Warsaw's Smart City Mirage: Unmasking Ranking Variations and Methodological Mysteries of IMD Smart City Index Report

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Abstract. Although the smart city concept is widely adopted globally, there is a growing need to assess the advancement of spatial entities. International Institute for Management Development (IMD) Smart City Index has been providing an annual rating of the smartest cities worldwide since 2019. However, because of the changed methodology for 2023, the comparison is not as straightforward as one would expect. The purpose is to illustrate how ranking position comparison can't be the unique method as a suitable way for judging a city's downgrade or promotion, giving a more friendly form of study for decision makers' assessments. This paper conducts a comparative analysis of the 2019 and 2023 IMD Smart City Index reports, using Warsaw as a case study. The significance and originality of this study is in emphasising the challenge of assessing cities only based on their ranking. Instead, the objective is to assign more value to the individual factors studied in the ranking, consequently proposing a more direct comparison among them. The authors demonstrate how the alteration in methodology impacted Warsaw's ranking position. Subsequently, a contrary trend was identified, rather than increasing as first suggested, Warsaw declined in the ranking, which corresponds to the worsening of most of the parameters examined in the research. Hence, the updated calculation methodology used in the IMD Smart City Index is more precise and may be regarded as a metric for assessing advancements in the search for smartness.

Keywords: smart city · sustainability · IMD · Smart City Index · Warsaw

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1 Introduction

In recent decades, urban areas have seen rapid and continuous growth. According to the 2022 World City Report published by UN-Habitat, the urban population accounted for 57% of the global population in 2021. The forecast indicates that there would be a projected growth to 68% by the year 2050, resulting in a total of 2.2 billion people living in urban areas [1]. The ongoing process of urbanisation and its resulting consequences in all aspects of urban life have led to a growing focus on sustainable development [2].

The concept of a "smart city" has become more popular worldwide as a way to tackle urbanisation, economic and technological growth and environmental issues [3, 4]. Furthermore, the relevance of this topic is increasing as technology assumes a more significant role part in everyday lives [5].

Despite being recognised since the early 1990s, there is no universally accepted definition for what constitutes a "smart city" or a "smart and sustainable city" [6–9]. Some researchers focus on the aspect of safety [10], other on healthcare innovations [11, 12], and still another on people' engagement and empowerment [13–15]. Most studies focus on three main groups of aspects such as socio-cultural, techno-informational, and organizational aspects of smart city notion [16]. Hui et al. [17] define a smart city as a city that is both sustainable and efficient from several perspectives. It achieves this by improving mobility, optimising the use of resources, enhancing health and safety, promoting economic and social growth, and enabling participatory governance through not only face to face communication, but also the use of information and communication technologies, cooperation, and investment in social capital. Ahmed et al. [18] concentrate on the use of cutting-edge technologies in the management of urban environments. Sarker [19] defines a smart city as "an urban environment" or an advanced contemporary context, able to guarantee the accessibilities of the city amenities, to enhance the citizens wellbeing.

Pandiyan et al. [20] discuss addressing urban challenges by optimising resources and maximising productivity in the mobility, waste management and the energy sectors. The authors emphasise the significant impact of socio-cultural aspects on improving urban quality of life through suitable environmental and mobility planning.

The rise of the smart city idea has led to several research papers predicting the assessment and ranking of cities globally based on their initiatives. The IESE Cities in Motion Index ("Instituto de Estudios Superiores de la Empresa"), the Smart Cities Index, the ISUI Smart City Index ("International Society for Urban Informatics"), the Digital City Index, the Innovation Cities Index, and the IMD Smart City Index are a few examples [21]. The Swiss International Institute for Management and Development's report (the IMD Smart City Index) focuses on the technical, economic, and social elements of cities, by analysing all aspects with indicators [22].

Indicators and rankings are important tools for evaluating the progress in smart development because they provide easily interpretable quantitative data. In order to effectively quantify the impact of using such ranking to monitor the development, it was important to concentrate the attention on a single aspect (analysing all 141 cities in the ranking would be inefficient). Warsaw was chosen as a case study because of its representative significance. Warsaw is the capital and largest city of Poland, and it is also one of two Polish cities included in the ranking. Furthermore, the city has been

honoured with several smart city awards and certificates. Upon examining the data, an anomaly was observed: despite the indicators worsening, the city's rating improved, which seemed to be a significant phenomenon.

For these reasons, the authors will examine Warsaw's scenario in the IMD Smart City Index research, with a particular emphasis on methodology. The index was selected due to its utilisation of citizen interviews and data collection across several cities, making it a highly regarded tool for policy makers and for attracting worldwide media attention. Furthermore, the researchers created case studies on several kinds of smart cities to demonstrate the varying phases of growth and diverse experiences in each city. The objective was to highlight the applicability of the index in multiple circumstances. To direct the research, the following research question was formulated: "What impact did changes in methodology and priorities have on Warsaw's Smart City Index rankings between 2019 and 2023, and what were the contributing factors to these shifts?" The authors further explore this topic by examining the changes made to the methodology of the IMD Smart City Index between 2019 and 2023 and how these changes impact the comparability of Warsaw's rankings in those two years. To accomplish this, the paper starts with an introduction (this section, the Sect. 1), that emphasises the growing notion of smart cities. The discussion then turns to analysing Warsaw as a smart city (Sect. 2) and the IMD Smart City Index, by discussing how the index assesses cities (Sect. 3). The Sects. 4 analyses the methodology employed and the results for this comparative analysis. Finally, the discussion and conclusions are focuses on Sect. 5. This section not only explores the implications of methodological alterations on Warsaw's ranking fluctuations, but also provides suggestions for policymakers.

2 Warsaw as Case Study

Warsaw, the capital of Poland is located in the centre of the country (Fig. 1). According to the Central Statistical Office, Warsaw covers 517.2 km^2 and has a population of 1,861,975 inhabitants, according to the Central Statistical Office [23]. This makes Warsaw the biggest and most populated city in Poland. The capital is also the 9th most populous in the EU [24]. Warsaw is situated in the Mazovian Region, which is the biggest and most populated in the country. It's located 300 km from the Carpathian Mountains and 260 km from the Baltic Sea. It operates as a central intellectual, political, cultural, and economic centre.

Warsaw is a city that is recognised as the smartest in Poland. In 2019, it won the Smart City Award in the category for cities with 500,000 inhabitants and more [25]. The Smart City Award aims to recognise people and initiatives that have significantly contributed to the progress of policies for developing smart cities in Poland. The award is designed for members of the business community and local government officials who improve the competitiveness of Polish cities, the country's economy, and businesses by using innovative ideas and management practices in their initiatives [26].

Warsaw was appreciated for its technological development with a view to the well-being of the citizens and tourists [25]. That year, the capital of Poland received the platinum certificate of ISO 37120 norm from the World Council on City Data (WCCD). It is an international standard to quantify indicators of quality of life and urban services

and therefore assess sustainable social development of cities. Certificates are awarded at five different levels: aspirational, bronze, silver, gold, and platinum, based on the number of indicators are submitted and verified.

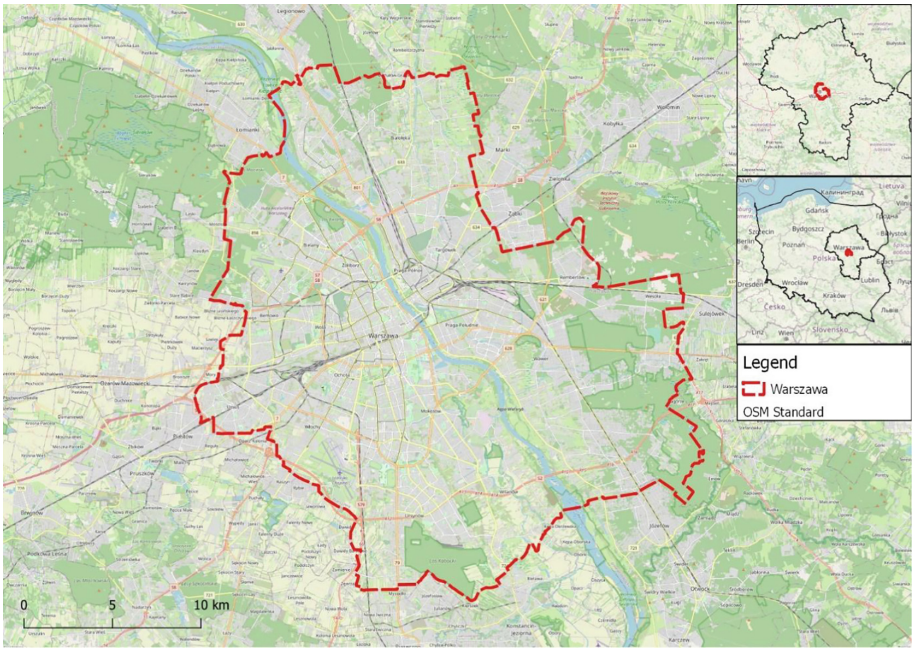

Fig. 1. Map of Warsaw (Source: Authors elaboration)

The certification procedure involves verifying 100 indicators, including 46 core indicators necessary for certification and 54 additional indicators. Those indicators are divided into seventeen categories. The auditors from the WCCD assessed several aspects of urban life in Warsaw, including urban planning, transportation, sanitation, recreation, education, and safety [27]. Knight Frank, a well-known real estate, and consultancy business produced two reports in 2018 on the aspirations of two Polish cities to become 'smart', one of them was Warsaw. The research examined the city across six areas of smartness: smart mobility, smart environment, smart economy, smart society, smart living, and smart government [28]. The selection of these parameters is not arbitrary but rather based on the recognition that they are internationally recognised as the key factors used to create the IMD Smart City Index, the most significant measure for evaluating the smartness of cities.

The selection of Warsaw as a case study for this research is ideal because it effectively demonstrates the significant discrepancies in rankings resulting from the use of two different assessment procedures to compute the IMD Index. It strongly emphasises the need of considering factors beyond just geographical comparison in order to accurately assess the city's development. By re-evaluating the calculating technique, it becomes evident that there has really been a decline in the city's growth.

3 IMD Smart City Index

The Smart City Index introduced by IMD evaluates both social, economic, and technological elements of the city. The former refers to inclusiveness, quality of life and environment. The index measures citizens' perceptions in five key areas (Table 1): health & safety, mobility, activities, opportunities (work & school) and governance, captured in two categories: structures and technologies.

Table 1. Key areas of IMD Smart City Index report. (Source: Authors elaboration)

Structures	Technologies
Health & safety	
Mobility	
Activities	
Opportunities	
Governance	

A total of 120 people from each city were polled for assessment. There are 15 indications offered under major categories. Survey participants are also asked to choose the 5 most important aspects for them, which constitute priority categories [29, 30]. The Human Development Index (HDI) is finally used to compute the final score. This index is computed based on predicted years of life, schooling, mean schooling period and Gross National Income per capita. Subsequently, the HDI is used to categorise cities into four groups. Cities within these are rated from AAA to D based on citizens' feedback [30]. Hence the score is relative. Moreover, the scores from past years are used into the calculation of the current year's results. What are the methodological changes between 2019 and 2023?

Initially, the number of cities featured has increased from 102 in 2019 to 141 in 2023. In addition, a new knowledge partner, The World Smart Sustainable Cities Organisation, provided guidelines for smart cities. Finally, the approach was revised. The 2023 IMD Smart City Index highlights that the alteration in calculation methodology is a response to the evolving global environment of smart cities. This transformation at the city level serves as a valuable signal of what the future could bring.

The SCI's methodology (Smart City Index) was enhanced by including more data at the municipal level. The SCI was developed as an analysis tool for the improvement of cities by using surveys to evaluate people' perceptions. Therefore, it is of utmost importance that the data collected is perfectly placed in the context of the cities examined.

The 2021 Index, as well as all previous years, depended on country-level Human Development Index (HDI) data provided by the United Nations Development Programme (UNDP). In 2022, the International Institute for Management Development intends to use HDI data at the city level, in order to provide a more realistic depiction of the socio-economic environment of specific cities [29].

4 Analytical Approaches in Analysing the Two Smart City Index Reports (2019–2023)

As previously mentioned, the research is based on comparing two Smart City Index reports created by International Institute for Management Development in Switzerland. The research focused just on these two years due to a recent change in methodology. Including two years in between (with no data for 2022) would not provide any new insights to the analysis. The modifications made to the calculation procedure between the 2019 and 2023 reports were carefully analysed to identify the changes affecting the ranking outcomes. Moreover, changes in the indicators were examined, especially in the priority areas. Analysis of trends revealed a substantial reversal in Warsaw's expected economic trajectory. Warsaw's rating decreased as expected due to lower scores on many parameters outlined in the revised approach.

Warsaw made its debut in the smart city rankings in 2019. Various changes have occurred in the indicators and overall rating for four years. Warsaw was ranked 61st out of 102 cities in 2019 and 44th out of 141 cities in 2023. The overall rating increased by 17 positions in the individual Smart City Index rankings. Comparing the metrics from 2019 and 2023 in the smart city index is remarkable. It is important to note that the methodology for generating the index in the 2023 Smart City Index has been changed.

The 2023 IMD Smart City Index enhanced the technique for calculating the index and comparing it to the previous version by introducing a new approach for calculating indicator methodology. So, according to new rankings published in the SCI 2023, in 2019 Warsaw should have been placed in 14th position instead of 61st. This paper examines and contrasts the first signs to comprehend the decline in Warsaw's ranks from 14th to 44th position.

Priority Areas

Figure 2 shows the IMD Smart City Index priority areas, which were selected from a list of 15 indicators. Survey participants were asked to choose 5 indications they considered most critical for their city. The top three top problems identified by survey respondents in 2019 were traffic congestion, air pollution, and affordable housing. Compared to 2023, only affordable housing is still in the top three. Affordable housing, security and health services have been the most highlighted indicators [29].

In 2023, there have been different changes in several priority areas compared to 2019. Participants in the survey said that some key topics had shifted since 2019. Figure 1 shows that among the 14 overall priority categories, only six, including affordable housing, recycling, basic utilities, school education, social mobility, and unemployment, were considered more concerning to the city in 2023 compared to the 2019 data.

Priority areas in Fig. 2 linked to traffic, such as road congestion and air pollution, have decreased in rank from the top positions to 5th and 6th place. Meanwhile, concerns about affordable housing and security are moving to the top. Conversely, the concern over unemployment has marginally risen, but citizen engagement has decreased. Additional factors such as employment, recycling, green spaces, and transport have been consistently identified as areas of concern with no notable improvements in Smart City Reports [29].

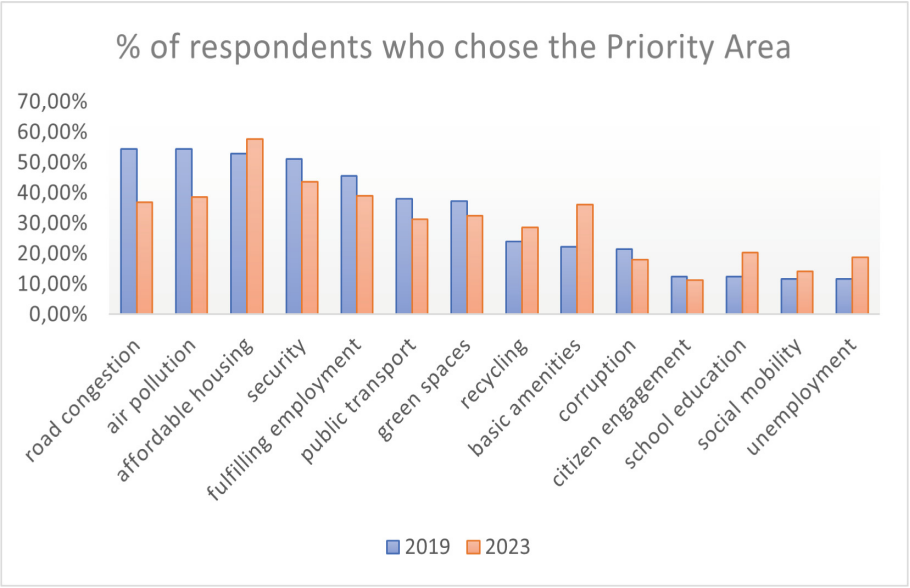

Fig. 2. Priority Areas, from 2019 to 2023, according to IMD Smart City Index (Source: Authors elaboration)

On comparing the indicator changes on Table 2, it is evident that several indicators have declined in the Smart City Index 2019 comparison to the 2023 SCI. Merely examining the ranking position without reviewing the whole record, it would have given the impression that Warsaw had improved (moving from 61st place to 44th). Warsaw fell from 14th rank in 2019 to 44th in SCI 2023 due to a general reduction in most metrics, with just three showing improvement. That proves that individual comparison of old ranking positions in the IMD Smart City Index with the new one is not relevant due to the changes in methodology.

Table 2. Structures Index, from 2019 to 2023, according to IMD Smart City Index [29, 31]

Index	2019	2023
Basic sanitation meets the needs of the poorest areas	74.66	64.1
Recycling services are satisfactory	61.98	61.3
Public safety is not a problem	66.39	61.1
Air pollution is not a problem	27.55	31.6
Medical services provision is satisfactory	47.93	46.3
Finding housing with rent equal to 30% or less of a monthly salary is not a problem	–	28.6

(*continued*)

Table 2. (*continued*)

Index	2019	2023
Traffic congestion is not a problem	32.51	31.4
Public transport is satisfactory	64.33	63.0
Green spaces are satisfactory	71.9	63.0
Cultural activities (shows, bars, and museums) are satisfactory	80.17	77.6
Employment finding services are readily available	77.96	65.4
Most children have access to a good school	78.4	68.4
Lifelong learning opportunities are provided by local institutions	75.48	70.4
Businesses are creating new jobs	78.93	69.3
Minorities feel welcome	61.43	58.3
Information on local government decisions are easily accessible	71.49	62.1
Corruption of city officials is not an issue of concern	40.5	40.7
Residents contribute to decision making of local government	59.37	54.7
Residents provide feedback on local government projects	65.43	63.3

It is necessary to study each increase or decrease of the individual parameter in order to be able to analyse the change in the city in detail (Table 3).

Table 3. Technologies index, from 2019 to 2023, according to IMD Smart City Index

Index	2019	2023
Online reporting of city maintenance problems provides a speedy solution	57.3	51.3
A website or App allows residents to easily give away unwanted items	66.67	62.2
Free public Wi-Fi has improved access to city services	71.49	62.6
CCTV cameras (Closed-circuit television camera) has made residents feel safer	71.21	55.2
A website or App allows residents to effectively monitor air pollution	73.42	64.4
Arranging medical appointments online has improved access	69.28	66.4
Car-sharing Apps have reduced congestion	55.1	49.1
Apps that direct you to an available parking space have reduced journey time	59.64	50.7
Bicycle hiring has reduced congestion	64.74	59.6

(*continued*)

Table 3. (*continued*)

Index	2019	2023
Online scheduling and ticket sales has made public transport easier to use	77.41	71.8
The city provides information on traffic congestion through mobile phones	-	50.1
Online purchasing of tickets to shows and museums has made it easier to attend	84.99	78.7
Online access to job listings has made it easier to find work	83.2	78.7
IT skills are taught well in schools	66.39	58.7
Online services provided by the city has made it easier to start a new business	68.32	63.7
The current internet speed and reliability meet connectivity needs	-	71.3
Online public access to city finances has reduced corruption	46.97	45.2
Online voting has increased participation	54.55	57.6
An online platform where residents can propose ideas has improved city life	68.04	63.7
Processing Identification Documents online has reduced waiting times	75.07	67.3
Ranking position	**61/102**	**44/141**
New ranking position	**14/102**	**44/141**

A significant aspect to consider is the methodology changes in the 2023 Smart City Index, impacting the comparison between 2019 and 2023. The index calculation method was improved, and a new way of calculating indicators was implemented. Therefore Warsaw, in updated rankings from previous years, published in SCI 2023, secured 14th place, a substantial improvement from its 61st position in the original SCI 2019.

The methodology changes involved transitioning from using country-level Human Development Index (HDI) as a proxy for evaluating health, knowledge, and standard of living dimensions to city-level HDI, provided by the Global Data Lab. This modification enhances the accuracy of city rankings and allows for better comparisons between cities.

The drop in ranking from 14th to 44th in IMD 2023 reflects the impact of these methodology changes, highlighting the necessity to consider the altered calculation approach when interpreting Smart City Index results. In addition, the analysis of the individual old parameters shows that almost all of them (33 out of 36) had a decrease compared to 2019.

5 Discussions and Conclusions

This paper presented research based on the case study of Warsaw as a smart city, based on the comparative analysis of the IMD Smart City Index Reports from 2019 and 2023. The main focus was on the methodology alternation that affected the relevance of the previous reports; therefore, it is important to discuss the significance of this change.

Here, the rationale behind the change as well as the impact on relevance and accuracy will be presented.

First of all, the changes made to the IMD Smart City Index methodology in 2019 and 2023 indicate a concerted attempt to improve the precision and relevance of city rankings. The Human Development Index (HDI) at the city level was adopted in place of the country-level HDI due to the realisation that city-specific data might provide a more detailed and accurate evaluation of urban regions. The knowledge that cities can differ greatly from their national averages in terms of development, infrastructure, and quality of life probably led to the decision to include city-level HDI. Rather than making generalisations based on national measures, the index sought to provide a more customised assessment by utilising city-level data to capture the distinctive qualities and accomplishments of particular cities. Secondly, the transition to the city-level HDI brought in an assessment approach that was more context-and locally-specific. The purpose of this modification was to improve the IMD Smart City Index's city rankings' relevance and accuracy.

The index aimed to provide a more accurate depiction of a city's development by considering characteristics unique to its urban environment by utilising data relevant to individual cities. This modification was made in order to reflect the different specifics of cities more accurately across the globe, considering their unique efforts, strengths, and problems as they work to become smarter. However, it was difficult to compare rankings directly between the two years due to the change in calculation techniques, particularly the addition of city-level HDI. Warsaw's move up the rankings—from 61st in 2019 to 44th in 2023—might at first seem to indicate improvement. But rather than being a direct outcome of the city's smart city efforts getting better, this change in rank was the consequence of methodological changes.

Caution should be used when interpreting ranking discrepancies due to the necessary methodological corrections. Comparing rankings from different methodologies without considering methodological adjustments may lead to erroneous findings. It is important to highlight that the altered approach may lead to variations in a city's ranking, which may not accurately represent the advancements made in its smart city projects. This highlights the importance of understanding the context and paying careful attention to methodological subtleties when evaluating changes in rankings. The subtleties produced by the methodological changes emphasise the need of recognising these variations to avoid misinterpretations and provide a more precise assessment of a city's progress throughout time.

There are a few limits to this research. Firstly, in order to accurately compare the ratings of each city and comprehend the underlying causes, the analysis of individual items is rather extensive. Additionally, because the analysis is based on surveys, it is highly dependent on the selection of the sample, making it especially sensitive to this decision.

The paper also addressed the changes in priority areas in Warsaw from 2019 to 2023. Therefore, it is crucial to examine its importance and implications. The surveys conducted by the IMD Smart City Index have identified significant shifts in crucial domains that are crucial for understanding the evolving needs and preferences of residents in the context of smart cities. These changes reflect the changing perspectives and

concerns of residents regarding the most significant issues impacting their quality of life and urban experiences.

These alternations have a multitude of impacts on smart city initiatives and projects. Primarily, they provide precious information that assists politicians and urban planners in adapting their plans and initiatives to more effectively meet the evolving needs of the population. Initiatives focused on enhancing safety measures, increasing healthcare accessibility, and strengthening emergency services may get more money and attention if security and health services have been identified as priority areas. Additionally, they indicate the need for a more comprehensive strategy for the development of smart cities. Initiatives should prioritise several areas of urban life, including social inclusion, affordable housing, security, healthcare, and environmental sustainability. Policymakers should use the Index's findings as a guide when developing integrated solutions to address these varied and changing objectives.

Local governments may use adaptive governance techniques in response to these evolving challenges. This requires the implementation of adaptable policy-making methods that can accommodate the dynamic demands of the people and the constantly evolving urban environment. For instance, if authorities see that restoring community participation in decision-making processes has diminished in significance, they may seek innovative methods to achieve this goal by using technology and community engagement platforms [32, 33].

In addition, the results of the Index can force an assessment of current programmes and policies to make sure they are in line with the priorities of the present. Budgets may need to be reorganised in order to allocate funds to sectors that the public believes have become more important, as indicated by the Index's highlighted citizen perceptions.

In summary, methodological changes make it difficult to compare Smart City Index ranks between years. Changes in methodology, like going from a country-level HDI to a city-level HDI, have an immediate effect on the assessment's criteria and statistics. This results in a fundamental change in the assessment of cities, complicating direct year-over-year comparisons. However, changes in priority areas and direct comparison of individual parameters may serve as a suggestion for policymakers to adjust or alternate existing strategies.

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