

## How to address sustainability at the city level

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**ABSTRACT:** A brief analysis of the environmental, social and economic paradigm of nowadays cities, allows reaching a conclusion: current cities are not sustainable. Considering this, it is very important to study the causes of such unsustainability and to develop models for sustainable cities. There are a limited number of studies in this area, but the scientific community lacks even more studies related to the implementation of these models in current cities. Consequently there is the need to explore this field. This work emerges with the objective of analysing how it is possible to implement sustainability in cities through the development of a sustainable city model and an urban regeneration plan. The development of sustainable city models is a very complex topic. The analysis of the state of the art shows that one must consider the relation between environmental and social aspects in the development of sustainable cities, while taking special concerns when considering the economic issues. It was also concluded that cities should be subject to performance assessments. It was also demonstrated that a city can only be sustainable if its population behaves in harmony with the city's sustainability model and that the behavior of a community is determinant in the sustainability level that a model can achieve.

### 1 INTRODUCTION

Our planet has been suffering profound changes in the last 60 years. Due to these changes, the world faces serious problems in the beginning of XXI Century at environmental, social and economic levels. These problems are caused mainly by the conjugation of three main factors: population growth, excessive resources consumption and increase in pollution (on air, water and earth). The construction sector is one of the major responsible for these negative impacts on the planet, being responsible for the extraction of about 24% of raw materials and the consumption of almost 40% of energy in Europe (EC, 2011), producing 35% of gases contributing to global warming (EU, 2010). The sector also produces 22% of all residues in Europe (APA, 2012) and 40% at a global scale (UNEP, 2011). These environmental impacts combined with the high importance at the social and economic levels show that the construction sector is not sustainable. This fact is even more notorious shifting from the building scale to the city scale.

In fact, it is common the recognition that nowadays cities are unsustainable. The World Wildlife Fund, in collaboration with the Global Footprint Network indicates the concept of environmental footprint as an indicator suitable for quantitatively access the level of sustainability of the planet and also the cities. In this report, the ecological footprint of Europe is 4.72. This means that if the entire planet would follow the lifestyle of the European inhabitants, 4.72 planets would be needed to meet the needs of the world population. The global average is in 2.7 planets, clearly showing that current state is unsustainable (World Wildlife Fund, 2012).

Over the past two decades, the appliance of the concept of sustainable development to the construction sector has been considered as one solution to solve these problems, emerging the concept of sustainable construction. Aiming to contribute to the implementation of this concept, sustainability assessment methodologies have emerged. BREEAM (Building Research Estab-

ishment Environmental Assessment Method) was the first environmental assessment method for buildings and was developed in the UK by researchers from BRE (Building Research Establishment) in 1988. This methodology has undergone many changes since its launch and in recent years has developed BREEAM International, which allows the use of this methodology internationally (BRE, 2013).

Another methodology for sustainability assessment with great impact at the international level is the American LEED (Leadership in Energy and Environmental Design) which was established in 1996 and is managed by the U.S. Green Building Council (USGBC). The expansion of this system to the outside of the United States is notorious, being used in many countries worldwide (US Green Building Council, 2013). Also in 1996, there were two important assessment methodologies sustainability, the SBtool (Sustainable Building Tool) and HQE (Haute Qualité Environnementale). The SBtool initially called GBTool (Green Building Tool) is a system developed by a team of stakeholders from more than 20 countries. This Green Building Challenge tool (GBC) was promoted by the International Initiative for a Sustainable Built Environment (iiSBE) and aimed to the creation of a system adaptable to the constraints of a local or regional building (Larsson, 2012).

In 2013, there are already dozens of tools available on the market for assessing sustainability in construction, mainly adaptations of the methodology SBTool. For example, in Portugal SBTool PT was developed, SBTool CZ in the Czech Republic; Protocol ITACA in Italy and SBTool Green in Spain. These methodologies are recognized as a way to enhance the application of the concept of sustainable construction, improving the performance of buildings and setting good practices that minimize the environmental impact of buildings.

However, some researchers are skeptical of some concepts used in these tools. The main criticisms are related to the efficiency of these methods in the assessment of sustainability and its effectiveness in improving the built environment (Senbel et al., 2003) (Bendewald and Zhai, 2013). One of the issues is based on the fact that these methods do not take into account the relationship between the buildings and the carrying capacity of the environment, since the buildings sustainability assessment is performed by comparing one buildings performance with benchmarks. Common construction practices benchmark is normally defined as existing and old buildings (low performance) and this may result in the assignment of sustainability levels that are not in line with reality. This is because new buildings are normally slightly better than conventional buildings, providing always high performance levels when compared to these benchmarks. It is common in sustainability assessments the attribution of ratings A and A+ to buildings. Nevertheless these buildings may be unsustainable when compared to the carrying capacity of the environment in which they operate.

Another common criticism is that these methods only assess the buildings when they should evaluate the entire set of buildings and infrastructure in a global scale with a holistic view. In fact, a building does not function as an isolated element but as an element that interacts with the environment in which it operates. Thus, the sustainability of the construction sector should be thought not only at the building but also at the urban scale. The scientific community is beginning to absorb this idea and there are some emerging studies that argue that sustainability should be considered at the city level (Bragança et al., 2013).

Taking this into account, recent initiatives have emerged to assess sustainability in urban planning. In 2008 BRE launched BREEAM Communities (BRE, 2012) for the evaluation of small enterprises and urban settlements. This methodology has already been updated in 2012. In 2009 LEED for neighborhood was launched (USGBC, 2012). iiSBE International convened a working group composed of urban technicians from various countries (Urban assessment working group) and is also developing a tool for the same purpose, SCTool (Sustainable Communities Tool) (iiSBE, 2013).

However, there is still some uncertainty in the criteria that these methodologies should access and that an urban area or city should verify to be considered sustainable, since most tools are still under development. Nevertheless, there are some studies that define sustainability criteria that cities or communities should satisfy, but there is still much work to do in the design of sustainable cities. Considering this important research gap in the area of urban sustainability, this work comes up with the objective of analyzing the processes and stages needed to transform existing cities into sustainable cities. The research question of this work is: How is it possible to transform existing cities into sustainable cities?

## 2 INSIGHTS FROM THE STATE OF THE ART

### 2.1 Sustainability in nowadays cities

With a growing world population and its continuous migration to cities, the needs of modern cities for energy, food, water and other materials have increased dramatically and are suppressed almost exclusively through importation, usually at great distances. This growing dependency of goods across borders puts the environment and life support systems on earth at risk (Grimm et al., 2008). In fact, the culture of import and export fostered by globalization and the current consumerism model completely neglects the environment and is unfavorable to society. The increasing dependence of urban societies in foreign goods causes a decrease in local production capacity and consequently causes social and economic dependency. The loss of local power in cities and countries allows the well-being of the communities to be placed in the hands of a small number of companies and people who often have no understanding or respect for the local economy, the community and their cultural and environmental interests (Grewal and Grewal, 2012a).

The companies linked to the construction sector are an example of this problem, because they have no economic incentive in the consideration of environmental and social aspects in their business (Grewal and Grewal, 2012b). Taking this into account, there is the promotion of an excessive consumerism in favor of the economic performance of companies (Roseland, 2005), resulting in an unsustainable built environment, especially at environmental level (Rosales, 2011). The large volume of construction in the last 30 years was economically advantageous for construction companies, especially those that were linked to public works. However, due to excessive construction, a housing bubble triggered the 2008 economic crisis. In fact, Eurostat data (Figure 1) shows that in Europe 27, the construction sector had a continuous and uninterrupted growth until 2008 (Stawińska, 2010).

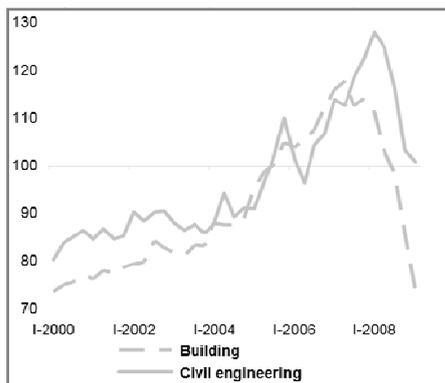


Figure 1. New construction in Europe 27 (EU-27) separated by building and engineering works (2005=100%).

For example, according to the results of the Portuguese 2011 census, the city of Braga, with 125.000 inhabitants, has an oversupply of about 19.000 dwellings (70.000 houses) in relation to the number of families (51.000 families). In Portugal there are more 45% of households than families (INE, 2012). This shows that housing was not increased in line with population growth that occurred in the city, countering the theoretical principles of the law of supply and demand. Amado states that in Portugal, the boom of urban expansion was regulated by insufficient and inadequate legislative principles, which led to a territorial organization without rules and planning (Amado and Ribeiro, 2011).

Regarding the serious problem of overbuilding, there is also a set of problems related to the way of life of urban populations that make cities sustainable. Taking into account the present economic model of consumerism in today's society, there is a huge consumption of materials and products that result in the excessive extraction of raw materials and waste production, when compared to values of non-urban populations.

Air pollution and noise in urban areas are also factors that degrade the life quality in cities. These problems are often aggravated by imbalanced urban development and increased mobility and traffic. As a consequence, the amount of emissions and noise due to road traffic has been

pointed out as the main reasons for non-compliance with regulations concerning these matters (Silva and Mendes, 2012).

## 2.2 *Criteria for the development of sustainable cities*

Considering these problems in current cities, it is imperative to create guides and models of organizational planning of urban areas that can be followed and applied in cities to implement sustainable development (Amado and Ribeiro, 2011). Thus, it is crucial to the definition of land use policies that take into account sustainability criteria (Reidsma et al., 2011, Huseynov, 2011).

Most existing studies seem to agree and point to the concept of cities with tall buildings, high-density construction areas and minimization of land occupation with low needs for materials and transport, as a solution for the development of sustainable cities (Cho and Lee, 2011, Feng and Xingkuan, 2011, Wener and Carmalt, 2006, Doughty and Hammond, 2004, Senbel et al., 2003, TGCCP, 2010). Doughty and Hammond assert that a cluster of high-density buildings, as long as having a well integrated network of infrastructure and transportation systems, can improve the energy efficiency of cities and reduce their environmental impacts (Doughty and Hammond, 2004). Compact cities may have an important role to ensure the efficient use of resources in certain urban areas because they can be designed to improve the energy efficiency of the built environment, promote the use of public transport and non-polluting alternatives such as cycling and walking and further improve the reliability of waste recycling and reuse of materials and products.

However there are other studies that consider different aspects for the design of sustainable cities. For example, Shan and Xingkuan only consider aspects of aesthetics and art in building, completely neglecting aspects related to the environment, society and economy (Xingkuan and Shan, 2011). Huseynov believes that cities must contain large green spaces to be considered sustainable (Huseynov, 2011). Ramos and Rocha go in the same direction and consider important the existence of green corridors within cities (Rocha and Ramos, 2012). Cho and Lee emphasize the importance of the satisfaction of the inhabitants in sustainable communities, mainly addressing the social component (Cho and Lee, 2011). Mendes also believes that one aspect to consider is the quality of life of the population (Mendes, 2004). Bragança et al. consider the importance of the orientation of buildings due to the planning of public roads to reduce the energy consumption of cities (Bragança et al., 2004). Newman develop the concept of sustainable city - based infrastructure system high efficiency in order to reduce the environmental impacts associated with transportation and car dependence (Mitchell and Casalegno, 2008).

## 2.3 *Sustainability assessment in the development of sustainable city models*

Nevertheless, these studies did not seek to define the criteria that cities should check holistically to be considered sustainable, focusing only on some aspects. This neglects the complexity of the interrelationship and interdependence of the various issues that must be addressed together in the development of sustainable cities. This multidisciplinary approach to sustainability is recognized in studies dedicated to sustainability assessment of buildings, in which criteria are defined encompassing various aspects simultaneously (Mateus and Bragança, 2011). And these criteria can be adapted to the urban level for the development of sustainable urbanizations (Amado and Poggi, 2012). The evaluation of sustainability of urban environments is very important. Danko and Lourenço argue that sustainability assessment is the first logical step in the development of plans to improve sustainability in urban environments. A preliminary assessment of levels of sustainability of each case allows an efficiency of time and resources that are related to the complex tasks of data acquisition, analysis and problem solving, which usually occur in such operations (Danko and Lourenço, 2007). Taking this into account, some existing studies seek to define indicators for assessing the sustainability of urban environments. Silva and Mendes developed an assessment indicator for air quality and acoustic comfort in cities (Silva and Mendes, 2012). Silva also developed an index for the assessment of sustainability related to urban mobility in cities (Silva et al., 2010). Danko and Lourenço developed a set of indicators to assess the sustainability level of urban wastewater management systems (Danko and Lourenço, 2007).

There are also some studies that define criteria for the evaluation and development of sustainable buildings and cities holistically. Wener and Carmalt, indicate that a sustainable city must

have sustainable high density buildings and establishes criteria for sustainable buildings that can be extrapolated for a sustainable city. Thus, a sustainable building should take into account the comfort and health of occupants, minimizing the consumption of energy and materials, encouraging healthy ecosystems (Wener and Carmalt, 2006). Robertson refers the importance of defining a multidisciplinary team in the design of a sustainable city (Robertson, 2012). Rosales also agree that the definition of sustainable city should take into account a holistic view of sustainability, highlighting the importance of using indicators to quantify the levels of sustainability (Rosales, 2011).

#### 2.4 *Economy and sustainability in cities*

Some studies have a different approach, indicating that in order to a city become sustainable, it must be self-sufficient in terms of energy, materials, food and water. Grewal and Grewal define a self-sufficient city as one that is able to meet their basic needs without recurring to importation (Grewal and Grewal, 2012a). Grewal and Grewal proved that a city can be totally independent in energy using currently available technologies (Grewal and Grewal, 2012a) and be independent in food production, with the adoption of modern production technologies such as efficient vertical farming (Grewal and Grewal, 2012b). These authors demonstrate the importance of increasing the self-sufficiency of cities because this property boosts the efficiency and sustainability in resources usage, increasing the autonomy and economic resilience against the negative effects of the global economic crisis.

Despite this, some authors are critical of the concept of self-sufficient cities, and say that it is an utopian concept (Parkin, 2000) (Doughty and Hammond, 2004). They assert that sustainability is a desirable and attainable goal globally, but do not agree that is achievable locally. However, they recognize that the causes of the problems of current cities are the excessive importation and unnecessary transportation of resources. Parkin considers that the implementation of sustainability in cities puts severe restrictions on the economic development of countries and companies and therefore can be considered impractical in the short or medium term, pointing to 2050 or after 2100 to achieve progress in the implementation of sustainability on the planet taking into account the current conditions (Parkin, 2000).

However, some authors argue that in sustainability, the economic aspects should not be considered and that the problems that should be addressed are those related to the environment and its load capacity, as well as the population life style (Senbel et al., 2003) (Lewis and Brabec, 2005, Feng and Xingkuan, 2011). Senbel argues that ecology and the implications of human consumption patterns are two environmental aspects that are not well represented on metrics based on economic performance (Senbel et al., 2003). Lewis and Brabec agree stating that the key factor in the analysis of a pattern of urban planning in sustainability is actually quantifying their impact on the ecological systems (Lewis and Brabec, 2005). In fact, many authors seem to point the economic development as an obstacle to achieve sustainability. Fresco considers that the current economic model is the main cause of unsustainability in cities and in the world (Fresco, 2007). The circular city and society envisioned by Fresco promotes equality between citizens and since the existence of money can cause inequalities, Fresco has created a new system to replace the monetary system, often called a "resource-based economy". This system has gained particular notoriety and receptivity in recent years as a result of the financial collapse. Thus, it becomes important to consider the social aspects of equality related to economic aspects in the operation of cities and communities.

#### 2.5 *Considering human behaviour in the development of sustainable cities*

Taking this into account, another research field that is very important and supported by a vast number of authors is that the development of sustainable cities must consider social issues and the willingness of inhabitants. Wener and Carmalt claim that sustainable buildings and therefore sustainable cities should be designed to meet basic human needs, taking into account the psychological effects and behaviors of individuals. Also the success of a sustainable city model, based on a good technical and environmental performance, depends largely on the degree to which designers are able to understand and predict human behavior and activities and their ability to use this knowledge to develop spaces that meet these needs (Wener and Carmalt, 2006).

Fonseca and Ramos also argue that inhabitants should be involved in the decision-making processes related to urban planning policies (Fonseca and Ramos, 2004). Girardet concept of sustainable city is that the organization of spaces should allow its citizens to meet their needs, improving the life quality without damaging the natural environment or the quality of life of neighboring populations, present and future (Girardet, 2008). Amado, highlights the importance of defining city models taking into account the wishes of the local population and concludes that public participation is mandatory during all stages of the organization of the territory in order to ensure a proper relationship between the community and the proposed urban form (Amado et al., 2010). Robertson and May highlight the importance of considering the social aspects stating that given the complexity of the interactions between humans and the environment, solutions to environmental problems cannot be purely technical and therefore cannot be divorced from social, cultural and politic aspects (May, 2008) (Robertson, 2012). Ross goes further and says that if the current cities ever develop into sustainable cities, will be due to social and political change and not due to technical improvements (Ross, 2011). Fresco agrees and says that long ago that there are technical means for the implementation of sustainability in cities and it is in the hands of citizens to act to implement sustainable practices (Fresco, 2007).

## 2.6 Existing sustainable city models

Although there are many studies about the characteristics that cities must fulfill to be sustainable, there is a lack of studies in which there are proposed new sustainable cities models. The first studies on models of urban planning cities began in the nineteenth century with the expansion of industrialization and increasing population migration to cities. In 1923 Burgess proposed the circular city model with concentric functional rings. This model was applied to the city of Chicago. It contains a strong industrial and business center and concentric rings of residential areas of increasingly higher classes as the distance from the center increases (Barcelona Field Studies Centre, 2013).

After the concept of Burgess, several models have emerged throughout the twentieth century. For example the model of Hoyt in 1939, also known as sectorian model and the model of Harrys and Hullman and 1945, also known as multi-core model (Figure 2) (Adhvaryu, 2010).

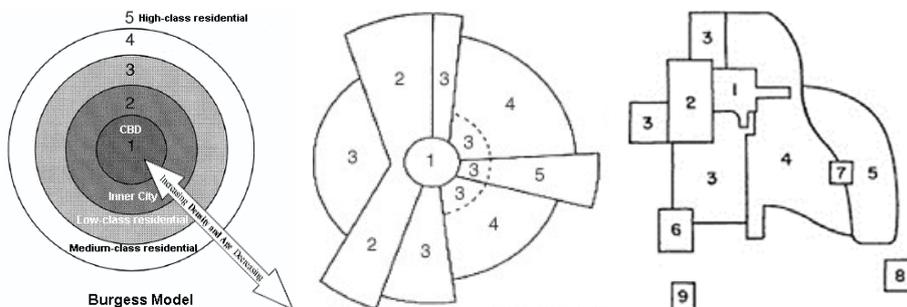


Figure 2. Burgess model (left), Hoyt model (centre) and Harrys and Hullman' model (right)

Despite the existence of these classic circular models of cities evolution, many existing cities evolved from a grid model, often organically and with little planning. There was not a true effort throughout history to implement sustainability models in cities. In part this was due to economic constraints but also due to the fact that these models attempted to exploratory understand the expansion of cities, rather than be sustainable cities models. In fact, the issues related to the carrying capacity of the planet and sustainability only began in the late twentieth century.

However, recently some initiatives with the objective of designing and building sustainable cities emerged. For example, Mendes proposes in his book "The future of cities" the implementation of an innovative conceptual model in mid-sized Portuguese cities, the concept of incubator city, based on the implementation of five dimensions, the intellectual city, the innovative city, the connected city, the authentic city and sustainable city (Mendes, 2011). Another example of a model that has raised notoriety in recent years is the one from Jacques Fresco, which idealizes a circular city with functional concentric rings, through the application of the latest technology to protect the environment and improve the lifestyle of populations. The city model of Fresco

(Figure 3), designed for cities up to one million inhabitants, adopts a resource-based economy, in a model where all waste is recycled and all energy comes from renewable sources, with efficient management of materials and resources (Fresco, 2007). Another example of a sustainable city model is the EcoTownZ project (Figure 3), a model of an ecological city with 150,000 inhabitants, which follows the traditional urban forms and can be built using current technology. The creators of the model claim that the city offers the best of urban and rural environments simultaneously and they can completely eliminate the traffic problems, promoting the use of public transport, cycling and walking (EcotownZ, 2008). Despite the existence of these models, there have been many critics of these models, as the implementation of a city of this type may involve building a city from scratch, being very difficult to adapt an existing city to the idealized model of sustainability.

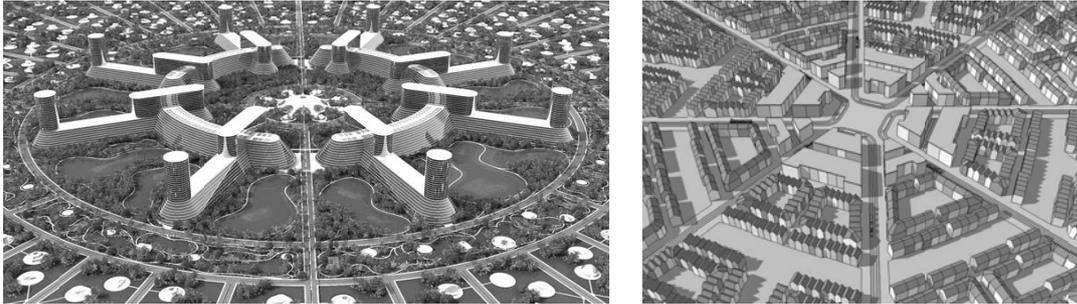


Figure 3. Sustainable city models: Fresco (left) and EcontownZ (right)

### 2.7 Urban regeneration examples

Despite some examples of cities being built from scratch, mainly in Asia, most of the existing efforts in the implementation of sustainability measures in cities have been conducted through the urban regeneration of existing cities. A common example is the city of Stockholm, in Sweden, which was considered the first European Green City by the European Commission (EC, 2010). Also in Sweden, the cities of Göteborg and Hammarby Sjöstad are also referred to as sustainable cities. There are numerous private and public initiatives to implement sustainable labels in cities, especially in northern Europe and the Scandinavian countries. As an example, the cities of Bristol, Leicester and Middlesbrough in England, Nantes in France, Rotterdam in the Netherlands, Aalborg, Ballerup and Frederikshavn in Finland (100 % of renewable energy), Oslo in Norway, Copenhagen in Denmark, Vitoria-Gasteiz in the Basque Country and Frankfurt, Freiburg, Hamburg and Kronsberg, in Germany, among others (EC, 2013).

However, these examples do not follow a long term urban regeneration model in order to transform current cities in sustainable city models. In these cities, there are efforts towards sustainability, which is commendable, but it can be argued that these efforts do not encompass all aspects of sustainability holistically and are not enough. The titles of "green city" are thus assigned improperly since there is the promotion of some individual measures that are recognized as interesting for the implementation of sustainability but the cities are not really sustainable as a whole.

Despite these recent plans (21st century), there are much older examples such as the case of Paul Grover plan to transform the city of Los Angeles (which is usually considered unsustainable) in a sustainable city. The plan includes changes to the technical design and in social, political and economic levels over 20 years to become a sustainable city (Grover, 1983). However, Grover's plan was never implemented and continued only as a proposal. The city of Los Angeles has evolved a lot since then and has greatly increased its environmental impact, being a case study in water importation at great distances. This poorly planned growth occurred in many cities around the world, in which there are technical means to implement improvements to make them more sustainable, but in most cases there is a lack of financial ability and/or political willingness to embark on this kind of plans. It is therefore very important to study and develop sustainable cities models and ways to implement these models in existing cities.

### 3 CONCLUSIONS

The development of sustainable cities is a very complex subject. However it is urgent to act at this level to mitigate the environmental and social problems that are present in nowadays cities and societies around the world. To develop a sustainable city, environmental and social aspects must be balanced, while being especially careful in dealing with economic issues.

It is important to note that the development of a sustainable city should be subject to sustainability assessment. Only with the use of sustainability assessment it is possible to compare holistically different models and decide on the implementation of the best solutions. In this evaluation, it is important to define a relevant set of quantifiable indicators. These indicators should respond to a set of criteria that cities should check to be considered sustainable.

A city can only be sustainable if the population is in harmony with its operational model, since the behavior of a community is determinant in the performance level that can be achieved. Several authors even relate the concept of sustainable city with the concept of sustainable community, since they are interdependent. Taking into account that in the design of a sustainable city, the communities operations should be considered, such as consumption patterns and lifestyle of the population, the opinions of the population must be predicted and studied in the design of a sustainable city. Thus, the design of a sustainable city model bounces off the strictly technical subject and addresses axiological issues related to the wills of people individually and collectively.

Finally, it is necessary to take into account that considering the state of development of most cities, it is difficult to implement some models of sustainable cities. In fact, many cities are implementing sustainability measures, disregarding sustainable city models. However, these measures prove to be insufficient for implementation of sustainability holistically. So it becomes necessary to study urban regeneration plans for long-term implementation of sustainable cities models.

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