.

4.10.4 Quality Education

Smart Eco Cities represent the convergence of technology, sustainability, and community wellbeing. As these cities aim to achieve goal of ensuring quality education for all, they are leveraging innovative approaches and digital advancements to transform educational methods. By embracing technology, caring for collaboration, and prioritizing sustainability education, Smart Eco Cities are paving the way for enhanced learning experiences and empowering residents to thrive in a rapidly evolving world.

In order to live sustainably, individuals must acquire certain skills, values, and attitudes. These competencies are essential for addressing the challenges of everyday life and actively contributing to the establishment of sustainable societies. However, in today's rapidly evolving world, characterized by constant shifts in social, economic, and political norms, continuous learning becomes a huge challenge. Lifelong learning emerges as a crucial asset that supports individuals and communities in attaining sustainable social and economic progress. This goal urges new cities to ensure inclusive, equitable, and high-quality education, as well as promote lifelong learning opportunities accessible to all. Having in consideration all of this issues, a list of important topics and areas is provided.

E-Learning Platforms: Smart eco cities are embracing e-learning platforms as powerful tools for expanding educational opportunities. These platforms provide a wealth of resources, including interactive courses, virtual classrooms, and multimedia content. By offering flexibility and personalized learning experiences, residents can acquire knowledge and skills at their own pace, fostering a culture of lifelong learning and providing the

population with greater accessibility to a high quality education. A mandatory requirement for this topic is a digital infrastructure with high-speed internet connectivity and Wi-Fi networks widely accessible.

Smart Classrooms: Equipped with state-of-the-art technologies, smart classrooms revolutionize traditional learning environments. Interactive whiteboards, projectors, and smart devices transform classrooms into dynamic spaces that foster collaboration, critical thinking, and creativity. These tools engage students in immersive learning experiences while empowering educators to deliver interactive lessons that cater to diverse learning styles.

Open Educational Resources (OER): Smart eco cities champion the use of open educational resources to promote equal access to quality educational materials. Open textbooks, online courses, and educational videos are made readily available, reducing financial barriers and empowering residents to pursue knowledge and skills regardless of their socioeconomic backgrounds. When speaking about OER the first thing that has to be taken in consideration are the UNESCO regulations done in 2019, a necessity to accomplish within this topic. (UNESCO, 2023)

Sustainable Education Practices: Sustainability education is seamlessly integrated into the curriculum of smart eco cities. Students learn about sustainable practices, renewable energy, waste management, and conservation. By instilling a sense of environmental stewardship, smart eco cities cultivate environmentally conscious citizens who actively contribute to building a sustainable future. (UNESCO, 2020)

To sum up, as the IEEE shows, "The ultimate goal of the smart education is producing a smart citizen who can be able to apply, manipulate and propagate whatever the circuitry, data and skills required to live in, run and sustain the smart cities." (IEEE, 2022)

4.10.5 Gender Inequality

Inequality between women and men is increasing in the world instead of decreasing. This is according to the new edition of the Global Gender Gap Index report published by the World Economic Forum (WEF). The increase in inequality, as measured by the GGGI index, occurred for the first time in the 12 years. The World Economic Forum has estimated that "at the current pace of change, it will take 100 years to achieve gender equality in the world's social and economic life."

Here are some key steps to promote gender equality in smart eco cities:

Inclusive urban planning: Ensure that urban planning processes consider the needs and perspectives of all genders. Engage women and other marginalized groups in decision-making processes related to urban design, transportation, infrastructure, and public spaces.

Accessible and safe infrastructure: Develop infrastructure that is accessible and safe for everyone, including women. This includes well-lit streets, reliable public transportation, accessible pathways, and public spaces designed to enhance safety and inclusivity.

Work-life balance and flexible employment: Implement policies that promote work-life balance, such as flexible working hours, parental leave, and childcare facilities. Encourage employers to adopt family-friendly policies that enable women to participate in the workforce while balancing caregiving responsibilities.

Gender-disaggregated data collection: Collect and analyze gender-disaggregated data to identify and address gender disparities in various aspects of smart eco cities. This data can inform evidence-based policies and interventions aimed at promoting gender equality.

Public awareness and cultural change: Conduct public awareness campaigns to challenge gender stereotypes and promote a culture of gender equality. Engage community leaders, schools, and media to change societal attitudes and promote inclusivity.

4.10.6 Clean Water and Sanitation

Clean water and sanitation are essential components of a smart eco city, as they directly impact the health, well-being, and sustainability of its residents.

Water Management Systems: Implementing advanced water management systems is crucial for optimizing water usage and reducing wastage. Smart metering, leak detection, and remote monitoring systems can help identify and address water leaks promptly, minimizing water loss.

Smart Water Distribution: Deploying smart technologies, such as sensors and real-time monitoring, allows for efficient management of water distribution networks. By monitoring water flow and pressure, cities can optimize supply, detect abnormalities, and respond quickly to maintenance needs.

Water Treatment and Purification: Employing innovative water treatment technologies ensures the provision of safe and clean water to residents. Advanced filtration systems,

such as membrane filtration, reverse osmosis, and ultraviolet disinfection, can effectively remove contaminants and pathogens.

Greywater and Rainwater Harvesting: Encouraging the use of greywater (water from showers, sinks, etc.) and rainwater for non-potable purposes, such as irrigation and toilet flushing, can significantly reduce the strain on freshwater resources. Smart systems can facilitate the collection, storage, and distribution of harvested water.

4.10.7 Affordable and Clean Energy

The importance of clean energy sources cannot be overstated in today's world, as we face pressing challenges such as climate change, air pollution, and resource depletion. Shifting towards clean energy is crucial for mitigating greenhouse gas emissions, reducing our reliance on finite fossil fuel reserves, and creating a more sustainable and resilient energy system.

Renewable Energy sources: Solar, wind, hydro and geothermal power are abundant and have significantly lower greenhouse gas emissions compared to other sources of energy, like fossil fuels. Governments, businesses, and individuals can invest in renewable energy infrastructure, promote research and development, and provide incentives to accelerate the transition to clean energy.

Improving energy efficiency: Reducing energy waste through better insulation, energy-efficient appliances, and sustainable building design, can decrease the overall energy demand and help reduce greenhouse gas emissions and energy costs.

Decentralized energy systems: The adoption of small-scale renewable energy installations, such as rooftop solar panels, can enhance energy resilience, empower local communities, and reduce transmission losses associated with long-distance power distribution.

Policy frameworks: Governments can establish supportive policies, including feed-in tariffs, tax incentives, and carbon pricing mechanisms, to encourage clean energy investments. Encouraging public-private partnerships, knowledge sharing, and capacity building can further accelerate the deployment of clean energy technologies worldwide.

4.10.8 Decent Work and Economic Growth

In the perspective of Smart Eco Cities there are several actions that can be taken to promote sustainable economic development and create decent work opportunities. Here

are some key initiatives:

Foster Innovation and Entrepreneurship: Smart Eco Cities can establish incubation centers and innovation hubs to encourage the development of sustainable technologies, products, and services. These initiatives can provide support, mentoring, and resources to aspiring entrepreneurs, leading to job creation and economic growth.

Promote Green Industries: Emphasize the development and growth of green industries such as renewable energy, sustainable agriculture, waste management, and eco-friendly manufacturing. This approach can create employment opportunities while reducing the environmental impact of economic activities.

Enhance Digital Infrastructure: Invest in high-speed broadband connectivity and robust digital infrastructure to enable the growth of digital industries and remote work. This allows people to work from home or in co-working spaces, reducing commuting needs and enhancing work-life balance.

Enable Circular Economy Practices: Encourage businesses and industries to adopt circular economy principles, such as recycling, reusing, and reducing waste. This approach can stimulate economic activity, create new jobs in waste management and recycling sectors, and contribute to sustainable development.

4 days week: The four-day workweek is an alternative work arrangement where employees work for four days in a week instead of the traditional five-day workweek. This new initiative has been taking strong last years and there is a lot of new studies and enterprises adopting this new culture. As the "4weeks" initiative sais, "Adopting a 4 day week is a business improvement strategy centered on working smarter rather than longer, and investing in the wellbeing of the most important asset to any business. We advocate for the 100-80-100 model – 100% of the pay, 80% of the time, but critically in exchange for 100% of the productivity." (4 Day Week Global, 2023)

From June to December 2022 a study was conducted in the UK comprising 61 companies and around 2,900 workers. Regarding the results, it can be concluded that it has been a success. 61 of the companies that participated, 56 report that they are continuing with the four-day week and 18 of these continuing companies have said that the policy is permanent. (Autonomy, 2023)

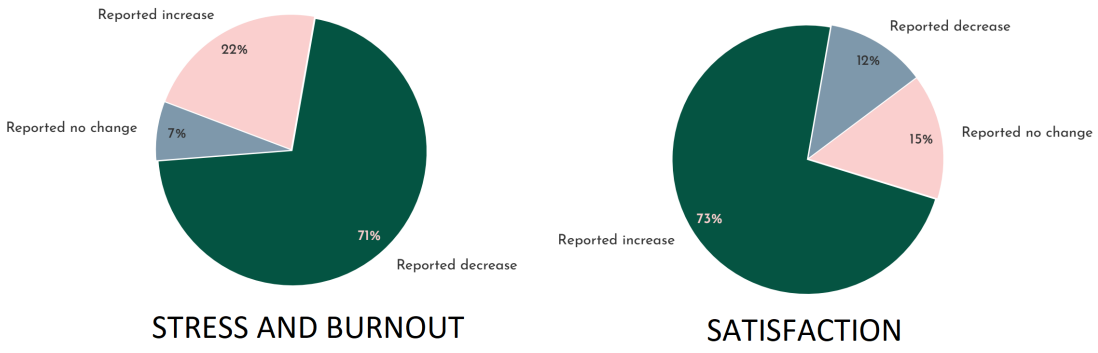

Figure 4.11: Comparison between Stress and burnout and Satisfaction

As can be observed in the Figure 4.11, there is some data supporting that study showing that this initiative can be beneficial for both, companies and workers.

4.10.9 Industry, Innovation and Infrastructure

The presence of robust and sustainable industry, innovation, and infrastructure is crucial for economic growth, job creation, and overall societal progress. This sector plays a pivotal role in driving technological advancements and promoting sustainable practices.

Governments and private sector stakeholders' priorities: These institutions should prioritize investment in infrastructure development, particularly in regions that are underserved or marginalized, including improving transportation systems, expanding access to reliable energy sources, and enhancing digital connectivity to bridge the digital divide.

Public-private partnerships: Collaboration between governments, businesses, and civil society organizations can attract funding, manage risks and leverage the expertise and resources of each sector, promoting innovation and enabling the development of sustainable infrastructure projects.

Small and medium-sized enterprises: Supporting these institutes by financial incentives and capacity-building programs will foster innovation, create jobs and drive economic diversification.

4.10.10 Reduced Inequality

In the perspective of Smart Eco Cities there are several actions that can be taken to try reducing inequalities among cities. As can be observed in Figure 4.12, there is a big inequality in the world depending on the areas.

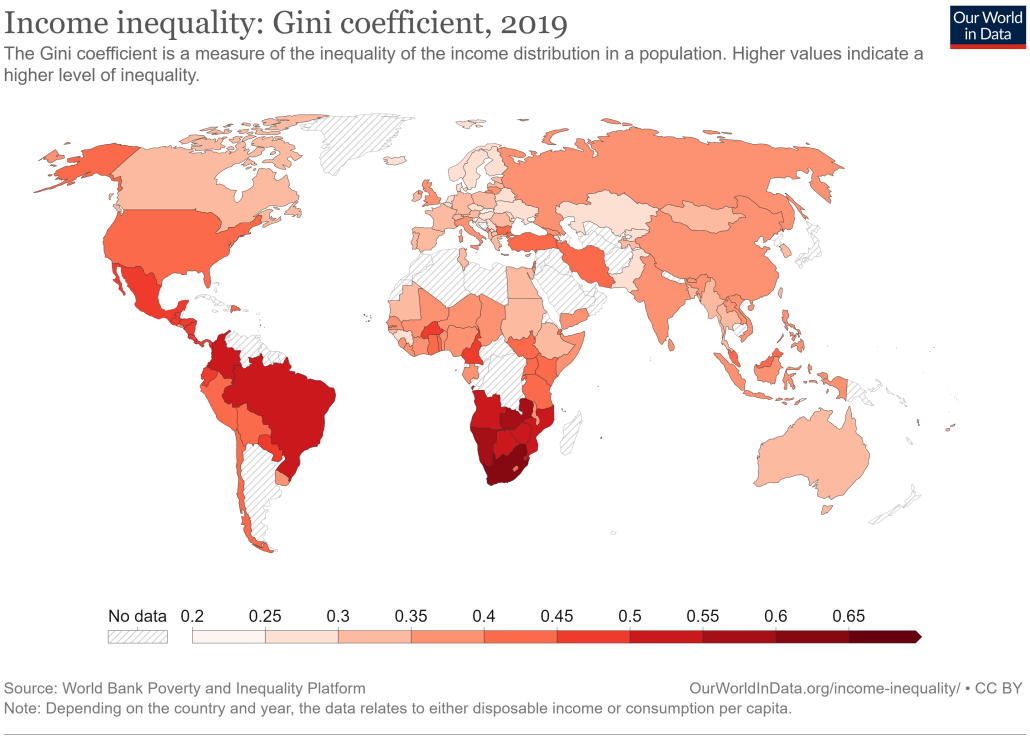

Figure 4.12: Income Inequality in 2019 (Roser, 2013)

Digital Inclusion: Ensure equitable access to digital technologies and internet connectivity for all residents of Smart Eco Cities. This includes providing affordable or free internet access in public spaces, promoting digital literacy programs, and bridging the digital divide among different socio-economic groups. An example of this is the United Nations Development Programme. (United Nations Development Programme, 2023)

Affordable Housing: Implement smart housing solutions that address the housing needs of all residents, including low-income households. This can involve the use of sustainable and energy-efficient building practices, innovative financing models, and mixed-income housing developments to ensure affordable and accessible housing options. A program that encourages actions among this topic is the United Nations Human Settlements Programme. (United Nations, 2023b)

Inclusive Urban Planning: Adopt inclusive urban planning strategies that consider the

needs and aspirations of diverse populations within smart eco cities. This involves engaging marginalized communities, promoting participatory planning processes, and incorporating universal design principles to create accessible and inclusive urban environments.

Social Safety Nets: Develop and implement social safety net programs that provide support and assistance to vulnerable populations within Smart Eco Cities. This can include income transfer schemes, healthcare subsidies, and educational support programs aimed at reducing poverty and inequality.

Inclusive Transportation Systems: Design and promote inclusive transportation systems that cater to the needs of all residents, including people with disabilities, the elderly, and those with limited mobility. This involves providing accessible public transportation options, pedestrian-friendly infrastructure, and promoting non-motorized transport modes. (UNECE, 2021)

Job Creation and Skills Development: Foster economic opportunities and promote skills development programs to reduce unemployment and enhance income generation for marginalized groups. This can involve supporting entrepreneurship, vocational training, and promoting inclusive hiring practices within smart eco cities. There are some institutions regulating this topics, like the International Labour Organization. (International Labour Organization, 2023)

It is important to approach these initiatives holistically and ensure that they are integrated into the overall development plans and strategies of Smart Eco Cities. By addressing inequality, inclusive environments can be created where all residents can thrive and benefit from sustainable urban development.

4.10.11 Sustainable Cities and Communities

Given the rapid growth of urban areas and their populations, cities and communities have a significant impact on the social, economic and environmental dimensions and therefore play a crucial role in sustainable development. Thus, it is important to address urban challenges and make communities more inclusive, resilient and environmentally friendly.

Urban planning: Cities design should prioritize compact and connected cities, promoting mixed-use developments, efficient land use, and green spaces. This can improve accessibility, and create walkable neighborhoods, closer to the model of 15 minute cities.

Investing in sustainable transportation systems: Cities can prioritize the development of public transportation networks, cycling infrastructure, and pedestrian-friendly streets. By providing affordable and convenient alternatives to private car use, cities can reduce traffic congestion, air pollution, and greenhouse gas emissions.

Waste management: Cities can implement recycling programs, promote waste reduction and separation, and invest in innovative waste-to-energy technologies. With that approach, cities can minimize waste generation and maximize resource efficiency.

Community engagement and participation: Encouraging citizen involvement, fostering partnerships between government, civil society, and private sector stakeholders, and incorporating local knowledge and expertise can lead to more inclusive and people-centered urban development.

4.10.12 Responsible Consumption and Production

Unsustainable consumption and production practices have led to resource depletion, environmental degradation, and social inequalities. Considering that, there is a critical need to shift towards sustainable patterns of consumption and production, to contribute to the well-being of both people and the planet.

Promote awareness: Raising awareness about the environmental and social impacts of consumption choices among individuals and providing information on sustainable alternatives and practices.

Sustainable production processes and technologies: Governments, businesses, and industries can invest in research and development for sustainable technologies, promote resource-efficient manufacturing methods, and adopt eco-design principles. This can lead to the production of goods that are environmentally friendly, durable, and easily recyclable.

Sustainable supply chains: Businesses can adopt sustainability principles throughout their supply chains, including responsible sourcing, fair labor practices, and ethical business conduct. This collaboration among organizations can ensure transparency and accountability in the production and distribution of goods.

4.10.13 Climate Action

Climate change poses significant risks to the planet's ecosystems, human health, and socio-economic systems, so it is crucial to address the global climate crisis and mitigate greenhouse gas emissions, adapt to the impacts of climate change, and foster a more sustainable and resilient future.

Land use and forest management: Protecting and restoring forests, implementing sustainable agriculture techniques, and promoting reforestation efforts can help sequester carbon dioxide and preserve biodiversity. Additionally, sustainable land management practices can help mitigate soil erosion, improve water management, and enhance ecosystem resilience.

Climate-resilient infrastructure: building infrastructure that can withstand extreme weather events, improving water management systems, and developing early warning systems for natural disasters. Investing in resilient infrastructure not only reduces vulnerability but also creates job opportunities and stimulates economic growth.

International cooperation: Developed countries can fulfill their commitments to provide financial resources and technology transfer to developing countries to support their climate change mitigation and adaptation efforts. Innovative financing mechanisms, such as carbon pricing, green bonds, and climate funds, can mobilize investments for climate action.

4.10.14 Life Below Water

Pollution in oceans is increasing more and more and it is leading to a not sustainable situation for the life below water. For the Smart Eco Cities is important to follow some rules to avoid that kind of pollution. The Figure 4.13 shows, the most polluting countries when speaking about the oceans. (NOAA, 2018)

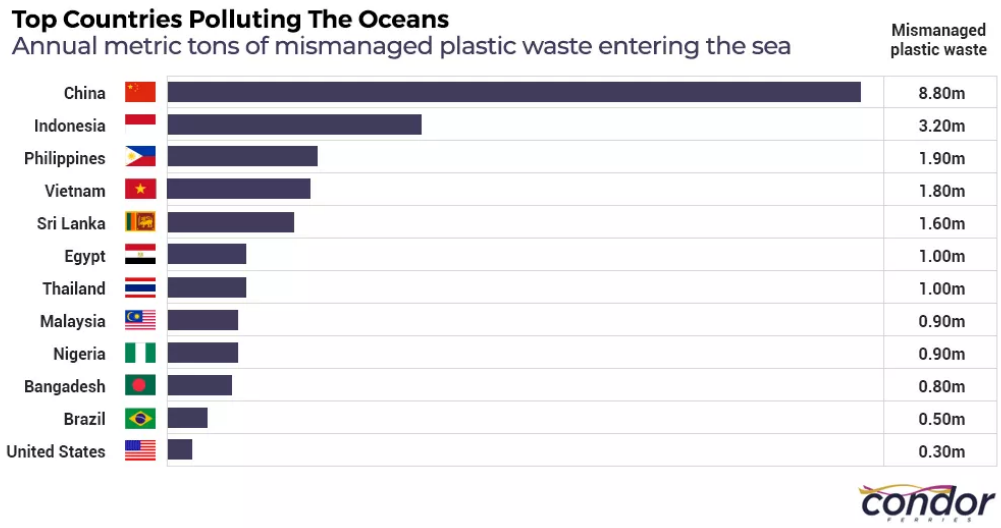

Figure 4.13: Top Countries polluting the Oceans (NOAA, 2018)

Marine Pollution Monitoring: Implement smart sensors and monitoring systems to detect and track marine pollution, such as oil spills, plastic waste, and chemical pollutants. These systems can help identify pollution sources, assess the impact on marine ecosystems, and enable prompt response measures. An organization that is already taking the right steps towards this is the National Oceanic and Atmospheric Administration.

Sustainable Waste Management: Promote proper waste management practices within the city to prevent waste from entering water bodies. Implement recycling programs, encourage waste reduction, and establish efficient waste collection and treatment facilities to minimize marine pollution.

Integrated Water Resource Management: Adopt innovative technologies for water conservation and management, such as smart irrigation systems, rainwater harvesting, and efficient water distribution networks. This approach ensures sustainable use of freshwater resources and reduces the pressure on marine ecosystems.

Sustainable Fisheries: Implement smart fishing techniques and practices to promote sustainable fishing and protect marine biodiversity. Technologies like satellite-based vessel monitoring systems, fish aggregating devices, and fishing gear modifications can help reduce bycatch, illegal fishing, and overfishing.

Marine Habitat Restoration: Develop and implement projects for the restoration and protection of coastal and marine habitats, such as mangroves, coral reefs, and sea grass meadows. These ecosystems play a vital role in supporting marine life, mitigating climate

change impacts, and preserving coastal areas. An authority in this area is the International Union for Conservation of Nature.

Sustainable Coastal Development: Plan and design coastal areas in a sustainable manner, considering the potential impacts of climate change and rising sea levels. Use nature-based solutions, such as green infrastructure, to protect coastlines, reduce erosion, and maintain healthy marine ecosystems.

4.10.15 Life on Land

This goal recognizes the vital role that healthy ecosystems play in supporting human well-being, providing food, clean air and water, and contributing to climate regulation. By addressing the challenges related to land management and biodiversity conservation, this goal seeks to protect and restore our natural habitats for the benefit of current and future generations.

Urban Green Spaces: Design and develop urban green spaces such as parks, gardens, and green rooftops to promote biodiversity and provide habitats for native flora and fauna. These green spaces can also contribute to climate regulation, air purification, and overall quality of life in cities.

Sustainable Land Use Planning: Implement smart land use planning strategies that prioritize the conservation and restoration of natural areas, including forests, wetlands, and other ecosystems. This involves considering the ecological value of land and integrating it into urban planning processes.

Reforestation and Afforestation: Undertake reforestation and afforestation projects to restore degraded lands and increase forest cover within and around cities. Smart technologies like remote sensing, GIS (Geographic Information System), and drones can aid in monitoring and managing these projects effectively. (Food & of the United Nations, 2023)

Wildlife Protection and Conservation: Develop smart systems and technologies for wildlife monitoring, protection, and conservation. This can include the use of remote sensing, camera traps, and data analytics to track wildlife populations, identify protected areas, and combat illegal activities like poaching and wildlife trafficking. (World Wild Life, 2021)

Sustainable Waste Management: Implement efficient waste management systems that

minimize the environmental impact of waste on terrestrial ecosystems. This involves waste reduction, recycling, composting, and safe disposal methods. Technologies like waste-to-energy systems and smart waste collection can optimize waste management practices.

4.10.16 Peace, Justice and Strong Institutions

Smart Eco Cities rely on robust governance, transparent decision-making, and effective institutions to create inclusive and sustainable urban environments. By promoting peace, justice, and strong institutions, Smart Eco Cities can ensure equitable access to resources and opportunities. This correlation highlights the importance of social and institutional transformations alongside technological advancements in building sustainable and thriving cities.

Transparent and Participatory Governance: Utilize smart technologies, such as e-governance platforms and digital tools, to enhance transparency, citizen engagement, and participation in decision-making processes. These tools can facilitate open dialogue, enable public feedback, and strengthen the accountability of institutions.

Data-driven Policy Making: Utilize data analytics and smart city technologies to gather and analyze data on various social, economic, and environmental aspects. This data can inform evidence-based policy making, help identify areas for improvement, and enhance the efficiency and effectiveness of public services.

Access to Justice: Develop digital platforms and mobile applications that provide easy access to legal information, dispute resolution mechanisms, and legal services. This can help ensure equal access to justice and empower individuals to exercise their rights and resolve conflicts efficiently.

Prevention of Corruption: Implement smart systems and technologies to prevent corruption and promote integrity in public institutions. This can include the use of blockchain technology for transparent and tamper-proof record-keeping, as well as whistleblower protection mechanisms to encourage reporting of corruption.

Safe and Inclusive Public Spaces: Use smart city technologies to enhance the safety and inclusivity of public spaces. This can include smart lighting, video surveillance, and crowd management systems that ensure the well-being and security of citizens, particularly marginalized groups.

Collaboration and Partnerships: Foster partnerships and collaboration between public institutions, private sector entities, civil society organizations, and local communities to promote sustainable development and strengthen institutions. This can involve joint initiatives, information sharing, and capacity building programs.

4.10.17 Partnerships to achieve the Goal

In the context of Smart Eco Cities, partnerships play a critical role in driving sustainable development. By fostering multi-stakeholder collaborations, Smart Eco Cities can leverage expertise, resources, and innovative solutions from different sectors to address complex urban challenges. These partnerships enable positive impacts for communities and the environment improving quality of life.

Public-Private Partnerships: Foster partnerships between public institutions and private sector entities to leverage their respective strengths and resources. This collaboration can drive innovation, mobilize investment, and facilitate the implementation of sustainable projects in Smart Eco Cities. (United Nations, 2023a)

Knowledge Sharing and Capacity Building: Promote knowledge sharing and capacity building initiatives to enhance the skills and capabilities of stakeholders involved in smart eco city development. This can involve training programs, workshops, and platforms for sharing best practices and lessons learned.

International Cooperation and Exchanges: Encourage international cooperation and exchanges between smart eco cities to facilitate the exchange of ideas, experiences, and technologies. This can involve city-to-city partnerships, study tours, and collaborative projects that promote sustainable urban development.

Financing Mechanisms: Explore innovative financing mechanisms to attract investment for sustainable projects in smart eco cities. This can include impact investing, green bonds, and crowd funding platforms that align with sustainable development objectives.

Multi-stakeholder Engagement: Engage a diverse range of stakeholders, including local communities, civil society organizations, academia, and the private sector, in the planning and decision-making processes of smart eco cities. This inclusive approach ensures that different perspectives are considered, fostering ownership and collective action.

Data Sharing and Standardization: Promote the sharing of data and the adoption of standardized approaches to data collection and analysis. This enables better collaboration,

benchmarking, and monitoring of progress towards sustainable development goals in Smart Eco Cities.

4.11 Rebuilding Ukraine cities as Smart Eco Cities

One hot topic nowadays is the Ukraine war. A big amount of cities is being destroyed, and it shows an opportunity to rebuild those cities (when the war finishes) as Smart Eco Cities. After all, for the entirety of human history, civilizations have rebuilt their cities after catastrophes. Rome after it was sacked by the Gauls, London and Chicago after great fires in 1666 and 1871, San Francisco after its great earthquake and fire of 1906, Warsaw, Berlin and Tokyo in the aftermath of World War II, Seoul after the Korean War and Sarajevo in the aftermath of the Balkan Wars are some real examples.

Cities that have been substantially destroyed have returned to their economic and cultural dominance within a few decades, short periods within the context of modern history. Even cities recovering from near total destruction, such as Hiroshima and Nagasaki in 1945, fairly quickly returned to their growth trajectory (Davis and Weinstein, 2022).

Ukrainian cities are poor by modern standards and especially modern European standards. Even before the Russian annexation of Crimea and the invasion of eastern parts of Donbas in 2014, Ukraine had seen its per capita GDP fall to the second lowest in Europe, and by 2021 it had fallen behind Moldova to have the lowest GDP in Europe. The reconstruction of Ukraine is associated with huge costs; financial assistance from the rest of the world seems indispensable. Considering how much aid Ukraine has received for military purposes, financing the reconstruction of cities in cooperation with the EU and the US seems possible. Figure 4.14 shows the calculated damage caused in Ukraine per sector, and the time it should take to recover as 2021's domestic production pace.

Figure 4.14: Damage in Ukraine by Construction Type

Ukraine main local materials are wood, kaolin (ceramics), cement (43.5 million t/year) bricks (fireclay 8 million t/year, other clays 2 million t/year), iron (6th largest producer, 7.24% of global output), glass (silica sands 3 million t/year). Materials are there, an end to the conflict and manpower to rebuild the cities is needed in order to develop Smart Eco Cities in this case.

Damage to the housing stock is the largest component of overall direct damage caused to property and infrastructure. The total area of damaged or destroyed housing objects is 83.1 mln m^2, which is 8.2% of the total housing stock.

— Partial (<10% damage to an object) 18 mln m^2 (15.4 thsd. Residential buildings)

— Average (10% - 40% damage to an object) 35,3 mln m^2 (65.7 thsd residential

— Completely destroyed 29.6 mln m^2 (72.7 thsd residential buildings)

Completely destroyed and significantly damaged buildings amount to 65 min m^2. With approximate calculations, to rebuild this amount of housing the following product may be needed:

— 3.9 million m^2 of glass

— 5.7 million m^3 or 11.9 million t of concrete

— 39.3 million m^3 or 14 billion units of bricks

— 45 million m^2 of roofing tiles

Assumption - For 1m^2 of brick construction needed

— 0.08 m^3 of concrete

— 0.06 m^2 of glass

— 0.61 m^3 of bricks

— 0.7 m^2 of roofing tiles

— 1m^3 of bricks – 350 units (based on The Confederation of Builders of Ukraine data).

4.12 Regeneration of Towns - Congress

How should the city of the future look and function? A new model of space management is the idea of a regenerative city. By emphasizing the ability to reproduce and multiply development potential, the regenerative city seeks to strengthen positive relationships with the natural system. A regenerative city is ecologically sustainable, economically efficient, smart and socially fair. In other words, it is the opposite of a concrete city, suffering from "autoholism", polluted with smog and noise, or excluding people with limited mobility. The city of the future, in general understanding, is a group of urban structures that are more or completely ecological. This means a more rational and careful use of natural resources, but also investing in renewable energy sources.

Taking into account the extremely rapid growth of cities, they must be designed in such a way that there are more green spaces in them. It must not be forgotten that the prevailing way of life should also undergo changes, which implies limiting pollution generated by transport methods as well as heat and energy producers. It is also worth focusing on environmentally neutral solutions - for example, the use of ecological building materials - says Izabela Rakuc - Kochaniak, president of the board of the Veolia Polska Foundation. It also draws attention to the importance of modern technologies, which will increasingly be used to create a new quality of life in cities. He adds: - The cities of the future will be powered by data from big data, the Internet of Things and artificial intelligence. Since the future of cities will still depend on people, it is necessary to build a "social ecosystem" that will foster the integration of residents, joint implementation of social projects, and local neighborly cooperation.

According to the UN, in about 7 years, 60% of the Earth's population will live in cities. Data from the Central Statistical Office (GUS) already confirm this state of affairs for

Poland. The LUX MED Group observes urban development trends with great interest. – For us, the priority in the city of the future is the health of the residents. That is why we want to support cities and enable them to develop based on specifically identified factors that require change - emphasizes Anna Rulkiewicz, President of the LUX MED Group. The starting point for properly diagnosing the health situation of Polish cities is the Healthy Cities Index - a report created by LUX MED, Warsaw School of Economics and the GAP Foundation. – We have created the Healthy Cities Index, which has identified cities with poviat (Polish country) rights that offer the best conditions for maintaining good health. During the work, eight main areas were identified, important from the point of view of creating conditions for a healthy life: health, population, municipal and social services, education, housing, environment, infrastructure, space.

A thorough analysis was carried out, e.g. implemented public health programs, mortality from selected civilization diseases, the area of green areas and air quality. The index is a tool that shows very broadly what is important for residents, what aspects to pay attention to and what to invest in to create a healthy and sustainable urban space - he explains.

Chapter 5

Conclusions

Is it possible to develop Smart Eco Cities?

Yes, it is possible to create Smart Eco Cities. With the right vision, planning, and collaboration among stakeholders, it is feasible to design and implement cities that integrate smart technologies, sustainable practices, and citizen engagement to foster a more environmentally friendly and livable urban environment.

Smart Eco Cities leverage cutting-edge technologies such as Internet of Things, artificial intelligence, and data analytics to optimize resource management, improve energy efficiency, enhance transportation systems, and promote sustainable living.

Moreover, the increasing global emphasis on sustainability and climate change mitigation has led to a greater focus on creating eco-friendly cities. Governments, organizations, and communities worldwide are recognizing the importance of transitioning towards low-carbon economies and embracing sustainable development practices. As a result, there is growing political will and financial support for initiatives aimed at building smart eco cities.

Furthermore, successful examples of smart eco cities have already emerged in various parts of the world. Cities like Aarhus, Amsterdam, and Bergen have implemented smart technologies and sustainable practices to enhance their urban environments and improve quality of life. These cities demonstrate that it is possible to create eco-friendly, technologically advanced, and livable urban spaces.

To sum up, while the development of Smart Eco Cities poses challenges, it is indeed possible to create these cities by leveraging technological advancements, promoting sustainability, and fostering collaboration among stakeholders. With a shared commitment to building greener, more efficient, and socially inclusive urban environments, smart eco

cities can become a reality and contribute to a more sustainable future for generations to come.

Is it possible to develop Smart Eco Cities until 2030 accomplishing with the SDGs?

Generally speaking, achieving the creation of Smart Eco Cities (that fully accomplish the Agenda 2030 goals) within the timeframe of 2030 poses significant challenges. The Agenda 2030, with its Sustainable Development Goals (SDGs), sets ambitious targets for global development, encompassing economic, social, and environmental dimensions. Creating Smart Eco Cities that align with these goals requires comprehensive planning, extensive investments, and widespread adoption of sustainable practices. While it may be challenging to achieve this level of transformation across all cities within the next decade, it is important to acknowledge that progress can be made in specific cases.

The development of Smart Eco Cities involves intricate coordination and cooperation among multiple stakeholders, including governments, urban planners, private sector entities, and the local community. It requires significant financial resources, policy changes, and technological advancements to create the necessary infrastructure and implement sustainable practices on a large scale. Achieving these goals within the limited timeframe of 2030 is a complex task that demands sustained efforts and commitments from all parties involved, and, in the part of cases, it is an impossible task.

Also, with the survey performed some conclusions regarding this topic were made. People believe the most important goals of Agenda 2030 are Quality Education, Zero Hunger and Climate Action. In the same point, people believe the most difficult ones to achieve by far are No Poverty and Zero Hunger. It is important to know that these topics are really huge and important, and due to the short time it is impossible to tackle all of them.

However, there are instances where specific Smart Eco City projects or initiatives may demonstrate substantial progress towards the Agenda 2030 goals before 2030. In certain regions or cities, favorable conditions, such as strong political will, robust funding, and a supportive ecosystem, can facilitate accelerated implementation. The experiences and lessons learned from these early adopters can serve as valuable examples for other cities aiming to embark on their own Smart Eco City journeys. Knowledge sharing, capacity

building, and international collaborations can accelerate progress and contribute to the broader realization of the Agenda 2030 goals.

In conclusion, while creating Smart Eco Cities that accomplish all the Agenda 2030 goals before 2030 may be challenging on a global scale, there are possibilities for progress in specific cases. By prioritizing certain SDGs and implementing targeted initiatives, cities can make substantial advancements towards sustainability. Continued efforts, collaboration, and learning from early adopters can pave the way for more widespread adoption of smart eco city principles and contribute to the achievement of the Agenda 2030 goals in the long run.

Will the people want to live there?

Yes, people will want to live in Smart Eco Cities, but achieving widespread adoption requires a combination of education, conscientiousness, and addressing concerns related to the phenomenon of "ghost cities".

Smart Eco Cities offer numerous advantages that can attract individuals and families seeking a sustainable, technologically advanced, and high quality of life living environment. They provide efficient transportation systems, green spaces, and improved air and water quality, creating healthier and more livable urban environments. Additionally, they often offer enhanced connectivity, digital services, and innovative amenities that enhance residents' quality of life.

For the successful adoption of smart Eco Cities, education and awareness play pivotal roles. People need to understand the benefits and potential of these cities in terms of environmental sustainability, economic opportunities, and improved well-being. Educating the public about the positive impacts of smart technologies, sustainable practices, and their long-term benefits can generate interest and enthusiasm.

In addition, fostering a sense of consciousness and responsibility towards sustainable living is crucial. Encouraging individuals to embrace environmentally friendly behaviors, such as reducing energy consumption, recycling, and using public transportation, can create a culture of sustainability within the city. Citizen engagement and participation in decision-making processes related to urban planning, resource management, and policy formulation also contribute to a sense of ownership and pride in the Smart Eco City concept.

Addressing concerns related to "ghost cities" is also important for the successful development of these cities. "Ghost cities" can arise from various factors such as overambitious development plans, economic downturns, or lack of adequate infrastructure. To avoid the creation of "ghost cities", careful planning, market analysis, and phased development strategies are necessary. It is essential to align the pace of construction with the demand for housing and ensure that Smart Eco Cities are built in locations where there is a genuine need and desire for sustainable urban living.

Additionally, focusing on creating vibrant communities is vital to combat the ghost city phenomenon. Providing a mix of residential, commercial, and recreational spaces, along with opportunities for economic growth and cultural activities, helps foster a sense of community and liveliness. By creating a strong social fabric and offering employment prospects, Smart Eco Cities can attract residents and avoid the abandonment often associated with "ghost cities".

In conclusion, while people will indeed want to live in smart eco cities due to the numerous advantages they offer, achieving widespread adoption requires a combination of education, conscientiousness and some attractions. By educating the public, fostering a culture of sustainability, and implementing thoughtful planning strategies that consider market demand and community-building, Smart Eco Cities can become desirable places to live, avoiding the pitfalls associated with "ghost cities" and realizing their vision of a sustainable future.

Smart Eco Cities are complex but not utopical

Throughout the report, it has become evident that Smart Eco Cities present a challenging topic to cover due to the multitude of subtopics and inherent complexities involved. The concept of Smart Eco Cities extends beyond traditional urban development, encompassing advanced technologies, sustainable practices, and citizen engagement to create efficient, livable, and environmentally conscious urban environments. However, the comprehensive coverage of this subject is a formidable task due to its multifaceted nature.

One of the main reasons why Smart Eco Cities pose a significant challenge is the wide range of subtopics they encompass. Urban planning and design, energy management, transportation systems, waste management, and digital connectivity are just a few areas that require in-depth exploration and understanding. Artificial Intelligence will be big

help to achieve the planned goals. Every possible form of synergy between production plants, industrial factories, waste disposal companies, and other forms of city activity should be taken into consideration and possibilities of such technologies should be carefully planned and designed before starting any project or developing the city. Dealing with all these sub-topics in one report is a major challenge, taking into account the breadth and depth of knowledge required.

Additionally, the dynamic nature of these cities introduces further challenges. As technology evolves and societal needs change, the definition of a Smart Eco City continues to evolve. This ongoing evolution demands continuous research and adaptation to stay up to date with emerging trends and best practices. Moreover, the implementation and maintenance of initiatives need collaboration among various stakeholders, including government bodies, private sector entities, urban planners, engineers, and the local community. Balancing these diverse interests and aligning them towards a common goal is a formidable task.

The integration of different systems and technologies within Smart Eco Cities presents another significant challenge. Interconnectivity and interoperability are critical for ensuring the seamless operation of systems such as smart grids, intelligent transportation networks, and data management platforms. However, harmonizing these disparate systems, each with its own set of protocols, standards, and stakeholders, poses a significant technical challenge that requires extensive coordination and cooperation, including fast treatment of huge amount of data, internet of things and proper use of artificial intelligence to quickly solve issues. Reconstruction or building from the beginning destroyed cities in Ukraine gives ample opportunities to test the latest technologies, they possibility to be introduced, tested, and used with the biggest effectiveness.

Furthermore, the success of Smart Eco Cities heavily relies on citizen engagement and empowerment. Active participation of residents in decision-making processes, awareness campaigns, and adoption of sustainable lifestyle practices is crucial for the long-term viability of these cities. However, fostering such engagement and ensuring equitable access to technological advancements can be challenging, particularly in economically disadvantaged communities or regions with limited resources.

In conclusion, the topic of Smart Eco Cities presents a vast landscape of subtopics and challenges that demand careful consideration. The multidimensional nature of this

field, coupled with the rapidly evolving technological landscape and the need for extensive stakeholder collaboration, makes it a complex area to explore comprehensively. Only through concerted efforts, ongoing research, and collaborative endeavors can the world strive towards creating truly smart eco cities that embody a vision of a greener and more sustainable future.

Chapter 6

Recommendations

Based on the discussion of the key initiatives and challenges related to the development of Smart Eco Cities, the following recommendations and guidelines can be made to accelerate progress towards sustainable urban development:

Develop Regulations and Standards

To ensure the successful implementation of Smart Eco Cities, it is essential to develop comprehensive regulations and standards that guide their planning, construction, and operation. These regulations should cover various aspects, including sustainability, building codes, data privacy, accessibility, governance, interoperability, and environmental impact.

By establishing clear guidelines and standards, city authorities can create a framework that promotes environmental sustainability, protects residents' rights, fosters inclusivity, ensures accountability, encourages innovation, and safeguards the well-being of both the community and the surrounding ecosystem. These regulations and standards will serve as a roadmap for the development and long-term success of Smart Eco Cities, enabling them to achieve their goals of creating sustainable, livable, and thriving urban environments. An example of an organization whose aim is to create such a standards and congregate initiatives is the C40 cities, an interesting one to keep an eye on.

Implement Measurements and Assessments

To effectively assess the progress and impact of Smart Eco Cities and the quality of life within them, it is essential to establish comprehensive measurement frameworks. These frameworks should encompass various dimensions, such as environmental sustainability,

social well-being, economic development, and technological advancement. By developing standardized indicators and measurement tools, cities can track their performance, identify areas of improvement, and make data-driven decisions to enhance residents' overall quality of life.

Additionally, implementing measurements should go beyond quantitative data and encompass qualitative aspects as well. Surveys, interviews, and social impact assessments can provide valuable insights into residents' perceptions, satisfaction levels, and experiences within the Smart Eco City. By combining quantitative and qualitative measurements, cities can obtain a holistic understanding of the strengths, weaknesses, and areas requiring attention, allowing them to implement targeted strategies for continuous improvement and creating thriving and sustainable communities.

Prioritize Education and Awareness

Education and awareness programs should be implemented to inform individuals about the benefits of sustainable practices and encourage behavior change. Promoting sustainability in schools, universities, and community centers can empower future generations to embrace sustainable lifestyles and contribute to the development of Smart Eco Cities.

Develop AI-Powered Governance Systems

AI technologies can enhance governance systems by automating routine tasks, improving decision-making processes, and increasing operational efficiency. Governments should explore the integration of AI-powered systems for managing city services, optimizing transportation networks, and enhancing public safety. However, it is crucial to ensure transparency, fairness, and accountability in the design and implementation of these systems.

Develop IoT and AI regulations

To ensure responsible and ethical use of IoT and AI technologies in Smart Eco Cities, governments and regulatory bodies should develop guidelines and standards. These guidelines should address privacy concerns, data security, algorithm transparency, and accountability. By establishing clear frameworks, cities can foster trust and confidence among residents and businesses.

The Plan

To achieve the successful development of a Smart Eco City, a comprehensive plan encompassing various aspects such as location, logistics, materials, time, labor, and price is essential. Here we present a detailed plan outlining key considerations and strategies for developing a Smart Eco City. By following this plan, stakeholders can navigate the complexities of Smart Eco City development.

— **Location**. Determining the location for a Smart Eco City requires careful consideration. While building new cities designed from scratch offers opportunities for incorporating sustainable features, it is also important to explore the potential of adapting existing urban areas or rebuilding cities that have faced significant destruction.

  Adapting existing cities can leverage the infrastructure, resources, and historical value already present, fostering a balance between preservation and modernization. In this case each city consists on a unique challenge with unique limitations and conditions, but it is also a huge opportunity to create innovative cities with historical background, as it is the case of some cities in Spain like Toledo or Valladolid.

  Similarly, rebuilding cities affected by natural disasters or conflicts provides an opportunity to integrate smart and eco-friendly principles from the ground up, ensuring resilience and sustainability. A comprehensive assessment of factors such as available land, proximity to resources, transportation networks, and environmental considerations should guide the decision-making process to identify the most suitable location for the Smart Eco City.

— **Logistics**. The logistics of building a Smart Eco City encompass various aspects, including governance structures, project management, and coordination of resources. Effective governance plays a crucial role in ensuring smooth implementation and the achievement of sustainable goals. It is essential to establish a clear governance framework involving multiple stakeholders, including government entities, urban planning authorities, environmental agencies, and local communities. This framework should outline roles, responsibilities, decision-making processes, and mechanisms for collaboration and accountability.

  A robust project management approach is vital to oversee the logistics of the construction process. This involves establishing a dedicated project team with

expertise in urban planning, architecture, engineering, and sustainable development. The team should develop a comprehensive plan that addresses various logistical aspects, such as site preparation, infrastructure development, construction sequencing, and resource allocation. Embracing digital technologies, such as IoT and AI tools, can enhance efficiency in project management, enabling real-time monitoring, predictive analytics, and data-driven decision-making.

Connecting with the next points, coordination of resources, including materials, manpower, and technology, is crucial for successful implementation. In the logistics phase, careful consideration should be given to the selection of materials, favoring sustainable and locally-sourced options whenever possible. Utilizing local materials not only supports the local economy but also reduces transportation emissions and costs. Collaborating with local suppliers, manufacturers, and contractors can ensure a steady supply chain and promote economic growth within the region.

Moreover, guidelines and standards for sustainable construction practices should be established to ensure that the logistics phase aligns with eco-friendly principles. This includes adopting green building techniques, efficient waste management systems, and energy-saving measures throughout the construction process. By integrating governance structures, effective project management, resource coordination, and adherence to sustainability guidelines, the logistics phase can be efficiently executed, laying the foundation for a successful Smart Eco City.

— **Materials**. The choice of materials for constructing a Smart Eco City is a crucial aspect that significantly impacts its sustainability, resilience, and environmental footprint. Opting for environmentally friendly and locally sourced materials can contribute to reducing the project's ecological impact, minimizing transportation emissions, and promoting local economic development.

One approach to material selection is to prioritize the use of sustainable and renewable materials. This includes incorporating materials such as responsibly sourced wood, bamboo, and natural fibers that have a lower carbon footprint compared to conventional construction materials. These renewable materials not only sequester carbon dioxide but also provide excellent thermal insulation properties, reducing the energy demand for heating and cooling within buildings.

Additionally, utilizing recycled materials can help minimize waste and conserve resources. Reclaimed wood, recycled metals, and repurposed construction materials can be incorporated into the design and construction process, reducing the demand for virgin resources. Implementing circular economy principles, such as incorporating materials from deconstructed buildings or utilizing waste materials as construction aggregates, can further enhance sustainability and resource efficiency.

Local materials should be prioritized whenever feasible. Using locally sourced materials reduces transportation distances, thereby reducing energy consumption and greenhouse gas emissions associated with long-distance transportation. Moreover, supporting local industries and businesses by utilizing their materials stimulates the regional economy and strengthens community ties.

It is important to ensure that the selected materials meet the required quality standards and safety regulations. Engaging with experts in sustainable construction and conducting life cycle assessments of materials can help in making informed decisions regarding their environmental impact, durability, and performance. Integrating sustainable certification systems, such as LEED (Leadership in Energy and Environmental Design) (Eurostat, 2023a) or BREEAM (Building Research Establishment Environmental Assessment Method) (BREEAM - BRE Group, 2023), can provide guidelines and benchmarks for selecting eco-friendly materials and construction practices.

By carefully selecting sustainable, recycled, and locally sourced materials, a Smart Eco City can reduce its ecological footprint, promote resource efficiency, and contribute to a more resilient and environmentally conscious built environment.

— **Time**. The timeline for building a Smart Eco City depends on various factors, including the scale and complexity of the project, the availability of resources, and the extent of existing infrastructure. Developing a comprehensive timeline is essential for effective project management and ensuring timely completion.

The timeline can be divided into different phases, each with its specific objectives and milestones. The initial phase involves comprehensive planning, feasibility studies, and securing necessary permits and approvals. This phase also includes conducting environmental assessments, engaging with stakeholders, and establishing governance structures.

The subsequent phase focuses on infrastructure development, including the construction of sustainable buildings, installation of renewable energy systems, implementation of smart grid networks, and deployment of intelligent transportation systems. This phase requires close coordination among various stakeholders, including architects, engineers, contractors, and technology providers.

Another critical aspect of the timeline is the implementation of smart city technologies and systems. This involves deploying IoT devices, integrating sensors and data analytics platforms, and establishing a robust network infrastructure. Implementing artificial intelligence tools for data analysis, predictive modeling, and optimization can enhance the efficiency and effectiveness of the city's operations.

The timeline should also consider the integration of existing cities or the redevelopment of damaged or outdated urban areas into Smart Eco Cities. In these cases, additional time may be required for adapting existing infrastructure, ensuring compatibility with smart technologies, and addressing any environmental or structural challenges.

The overall duration of building a smart eco city can vary significantly depending on the scale and scope of the project. While smaller-scale developments may take a few years to complete, larger and more complex projects may span over a decade or longer. Efficient project management, clear communication, and effective collaboration among all stakeholders are crucial for ensuring that the project stays on track and meets its established timelines.

It is important to note that the timeline for building a smart eco city is not a rigid and fixed schedule. It may need to be adjusted and adapted based on unexpected circumstances, changes in technology, and evolving stakeholder needs. Flexibility and agility in project management are essential to navigate potential challenges and ensure successful implementation within the defined timeframe.

— **Labour and Workforce**. Building a Smart Eco City requires a significant amount of skilled and specialized labour to carry out various tasks and ensure the successful implementation of the project. The labour requirements encompass a wide range of disciplines, including architecture, engineering, construction, urban planning, information technology, and sustainability.

The number of people needed for the construction and operation of a Smart Eco

City depends on the size and complexity of the project. During the construction phase, a substantial workforce will be required for tasks such as site preparation, building construction, installation of infrastructure systems, and landscaping. This may include architects, engineers, construction workers, electricians, plumbers, technicians, and other skilled professionals.

In addition to the construction phase, it requires ongoing maintenance and operation, which necessitates a workforce to ensure the smooth functioning of various systems and technologies. This includes personnel responsible for monitoring and maintaining renewable energy systems, managing the smart grid network, overseeing waste management and recycling, and providing support for digital infrastructure and connectivity.

To meet the labour requirements, it is essential to develop comprehensive workforce development strategies. This involves investing in training and education programs to build the necessary skills and expertise in areas such as sustainable construction practices, renewable energy technologies, smart city management, and data analytics. Collaboration between educational institutions, industry associations, and government entities can help create specialized training programs that address the unique needs of building and operating smart eco cities.

Moreover, it is crucial to ensure fair labour practices and provide a supportive work environment for the labour force involved in the construction and operation of smart eco cities. This includes fair wages, safe working conditions, access to healthcare benefits, and opportunities for professional growth and advancement. Emphasizing diversity and inclusion in the labour force can also contribute to a more equitable and representative workforce.

Efficient labour management and coordination are essential to ensure the timely completion of the project. Effective project management practices, including workforce planning, resource allocation, and clear communication channels, can help optimize labour utilization and mitigate potential delays or bottlenecks.

Engaging the local community in the labour force can bring additional benefits, such as fostering economic growth, creating job opportunities, and promoting social cohesion. Providing training and employment opportunities for local residents can

contribute to the overall development of the community and enhance the sense of ownership and pride in the smart eco city.

By considering labour as a critical aspect of building a Smart Eco City and implementing strategies to attract, train, and retain a skilled workforce, it is possible to create a sustainable and thriving community while also stimulating economic growth and social well-being.

— **Price**. The cost of building a Smart Eco City encompasses various factors, including land acquisition, infrastructure development, construction materials, labour, technology implementation, and project management. The overall price of the project depends on the scale, complexity, and specific requirements of the city.

Land acquisition constitutes a significant portion of the expenses, as securing suitable land for the development of the city involves purchasing or leasing properties. The location, size, and proximity to existing infrastructure can influence land prices. Adapting existing cities or rebuilding destroyed cities may offer cost-saving opportunities by repurposing existing infrastructure, but it may also require additional investments in retrofitting and upgrading.

Infrastructure development costs cover the construction of roads, transportation networks, utilities, and public facilities. This includes the installation of smart grids, renewable energy systems, water management systems, waste management facilities, and digital connectivity infrastructure. Efficient planning and design, as well as strategic partnerships with public and private entities, can help optimize infrastructure costs.

Connecting with the materials section, the choice of materials used in construction also affects the overall price. Local materials sourced from nearby regions can be more cost-effective due to reduced transportation costs. Furthermore, selecting sustainable and energy-efficient materials can lead to long-term cost savings through reduced maintenance and operational expenses.

Also, labour costs including wages, benefits, and training, form a significant component of the project's price. The number of workers required, the complexity of the tasks, and prevailing labour market conditions can influence labour expenses. Implementing fair labour practices, fostering workforce development, and optimizing

labour utilization can help manage and control labour costs effectively.

Incorporating advanced technologies, such as IoT devices, artificial intelligence tools, and data analytic platforms, may involve additional expenses related to equipment procurement, software development, and implementation. However, these investments can provide long-term benefits in terms of operational efficiency, resource optimization, and enhanced services for residents.

Effective project management practices, such as budgeting, cost control measures, and risk management, are crucial to ensure that the project remains within the allocated budget. Regular monitoring, transparent financial reporting, and periodic assessments can help identify cost overruns and implement corrective measures promptly.

To manage the financial aspect of building a Smart Eco City, it is essential to explore various funding options, including public-private partnerships, government grants, development loans, and investment from private stakeholders. Engaging with financial institutions, international organizations, and impact investors can provide access to capital and expertise in sustainable development financing.

A comprehensive and transparent cost analysis, taking into account both upfront investments and long-term operational expenses, is vital to ensure the financial viability and sustainability of the Smart Eco City project. Balancing affordability, value for money, and long-term benefits can help create a financially feasible and economically viable city.

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