Research on Global Indexes for Smart City Classification and Methods to Evaluate the Intelligence Level of Smart Cities

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Abstract

This study provides a comprehensive review of the global indices utilized to categorize smart cities and examines the approaches applied to assess their intelligence levels. The study utilizes multiple esteemed global indices, like the IESE Cities in Motion Index and the IMD Smart City Index, to emphasize the multifaceted indications and aspects that define a city's intelligence. This research delineates a framework for evaluating the overall intelligence level of a smart city by analyzing variables like governance, technology, infrastructure, sustainability, and quality of life.

1 Introduction

The notion of *smart cities* has emerged as a central theme in urban development, propelled by the necessity to improve efficiency, sustainability, and quality of life in metropolitan areas by technological integration. A smart city utilizes digital technologies, including the Internet of Things (IoT), Artificial Intelligence (AI), and big data, to enhance urban systems encompassing transportation, infrastructure, governance, and social services. Assessing the intelligence level of a smart city is a complicated endeavor necessitating diverse evaluation frameworks.

Numerous international organizations and institutions have created indexes that evaluate and rank cities according to their smart city initiatives. These indices encompass various elements, including technology adoption, governance frameworks, urban mobility, and environmental sustainability.

This paper intends to examine these indices and the methodology employed to assess a city's intelligence, offering a thorough framework for evaluating urban smartness.

Global Indices for Smart City Classification

Global smart city indices offer standardized frameworks for assessing and comparing the performance of cities globally. Presented below are several prominent indices along with their corresponding dimensions.

1.1 IESE Cities in Motion Index (CIMI)

The *IESE Cities in Motion Index (CIMI)*, developed by the IESE Business School at the University of Navarra, is a comprehensive framework that evaluates cities based on their ability to balance economic growth, environmental sustainability, and social cohesion. The CIMI ranks 174 cities globally across nine key dimensions:

- **Human Capital**: Assesses the educational framework and talent cultivation, emphasizing the quality of education, universities, and intellectual resources.

- **Social Cohesion**: Assesses the extent of social inclusion, equity, and welfare opportunities.

- **Economy**: Evaluates economic vitality, growth prospects, business environment, and job creation.

- **Governance**: Concentrates on public administration, civic engagement, transparency, and the prevalence of corruption.

- **Environment**: Analyzes the city's sustainability initiatives, resource allocation, and strategies to mitigate pollution and climate change.

- **Mobility and Transportation**: Examines the infrastructure and efficacy of transportation networks and intelligent mobility solutions.

- **Urban Planning**: Addresses urban density, zoning regulations, and the administration of public places.

- **International Outreach**: Assesses the city's global connectivity and appeal for tourists, commerce, and foreign investments. Evaluates the

extent of technology adoption, the accessibility of digital infrastructure, and the execution of intelligent systems.

The CIMI combines both quantitative data (economic indicators ...) and qualitative assessments like citizen satisfaction to provide a holistic ranking.

1.2   IMD Smart City Index

The *IMD Smart City Index*, created by the IMD Smart City Observatory in partnership with the Singapore University of Technology and Design, examines individuals' perceptions of technology's influence on urban performance. This index distinguishes itself by incorporating citizen comments directly into its ranks, rendering it unique among worldwide indices.

- **Structures (Infrastructure)**: Evaluates the existing physical systems, including electricity grids, transportation networks, and water systems.

- **Technologies**: Assesses the utilization of digital instruments and platforms that improve urban efficiency, including smart meters, e-government services, and IoT networks.

- **Health and Safety**: Assesses the city's medical facilities, emergency services, and public safety systems.

- **Mobility and Activities**: Emphasizes mobility alternatives, encompassing public transit and real-time traffic management systems, alongside accessibility to cultural and recreational pursuits.

- **Opportunities (Education and Employment)**: Analyzes the accessibility of quality education, employment prospects, and talent development within the city.

- **Governance and public Participation**: Assesses the capacity of digital platforms to facilitate public involvement in governance and decision-making processes. Evaluates the city's strategies for mitigating pollution, enhancing green spaces, and shifting towards renewable energy sources.

The IMD index emphasizes the human-centric aspect of smart city development, giving weight to how citizens experience smart services and infrastructure.

1.3 Eden Strategy Institute's Smart City Government Rankings

The *Eden Strategy Institute's Smart City Government Rankings* emphasizes the influence of municipal administrations on the advancement of smart cities. It evaluates cities according to the efficacy of their governing techniques and their capacity to execute intelligent initiatives. This index assesses ten dimensions, which include:

- **Vision**: The long-term objectives and strategy framework of the municipal government for smart city advancement. Leadership: The capacity of municipal leaders to direct initiatives, establish collaborations, and distribute resources effectively.

- **Budget and Financing**: The monetary resources allocated for smart city initiatives.

- **Support Programs**: Government-sponsored initiatives that foster innovation, startups, and the advancement of digital solutions.

- **Data Governance**: The capacity to administer and leverage data securely, efficiently, and transparently for public services. Collaboration and Ecosystem: The participation of commercial sector and academic partners in the city's smart initiatives.

- **Talent Readiness**: The accessibility of proficient workforce, research capabilities, and innovation potential inside the city. Digital Inclusion: Guaranteeing that all citizens, irrespective of socioeconomic status, have access to intelligent services and technology.

- **Sustainability and Impact**: The efficacy of intelligent initiatives in tackling enduring concerns such as climate change, resource depletion, and urbanization pressures. Track Record: The success and results of previously executed smart city initiatives.

This index underscores the significance of governance in the success of smart city initiatives, illustrating that technology alone is insufficient without robust leadership and administration.

1.4 Roland Berger Smart City Strategy Index

The *Roland Berger Smart City Strategy Index* evaluates cities according to their strategic planning and implementation of smart projects. The index evaluates the extent to which cities are equipped to realize their smart city objectives across many areas, including:

- **Smart Governance**: Engagement of citizens, transparency, and the execution of electronic government services. Smart Mobility: Efficient public transit systems, shared mobility alternatives, and real-time traffic management.

- **Smart Energy**: The implementation of renewable energy sources, intelligent grid systems, and energy-efficient structures. Policies regarding garbage management, air quality regulation, and the development of green spaces. Smart Buildings: The incorporation of IoT and energy-efficient technology in architecture and urban development. Smart Healthcare: Digital health solutions, telemedicine, and the implementation of health-monitoring systems.

- **Intelligent Education**: E-learning platforms, digital literacy programs, and advanced school infrastructure.

- **Smart Economy**: The advancement of a knowledge-driven economy propelled by innovation and technology.

1.5 Arcadis Sustainable Cities Index

The *Arcadis Sustainable Cities Index* assesses cities by measuring the equilibrium of social sustainability (people), environmental sustainability (planet), and economic sustainability (profit). Although it largely emphasizes sustainability, it also encompasses aspects of smart city development, including:

- **Individuals**: Availability of education, healthcare, and public services.

- **Planet**: The city's dedication to renewable energy, climate change abatement, and the preservation of natural resources. Profit: Economic resiliency, commercial prospects, and technical advancement.

Arcadis asserts that authentic smart cities must be sustainable, harmonizing technology progress with enduring environmental and social objectives.

2 Classifying the Intelligence Level of a Smart City

Evaluating the intelligence of a smart city necessitates the assessment of several domains that contribute to its overall sophistication. The following are the principal dimensions employed to categorize a smart city's intelligence.

2.1 Technology Implementation

Technology is at the heart of smart city development. A smart city leverages IoT devices, AI, big data analytics, and other digital tools to optimize urban operations and services.

- **IoT Implementation**: Assesses the degree of integration of IoT devices inside urban infrastructures, including transportation, energy, and public services. Artificial Intelligence: Assesses the city's implementation of AI in domains such as traffic control, predictive maintenance, and public safety.

- **Big Data Analytics**: The application of data analytics to enhance urban operations and facilitate data-informed decision-making.

- **Automation**: The implementation of automated systems in public services (e.g., automated public transportation systems, intelligent garbage collection).

2.2 Infrastructure Quality

Smart cities must have robust infrastructure that supports technological growth, innovation, and urban efficiency. This includes both physical and digital infrastructures.

- **Digital Infrastructure**: The accessibility and caliber of high-speed internet, 5G networks, and intelligent communication technologies.

- **Transportation Systems**: The efficacy and amalgamation of intelligent mobility solutions, encompassing electric cars (EVs), public transportation, and real-time traffic management systems.

- **Utilities**: The implementation of intelligent grids for the management of power, water, and garbage.

2.3 Environmental Sustainability

The intelligence of a city is closely tied to its environmental sustainability efforts. Smart cities aim to reduce their environmental footprint while enhancing the quality of life.

- **Renewable Energy Adoption**: Measures the extent to which the city has integrated renewable energy sources (e.g., solar, wind).

- **Carbon Emissions Reduction**: Evaluates the effectiveness of policies aimed at reducing greenhouse gas emissions.

- **Waste Management**: The implementation of smart recycling systems and waste-to-energy technologies.

2.4 Governance and Citizen Engagement

Smart governance is a crucial aspect of a smart city. It involves the use of technology to increase transparency, citizen participation, and the efficiency of public services.

- **E-Government Services**: The provision of digital platforms enabling citizens to access governmental services and submit comments.

- **Open Data Initiatives**: The utilization of open data platforms to promote civic innovation and transparency. Citizen Participation: The extent to which individuals can engage in decision-making processes via digital platforms.

2.5 Mobility and Transportation

Intelligent mobility is fundamental to a city's level of sophistication. It emphasizes the development of efficient, eco-friendly, and accessible transportation networks.

- **Shared Mobility Services**: The provision of car-sharing, bike-sharing, and ride-hailing services. Electric Vehicles and Charging Stations: The proliferation of electric vehicles and the accessibility of charging infrastructure.

- **Intelligent Traffic Management**: The application of real-time traffic data and artificial intelligence to alleviate congestion and enhance route efficiency.

2.6 Quality of Life

A smart city ought to enhance the entire quality of life for its residents by offering superior healthcare, education, and public safety services.

Healthcare Services: The accessibility of telemedicine, wearable health monitoring devices, and AI-driven diagnoses.**Education**: Availability of e-learning platforms, intelligent classrooms, and digital literacy initiatives. Public Safety: The implementation of surveillance systems, predictive policing, and emergency response technologies.

2.7 Economic Competitiveness

A city's intelligence is also measured by its ability to foster economic growth, innovation, and job creation through smart technology.

- **Innovation Ecosystem**: The presence of research institutions, tech hubs, and startup incubators.

- **Job Creation in Technology Sectors**: The growth of employment opportunities in industries related to AI, IoT, and digital services.

- **Ease of Doing Business**: The ability to attract investment through smart policies and streamlined government processes.

3 Methodologies for Evaluation

Multiple approaches exist for assessing and categorizing the intelligence level of a smart city. These techniques offer a framework for evaluating the performance of cities across the aforementioned criteria.

3.1 Key Performance Indicators (KPIs)

KPIs are measurements intended to assess the efficacy of smart city programs. Typical key performance indicators encompass energy usage per capita, internet accessibility rates, and citizen satisfaction levels for smart services. These

indicators are crucial for assessing progress and pinpointing areas requiring enhancement.

3.2 Citizen Surveys and Perception Studies

The perception of citizens is essential in assessing smart cities. Surveys and research can yield insights into inhabitants' perceptions of the efficacy of smart services, enhancements in quality of life, and the accessibility of emerging technology. Integrating user feedback guarantees that smart city programs remain focused on the populace.

3.3 Data Analysis and Benchmarking

The evaluation based on data entails the collection and analysis of extensive datasets from urban systems. Cities employing big data and real-time analytics can enhance their comprehension of traffic patterns, energy use, and public service utilization, hence facilitating more informed decision-making. Comparing these data with world leaders enables cities to establish achievable improvement targets.

4 Challenges and Considerations

The potential of smart cities is immense, although numerous problems must be confronted in their growth.

4.1 Data Privacy and Security

The implementation of smart technologies and IoT devices in urban areas produces substantial volumes of data, prompting apprehensions regarding data privacy and security. Cities must implement comprehensive cybersecurity frameworks to safeguard sensitive information and ensure the responsible management of residents' data.

4.2 Digital Divide and Inclusivity

A major problem for smart cities is guaranteeing that all inhabitants reap the benefits of technology progress. Vulnerable populations, like low-income

households and the elderly, may be at risk of becoming marginalized. Initiatives should be undertaken to close the digital divide by offering inexpensive technological access and guaranteeing the inclusivity of smart services.

4.3   Environmental Impact and Sustainability

Although smart cities seek to improve sustainability, the implementation of new technology may result in environmental repercussions, like heightened energy usage and technological waste. Cities must implement a comprehensive strategy for sustainability, taking into account both the immediate and enduring environmental consequences of its actions.

5   Conclusion

Assessing the intelligence level of a smart city is a multifaceted process that necessitates the study of several criteria, including technological adoption, infrastructure advancement, environmental sustainability, and public participation. The worldwide indices examined in this research offer essential frameworks for evaluating and contrasting the performance of cities. Utilizing these frameworks enables communities to pinpoint areas for enhancement, establish strategic objectives, and ultimately elevate the quality of life for their inhabitants.

6   References

- IESE Cities in Motion Index (CIMI)

- IMD Smart City Index

- Eden Strategy Institute's Smart City Government Rankings

- Roland Berger Smart City Strategy Index

- Arcadis Sustainable Cities Index

- ISO 37120: Sustainable development of communities

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