MEASURING URBAN DIGITAINABILITY

Projekt Report

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SUSTAINABLE SMART CITIES

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Outline

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1. Introduction

With the acceleration of urbanization on a global scale, the significance of smart and sustainable cities has become increasingly prominent. In the pursuit of making our cities smarter, more sustainable, and inclusive, we are presented with a formidable challenge. An innovative and strategic solution has emerged to address the pressing urban issues we face. This solution centers around the concept of a "Smart City," which seeks to elevate urban intelligence, stimulate sustainable economic growth, and foster social development (Caird & Hallett, 2018; Zhao et al., 2021). Governments, organizations, and urban planners worldwide have been employing various indices to measure the progress and effectiveness of cities' performances in the direction of becoming smart and sustainable. These indices are designed to establish a standardized framework for assessing cities' performance in crucial areas such as technology integration, environmental preservation, infrastructure advancement, and overall living standards. Nevertheless, the proliferation of these indices has resulted in a fragmented landscape characterized by distinct methodologies, indicators, and weightings. This diversity can lead to perplexity and discrepancies when evaluating the performance of cities. Hence, there exists a necessity to undertake a comprehensive evaluation of existing smart and sustainable cities indices in order to streamline and enhance their effectiveness.

2. Our Challenge

The primary aim of this challenge is to conduct a thorough assessment and examination of current indices for smart and sustainable cities to improve the existing existing/current WeGo-IMD Index (WeGo & IMD, 2023). The focus is on its strengths, weaknesses, and potential areas for enhancement. The overarching objective is to establish a standardized index that can improve the precision, significance, and objectivity of previous indices. Therefore, we had to answer the question:

How can we measure and benchmark sustainable smart cities?

The intended impact of the comprehensive evaluation of smart and sustainable cities indices is to cultivate positive and transformative changes in urban development practices, policy-making, and overall urban living standards globally. The impact is multi-dimensional and far-reaching. That means that the improved index should contribute to informed decision-making, enhanced urban sustainability, sustainable economic growth, environmental conservation, equity and inclusion, policy innovation, public awareness and engagement, as well as positive feedback loops inside a city.

Ultimately, the envisioned impact is to stimulate a global movement toward more intelligent, sustainable, and inclusive urban environments that not only prioritize economic growth but also prioritize the well-being of residents, the environment, and future generations. The research endeavors to catalyze positive change that leaves a lasting imprint on the way cities are conceptualized, developed, and managed.

In conclusion, this challenge strives to strike a balance between ambition and practicality, taking into account the different dimensions of smart and sustainable cities, while keeping the focus on the evaluative aspects rather than generating new solutions from the ground up. The objective is to offer actionable insights that can facilitate positive changes in urban development practices.

3. Our Solution

Our solution focuses on enhancing the index's quantifiability by introducing more objective measurements within its indicators as well as its methodology. It included three deliverables that consisted of a metadata set of objective indicators, a list of recommendations with a focus on the We-Go Index methodology to make it more representative, and a template of our new and improved index using the case of Istanbul, Turkey.

The metadata set presented by our team includes a plethora of different components. It consists of additional themes, in which we included various objective indicators as well as their respective recommendations of methodologies. In the case of Istanbul presented in our template, the team particularly focused on equity, female-friendly, sustainable urban planning, and disaster preparedness indicators. The first objective indicator belonged to the "social" theme and would potentially be addressed through measurement frameworks such as the Gini Index of Income Inequality. This framework offers quantitative metrics such as income and wealth distribution, housing equity, and access to financial services (OECD, 2023). Next, the second social indicator would be improved by including objective parameters found in indices such as the Gender Development Index or the Gender Inequality Index. These indices provide criteria such as the number of parliament seats, labor force participation rate, male-to-female mortality ratio, and many more (UNDP). Next, we improved the WeGo Index by introducing a new 'Environment' category, which includes the "Sustainable Urban Planning" indicator. For this indicator, the team was inspired by the Smart City Index Master Indicators Survey (SCIMI) and decided to incorporate it into our own. The methodologies used for this index within the SCIMI included various objective assessments, such as the number of LEED or BREAM sustainability-certified buildings, the percentage of commercial/ industrial buildings with smart meters, the rate of commercial buildings with automation systems, and so on (Cohen, 2014).

Finally, our focus on the disaster preparedness indicator was mainly influenced by the case country we decided on for our template. We chose to include a new category named "Resilience and Adaptability" in order to ensure a more accurate and comprehensive evaluation of a city's smartness, considering Turkey's susceptibility to earthquakes. We included as a recommended

methodology the SENDAI framework for disaster and risk reduction, as well as any other comparable national or local disaster risk reduction strategy.

Figure 1: New Index criteria

Criteria	Indicator	Description	Source
Environment/ Health and Safety	Environmental Performance	Environmental Performance Index	
	Sustainable urban planning	Climate resilience planning/Sustainability-certified buildings Does your city have a public climate resilience strategy/plan in place? (Y/N) If yes provide link.: • Number of LEED or BREAM sustainability-certified buildings in the city (note: if your city uses another standard please indicate) • % of commercial and industrial buildings with smart meters • % of commercial buildings with a building automation system;	Adapted from Smart City Index Master Indicators Survey (Cohen, 2014).
	Density	Population-weighted density (average densities of the separate census tracts that make up a metro)	Adapted from Smart City Index Master Indicators Survey (Cohen, 2014).
	Green space per capita	Green areas per 100,000 (in m2) (ISO 37120: 19.1)	Adapted from Smart City Index Master Indicators Survey (Cohen, 2014).
	Climate vulnerability	Risk to the city due to climate change. - National Geographic	IESE Cities in Motion Index
	Safety	Crime rate / smart crime prevention • Violent crime rate per 100,000 population (ISO 37120: 14.5)	Adapted from Smart City Index Master Indicators Survey (Cohen, 2014).
	Single health history	• % of residents w/ single, unified health histories facilitating patient and health provider access to complete medical records	Adapted from Smart City Index Master Indicators Survey (Cohen, 2014).
	Nutritional status	• Nutritional status of children • Nutritional status of population	OECD
	Mortality	• Mortality rate under 5 years old • Life expectancy at birth	OECD

	Sanitation	• Percent of population with adequate sewage disposal facilities	OECD
	Drinking water	• Population with access to safe drinking water	OECD
	Healthcare delivery	• Percent of population with access to primary health care facilities • Immunization against infectious childhood diseases • Contraceptive prevalence rate	OECD
	Atmosphere/Climate change	• Emissions of greenhouse gases	OECD
	Ozone layer depletion	• Consumption of ozone depleting substances	OECD
	Agriculture	• Arable and permanent crop land area • Use of fertilizers • Use of agricultural pesticides	OECD
	Forests	• Forest area as a percent of land area • Wood harvesting intensity	OECD
	Desertification	• Land affected by desertification	OECD
	Urbanization	• Area of urban formal and informal settlements	OECD
	Oceans, seas, and coasts/Coastal zone	• Algae concentration in coastal waters • Percent of total population living in coastal areas	OECD
	green energy	Share of nationwide energy consumed from renewable sources. Share of electricity consumption from renewable sources.	EasyPark
	waste management	Waste generated per capita. Waste collection coverage. The recycling rate in each country.	EasyPark
Mobility			
	Traffic Inefficiency Index	This index is an estimate of traffic inefficiencies. High values represent high driving inefficiencies, such as long travel times - Numbeo	IESE Cities in Motion Index
	Efficient transport/Clean-energy transport	Kilometers of bicycle paths and lanes per 100,000 (ISO 37120: 18.7); • # of shared bicycles per capita • # of shared vehicles per capita • # of EV charging stations within the city	
	Multimodal	Public transport/	IMD Smart City Index Report

	access		2023
	Technology infrastructure	% of total revenue from public transit obtained via unified smart card systems; • Presence of demand-based pricing (e.g., congestion pricing, variably priced toll lanes, variably priced parking spaces). Y/N • % of traffic lights connected to real-time traffic management system • # of public transit services that offer real-time information to the public: 1 point for each transit category up to 5 total points (bus, regional train, metro, rapid transit system (e.g. BRT, tram), and sharing modes (e.g., bike sharing, car-sharing) • Availability of multimodal transit app with at least 3 services integrated (Y/N)	IMD Smart City Index Report 2023
Governance			
	ISO 37120 certification	Whether or not the city has ISO 37120 certification. Certified cities are committed to improving urban services and quality of life. This variable is coded from 0 to 6. The highest value is assigned to the cities that have been certified for the longest time. A value of 0 is assigned to cities that are not certified. - World Council on City Data (WCCD)	IESE Cities in Motion Index
	Freedom of press		Freedom of Press Index
People			
	female-friendly	This variable indicates whether a city provides a friendly environment for women (on a scale of 1 to 5). Cities with a value of 1 have a more hostile environment for women; those with a value of 5 are very female-friendly. - Nomad List	IESE Cities in Motion Index
	Happiness	Countries with a higher value are those where the level of overall happiness is higher. - World-Happiness-Index	IESE Cities in Motion Index

	LGBT-friendly	This variable indicates whether a city provides a friendly environment for the LGBT community (on a scale of 1 to 5). Cities with a value of 1 have a more hostile environment for this community; those with a value of 5 are very LGBT-friendly. - Nomad List	IESE Cities in Motion Index
Living			
	Culture and well-being;	Percentage of inhabitants with housing deficiency in any of the following 5 areas: potable water, sanitation, overcrowding, deficient material quality, or lacking electricity	Adapted from Smart City Index Master Indicators Survey (Cohen, 2014).
	Quality of life ranking;	Mercer ranking in most recent quality of life survey	
	Purchasing Power	Purchasing power in buying goods and services in the city (based on the average salary), compared to that of New York City residents. If local purchasing power is 40, this means that inhabitants with an average salary can afford to buy 60% less goods and services than New York City residents with an average salary. - Numbeo	IESE Cities in Motion Index
	Internet speed	Fixed-line Internet speed in megabytes per second (country). - World Population Review	IESE Cities in Motion Index
Social	Equity/ Poverty	• Gini index of income inequality	OECD
	Gender equality	• Female to male number ratio • Female to male wage ratio	OECD
	Literacy	• Adult Secondary education achievement level Literacy • Adult literacy rate	OECD
	Housing/ Living conditions	• Adult Secondary education achievement level Literacy • Adult literacy rate	OECD
	Population Change	• Population growth rate • Population of urban formal and informal settlements	OECD
	Equity	• Gini index of income inequality	OECD

	female-friendly	Share of seats in the parliament, labor force participation rate, male to female mortality ratio, etc.	Gender Development Index, Gender Inequality Index (UNDP)
	Compliance with SDG Goals		City plan to comply with the SDGs
resilience & adaptability	desaster preparedness	SENDAI framework for disaster and risk reduction/ equevivalent framework	city can has eaither or just one of it
		city has national/local desaster risk reduction strategy	
economic	entrepreurship	number of start-ups in the city per year	

Our suggestions include:

- Enhance comprehensiveness and measurement frameworks
- Align frameworks with city strategies
- Use of big data analytics and IoT for modeling and scenario analysis
- More focus on Environmental, Social, and Governance (ESG) criteria

Recognizing the profound impact of survey methodology on the accuracy and effectiveness of the index, we present a series of recommendations for improving survey methodology. These recommendations aim to strengthen the survey's robustness, inclusivity, and comprehensiveness. We recommend the careful integration of the following factors into the methodology:

Influencing Factors: Consideration of cultural elements and adept management of the intricate landscape of data privacy regulations and data accessibility.

Population Definition: Selection of a sample size representing either 1,000 individuals or 1% of the total population instead of the current 120 residents from a given city, wherein the survey was conducted based on online question and answer from these residents.

Survey Type: Offering diverse survey options, including online, paper-based, telephone, or in-person interactions, to accommodate different preferences and accessibility.

Sampling Frame: Ensuring inclusivity by incorporating various demographic factors such as age, gender, educational attainment, residency status, social stratum, immigrant status, and income.

Fieldwork and Data Gathering: Enhancement of survey data through access to data sources from WeGo, other cities, and global indices.

These proposed improvements to survey methodology ensure a more comprehensive, inclusive, and effective assessment of the intelligent and sustainable attributes of cities. This approach aligns seamlessly with WeGo's overarching objectives of promoting sustainability and smart city development.

4. Methodology

In our effort to enhance WeGo's existing smart city index, a tool for measuring a city's sustainability, we have taken a comprehensive approach. This approach is grounded in thorough investigation, involving an extensive review of multiple global smart city and sustainability indices, as well as a comprehensive analysis of scholarly literature. Throughout our journey of discovery, we encountered a diverse array of more than 1,152 unique indicators used to assess the smartness and sustainability of cities.

Our analysis of established indices, including the OECD Index [5,6], Cohen Index(Cohen 2014), IESE Index[7], Easy Park Index[8], and a rich array of scholarly sources, has enabled us to distill this extensive pool of data into a more focused set. As a result, we propose the inclusion of a total of 57 new indicators within the assessment framework, enhancing our ability to evaluate the smartness and sustainability of cities effectively.

Our Drawbacks of the existing Index include a lack of balanced distribution of indicators, static assessments of SCA tools, limited assessment to the local specifics, unclear role of stakeholders in the policy implementation process, and the feasibility of issues across the tools

- Lack of quality due to diversified measures
- Does not take into consideration certain themes, such as governance and people
- Does not take into consideration smart city urban planning
- Discrepancy between ‘’sustainable’’ and smart’’ in some cases
- Financially unrealistic in some cases
- Technically unrealistic in some cases

As we delved into our research, we found that in Europe, the Smart Cities initiative has undertaken the compilation of a vast repository of smart city indicators drawn from more than 90 cities across the continent. European scholars have systematically categorized these indicators based on the six fundamental elements mentioned earlier. Based on thorough research and in-depth analysis, we have discovered crucial aspects for evaluating smart cities, as described by Cohen (2014). Within the realm of individuals, these characteristics encompass education, continuous learning throughout one's life, ethnic diversity, and a receptive mindset. Within the realm of governance, there are elements such as political consciousness, the delivery of public and social services, and the advancement of effective and transparent administration. Living conditions encompass a wide range of factors, such as cultural and recreational facilities, health conditions, personal safety, gender equality, housing standards, availability of educational resources, attractiveness for tourism, and the fostering of social unity. The economic components encompass elements such as pioneering entrepreneurship, influencing the city's reputation, enhancing efficiency, optimizing labor market conditions, and promoting international integration. Mobility issues cover the local transport system, national and international accessibility, the establishment of ICT infrastructure, and guaranteeing the long-term viability of the transport network. In addition, environmental considerations encompass factors such as the quality of air, understanding of ecological issues, and the responsible administration of sustainable resources. These factors collectively contribute to the overall efficiency and long-term viability of smart cities (Cohen, 2014). This comprehensive framework enhances our comprehension and assessment of smart city characteristics, advancing the goals of urban growth and sustainability.

5. Key learnings & Outlook

Our goal was to promote constructive changes for assessing city performance in various sustainability-related domains. Our effort aims to have a multifaceted and extensive impact. We have identified important areas for development and have put forth all-inclusive solutions to handle the complexity and diversity of smart city evaluation through in-depth study and analysis. We highlighted the shortcomings of the current indices throughout our study, stressing the importance of a balanced indicator distribution and the incorporation of Environmental, Social, and Governance (ESG) factors. We acknowledged that the current indexes might ignore some themes, and occasionally show differences between "smart" and "sustainable". We suggested using more representative survey methods and objective measures that comply with the Sustainable Development Goals (SDGs) to overcome these problems.

We recognized the wide range of indices now in use that are intended to assess a city's performance in several sustainability-related areas. However, evaluating and comparing city performances has become more difficult due to the diversity of these indexes. A broad range of indicators allows for a more thorough assessment, but in order to guarantee valid comparisons, standardization and an inclusive approach are also required. Finding the most pertinent indicators for the particular circumstances of each city is essential. By taking into consideration differences in population demographics, cultural factors, and economic inequities, inclusivity guarantees a comprehensive understanding of a city's sustainability. As a result, our task was to develop a standardized index that enhances improves precision, objectivity, and comprehensiveness.

Besides, the growing prevalence of citizen-centric smart city indexes will increasingly play a pivotal role in furnishing real-time insights into urban life and ensuring the prioritization of citizens' needs. As a result, increasing citizen participation in evaluation processes will significantly enhance the inclusivity dimension of smart city measurements.

Moreover, we found that it is crucial to evaluate a city's resilience and adaptability since it highlights its capacity to endure and recover from unforeseen difficulties and interruptions. This goes beyond new developments in technology and includes the city's capacity to deal with and properly adjust to social, economic, and environmental changes. It's important to recognize the difficulty in applying this indication consistently because the resilience and adaptability of each

city vary greatly. Therefore, creating a thorough framework for measuring intelligence that takes these differences into account is a difficult but necessary undertaking.

The measurement of sustainable smart cities is an ever-evolving field that takes into account changing sustainability objectives and urban dynamics. Assessment methodologies, indicators, and objectives must change as cities continue to change.

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