

The Role of Urban Transparency in Fostering Investment in Smart Cities and Promoting Sustainable Development: An Econometric Study of Selected Smart Cities

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Abstract—This study aims to highlight the role of urban transparency in advancing the smart city initiative and achieving sustainable development. Urban transparency is measured using two indicators: the Transparency Index and the Citizen Participation Index, both of which are considered independent variables. As for the dependent variable representing smart cities is measured by the Human Development Index (HDI). The study covers the top 20 smart cities selected from a total of 148 smart cities, based on reports published by the International Institute for Management Development (IMD), over the period 2019–2025, furthermore, EVIEWS 12 software was used to estimate the baseline panel data models. The study findings revealed that the Citizen Participation Index has a positive effect on promoting investment in smart cities and achieving sustainable development, whereas the Transparency Index has no statistically significant effect on promoting investment in smart cities and achieving sustainable development. The study also recommended strengthening the participation of citizens and civil society in decision-making processes in order to direct investments towards meeting the actual needs of the community. This would contribute to improving investment efficiency in smart cities and reducing resource waste.

Keywords—Transparency, Citizen Participation, Sustainable Development, Smart Cities.

JEL Classification: H83, D71, Q01, R58.

I. Introduction :

The contemporary urban environment is undergoing profound and rapid transformations, accompanied by increasing environmental and economic pressures resulting from accelerated population growth and urban concentration, in addition to challenges related to energy resources and their rising costs. These issues are considered among the major problems facing most large cities worldwide, particularly in developed countries. To improve this situation and address such problems, a new development model known as “Smart Cities” has emerged. This model aims to redesign urban infrastructure by leveraging modern technologies, such as the Internet of Things, artificial intelligence (AI), and big data analytics, to manage assets and resources with a high degree of efficiency. However, digital transformation and the

computerization of cities cannot be separated from sound governance frameworks, as shortcomings in these frameworks may lead to regulatory gaps or the marginalization of community participation. Hence, the concept of “urban transparency” emerges as an indispensable fundamental pillar. It serves as a reliable means of communication between decision-makers and citizens, as well as a mechanism for ensuring transparent access to urban data and combating administrative and financial corruption.

Therefore, based on the foregoing, the central research question of this study can therefore be formulated as follows:

- To what extent does urban transparency impact the promotion of the smart city initiative and the achievement of sustainable development?

A. Research Hypotheses:

- The Transparency Index has a statistically significant effect on advancing the smart city initiative and achieving sustainable development.
- Citizen participation has a statistically significant effect on advancing the smart city initiative and achieving sustainable development.

B. The importance of the study:

Indeed, the integration of urban transparency into the smart city environment represents a qualitative shift that contributes to maximizing development returns and attracting sustainable investment. Therefore, the significance of this study lies in its examination of the theoretical aspects of smart cities, the mechanisms for implementing the smart city model, and its main dimensions, including transparency and citizen and community participation in decision-making. The study also seeks to measure the impact of technological transparency indicators on development efficiency levels in smart cities. Its aim is to derive strategic findings and recommendations that can assist urban planners in decision-making by integrating urban transparency policies into sustainable development plans. It also aims to help economic and governmental institutions create an investment-friendly environment based on clarity and urban

transparency, thereby contributing to improving the efficiency of urban resource allocation.

C. Previous Studies:

1. **Giffinger and al. (2007) study:** This study aimed to develop an assessment model based on six key dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. The study adopted a quantitative analytical approach and concluded that smart governance is a fundamental dimension, encompassing criteria such as transparency, participation, and public services. It also serves as a key pillar for ensuring the success of the other dimensions of sustainable urban development.
2. **Nam and Pardo (2011) study:** This study aimed to establish a theoretical foundation for the concept of smart cities by examining their three main components: technology, government, and people. It adopted a descriptive-analytical approach and emphasized that the absence of urban transparency hinders the achievement of sustainable development and reduces the efficiency of economic resource allocation due to administrative opacity and declining opportunities for sustainable investment. The study concluded that focusing on technology alone is insufficient to ensure the success of smart cities. Rather, success requires a high level of transparency, particularly within government institutions, clear regulatory frameworks, and stakeholder participation to ensure efficient resource allocation and achieve sustainable development.
3. **Albino and al. (2015) study:** This study aimed to analyse the evolution of the concept of smart cities and identify their key dimensions and pillars: smart economy, smart people, smart mobility, smart environment, smart living, and smart governance. It highlighted that technology alone is insufficient to achieve sustainable development unless supported by an institutional governance framework that links human capital with modern technologies. It also emphasized the need for clear and transparent indicators to assess the success of cities in their digital transformation and sustainable development efforts.
4. **Kitchin (2016) study:** This study examined the critical and ethical dimensions of designing smart cities based on big data. It employed a critical analytical approach to demonstrate that digital infrastructures, which are often managed according to a technocratic logic, tend to marginalize ethical considerations and transparency in favour of administrative control efficiency. The study also highlighted the risks associated with the monopolization of data by technology companies and the lack of transparency, emphasizing the need for legislation to ensure that urban information is accessible to citizens and to promote equitable development. The study concluded that smart cities need to be restructured through the adoption of clear ethical principles that ensure access to information, protect privacy, and empower citizens to act as key stakeholders in the urban environment rather than merely as objects of surveillance.
5. **Meijer and Bolívar (2016) study:** This study aimed to clarify the role of the concept of Smart Governance in

modern cities. It emphasized that smart governance does not merely involve the use of technology in government offices or the provision of online services; rather, it entails transforming decision-making processes and fostering extensive collaboration among the public sector, the private sector, and citizens. The study emphasized that the success of smart governance is closely linked to its commitment to the principles of openness, with transparency and data accessibility serving as effective tools for building institutional trust and reducing mistrust between public administration and society. The study concluded that transparency and access to open data constitute cornerstones of building trust between local government and society, thereby contributing to improved public service efficiency.

A review of the previous studies reveals that they focused primarily on the technological dimension or the general framework of smart governance, while also presenting theoretical critiques of the lack of transparency in smart cities. This constitutes the research gap addressed by the present study, which focuses on the applied and empirical assessment of transparency and citizen participation as variables influencing investment promotion in smart cities and the achievement of sustainable development. In doing so, the study seeks to bridge the knowledge gap between economic theories and quantitative indicators of development performance.

II. The Theoretical Framework of the Study

1. **Definition of Smart Cities:** There are numerous definitions of smart cities and their dimensions, the following are some of these definitions:
 - A smart city is defined as a city that relies on the intelligent and coordinated use of all available technologies and resources to develop integrated, liveable, and sustainable urban centres. In other words, a smart city depends on the intelligent exchange of information flowing between its various subsystems, the analysis of these information flows, and their transformation into services for citizens, while ensuring the efficient and sustainable management of the ecosystem's resources (**Vito, Umberto, & Rosa, 2015**).
 - The International Data Corporation (IDC) defines smart cities as "distinct entities (towns or cities) governed at the regional rather than the national level and built on information and communications technology (ICT) infrastructure that enables efficient city management and promotes economic development, sustainability, innovation, and citizen participation" (**Lazreg, 2022, p. 589**).
 - A smart city is also defined as "a specific geographical area that employs advanced modern technologies based on information and communication technologies (ICT) and integrates them with the environment to meet the needs of individuals and society in terms of well-being. It places particular emphasis on environmental security and protection and makes use of electronic devices and sensors, as well as advanced communication networks designed and developed to collect and provide data in a timely manner" (**Wojciech & Kacper, 2021, p. 511**).

- It can also be defined as a city that uses information and communication technologies (ICT), with a focus on leveraging data to promote growth and advance sustainable development. Accordingly, the success of smart cities depends largely on the effective use of technology to process data and support appropriate decision-making (Yusuf, Simon, Dieter, & Alexander, 2023, p. 209).

Based on the foregoing, a smart city can be defined as “a city in which public services are delivered through the Internet and information and communication technologies (ICT) to facilitate the collection of large volumes of data and use them to support appropriate decision-making at the right time and place, while ensuring environmental protection. It is an urban area that integrates technology with the environment to improve the quality of life of individuals and society.”

2. Mechanisms for Implementing the Smart City Initiative:

The implementation of the smart city initiative must take into account the developmental and competitive challenges that cities face amid economic and technological changes, which may affect the quality of urban life in areas such as housing, the economy, culture, and social and environmental conditions (European Smart Cities, 2015), accordingly, implementing smart city projects requires comprehensive strategies that encompass several dimensions, including political, economic, and social mechanisms (Aguari, 2022, p. 738).

• Political Mechanisms:

These involve adopting sustainable environmental planning across all government and administrative activities within the smart city. They include citizen services and the intelligent use of e-governance through public services provided to citizens, as well as established administrative practices, such as managing information and data used within the smart city and processing them through digital platforms. The management of public facilities and services, from the submission and review of applications to the issuance of decisions, including the payment of fees through digital means (electronic payment). In addition, transparency and open data are essential, based on governments making data available to the public and allowing its reuse to facilitate innovation and improve public policies. This also involves creating e-government platforms by ensuring access to information and communication technologies (ICT), Internet connectivity, and electronic participation. It further includes e-administration, the electronic delivery of government services, and the adoption of a clear vision for smart city management. Such platforms should enable communication and interaction with citizens to improve the delivery of public services and enhance understanding of the executive functions that governments must perform in general.

As for overall government policy, it should prioritize sustainable development in smart cities across all levels of public policymaking. This process begins with identifying the problem that requires government intervention, followed by gathering the available alternatives for addressing it. The next stage involves examining and comparing these alternatives to select the most appropriate option, followed

by implementing the chosen alternative and monitoring and evaluating its outcomes in accordance with sustainable development requirements. This also entails identifying any undesirable impacts that may pose risks to future generations and their prospects. Therefore, the development of smart cities requires the adoption of a participatory approach to decision-making, which can encourage smart city initiatives that benefit citizens, government entities, telecommunications providers, and private-sector investors.

• Social Mechanisms:

Environmental planning for sustainable development in smart cities requires the provision of the prerequisites for smart living and smart mobility, based on the two key elements of creativity and knowledge. Smart living is manifested in the following ways:

- Improving citizens' quality of life;
- Raising living standards and providing employment opportunities;
- Providing healthcare, physical safety, and educational opportunities;
- Developing physical infrastructure and services, including transportation, energy, water, telecommunications, and the manufacturing sector;
- Enhancing the capacity to respond to natural disasters and climate change.

As for smart mobility and transportation, they are among the most important characteristics of sustainable smart cities, as reflected in the following aspects:

- Efficiency and intelligence of transportation systems;
- Leveraging communication networks to improve the movement of vehicles, people, and goods;
- Promoting integration between cars and bicycles and improving social behaviour;
- Managing transportation to facilitate accessibility and ensure the provision of logistical services.

• Economic Mechanisms

Environmental planning for sustainable development in smart cities requires economic prosperity while respecting the stages of economic planning that address the various dimensions of sustainable development. It also requires avoiding the depletion of resources at the expense of future generations' ability to meet their own needs. The mechanisms of the smart economy are as follows:

- Attractiveness and Competitiveness: By creating an interactive investment environment between the public and private sectors.
- Sustainable Productivity: By planning for product sustainability without depleting resources or harming the environment.
- Fostering Innovation and Encouraging Creativity: By establishing economic groups to finance development.
- Accuracy, Speed, and Entrepreneurship in Service Delivery: By ensuring efficient service delivery and providing a suitable environment for business activities.

• Technological Mechanisms

The technological mechanisms for sustainable environmental planning in smart cities require the deployment of all available technological, information, and communication technologies, as well as the training and development of human resources capable of using these technologies to improve public life in smart cities. These mechanisms are based on the following:

- **Deploying Technological Equipment and Applications:** Using technological equipment and applications that facilitate data generation, classification, and analysis.
- **Qualifying and Training Human Resources:** Investing in human capital and developing smart individuals by continuously improving educational levels and enhancing skills.
- **Encouraging Initiative, Innovation, and Participation in Public Life:** Promoting these values to improve service delivery and achieve economic well-being.
- **Environmental Mechanisms:**

Environmental planning to achieve sustainable development in smart cities is implemented through the following measures:

- **Eliminating Environmental Pollution:** By promoting green transportation options, such as walking and other modes of transport powered by electricity or solar energy, while reducing reliance on conventional means of transportation.
- **Reliance on Renewable Energy:** Using renewable energy sources, such as solar energy, wind energy, geothermal energy, and hydropower, to operate various devices and equipment.
- **Construction of Green Buildings:** Integrating environmental sustainability into all stages of building development, from planning and design to construction, sustainable operation, and renovation.
- **Development of Smart Parks and Facilities:** Establishing smart parks and facilities as key features of sustainable smart cities.
- **Solid and Liquid Waste Management:** Managing waste through waste recovery and recycling, and converting it from an environmental pollutant into a source of energy.

3. The Fundamental Dimensions and Pillars for Implementing the Smart Cities Initiative:

Smart cities play an important role in achieving urban development by integrating technology with the environment and creating innovative practices to preserve the surrounding environment, both now and in the future. Smart cities can be built upon three fundamental pillars: the technological pillar, the social pillar, and the environmental pillar, which form the basis of sustainable development. From a social perspective, smart cities are founded on knowledge, education, and creativity. As for an environmental perspective, a smart city is considered a healthy city, characterized by the availability of energy distribution networks and renewable energy sources. From an economic perspective, a smart city relies on the knowledge economy to promote growth and strengthen development (Lazreg, 2022, p. 594). It is also based on three technological, human, and governmental factors (Taewoo and Theresa, 2011). Among the most important

dimensions underpinning development in smart cities are the following (Vito, Umberto, and Rosa, 2015):

- A. **Smart Governance:** Smart governance is characterized by transparency and the provision of open data to citizens to enable their participation in decision-making. A smart city seeks to establish an efficient and transparent system based on cooperation among authorities, individuals, and institutions through the use of modern management technologies, particularly e-governance. Many researchers also emphasize that smart governance creates the necessary conditions for integrating and implementing the other five dimensions of smart cities.
- B. **Smart People:** Smart people constitute an educated community that takes the initiative to bring about change and makes effective use of technology. They seek to improve the city's performance and enhance living conditions. A smart community is also innovative and willing to adopt modern technologies, such as electronic applications and platforms, to facilitate access to various government offices and administrative departments and benefit from their services, while taking into account citizens' participation in planning, evaluation, and management (Dirk, Farzam, Fosca, & Regula, 2021).
- C. **Smart Environment:** A smart city relies on the rational and sustainable management of natural resources by protecting the environment, reducing greenhouse gas emissions, improving energy consumption efficiency, and adopting energy-efficient building designs through the use of renewable energy sources. Environmental and financial costs can also be reduced through the use of information technology to monitor environmental conditions and improve air quality, housing, heating, and lighting. Furthermore, smart cities seek to reduce waste generation and wastage, promote waste recycling, and ensure the efficient use of water resources, in line with the objectives of sustainable development.
- D. **Smart Living:** Smart cities seek to provide an optimal living environment for their residents by ensuring universal access to information and communication technology (ICT) infrastructure and delivering services across various sectors, including healthcare, security, cultural services, sports, and recreation.
- E. **Smart Mobility:** Smart cities implement sustainable transportation systems that rely on emission-free means of transport (Rebecca J. Sinclair, 2026, p. 480). They also adopt intelligent traffic management systems that use advanced information and communication technologies to collect, process, and transmit data electronically. These technologies enable the establishment of an extensive network of connections between the city's resources, helping to reduce traffic congestion.
- F. **Smart Economy:** Smart cities are characterized by innovation, creativity, high productivity, and labour market flexibility. They promote projects that foster local and global connections to facilitate the free exchange of goods, services, and knowledge. They also ensure the optimal use of information and communication technologies (ICT) to develop and

deliver new products and services (**Centre of Regional Science, Vienna UT, 2007**).

4. **Successful International Experiences and Initiatives in Smart Cities:**

Numerous successful smart city projects have been launched around the world. These initiatives can be explored across North America, Europe, Asia, South America, the Middle East, and Africa, with the aim of drawing lessons and benefiting from their experiences. The names of these cities can be presented as follows (**Vito, Umberto, & Rosa, 2015**):

- **North America:** Projects include open-data digital portals, such as Seattle's city portals, as well as improvements to transportation and water infrastructure, as illustrated by projects in Riverside, San Diego, and San Francisco.
- **Europe:** Cities such as Zurich, Oslo, Copenhagen, London, Stockholm, Barcelona, Amsterdam, Paris, Porto (Portugal), and Tallinn (Estonia) have implemented wide-ranging strategies in e-government, digital skills development, and the use of multi-purpose smart cards for transportation and public utilities.
- **Asia:** Significant efforts have been made in Singapore, through initiatives such as IT2000 and iN2015, aimed at providing mobile connectivity and comprehensive Internet access; in China, through dozens of smart city projects focused on infrastructure modernization; and in South Korea, through the development of entirely new cities, such as Songdo, equipped with integrated digital infrastructure in every residential unit to manage urban data through a centralized city control system.
- **The Middle East:** Dubai is considered one of the leading examples of smart city development, encompassing projects such as Desert Rose City, Dubai South, Dubai Silicon Oasis, Masdar City, and the Zayed

Smart City Project (Thabet & Ahmed, 2020, p. 70). The latter was launched in Abu Dhabi in 2018 as a pilot phase of the five-year Smart Cities and Artificial Intelligence Plan (2018–2022) (Madjoub & Ziani, 2021, p. 92). In addition, the Dubai government established the Dubai Smart Office in 2015 as the entity responsible for transforming Dubai into a smart city through an integrated smart transformation strategy. The office oversees cooperation and coordination among partners from both the public and private sectors.

D. III Methodology and Tools

1. **Study Population and Sample:** The study population consists of smart cities worldwide, totalling 148 cities according to the annual report published by the International Institute for Management Development (IMD) in 2026. The study sample comprises the top 20 smart cities ranked by the aforementioned institute. The data for the study were collected from annual reports published over the period from 2019 to 2025.
2. **Study Variables:** The variables selected for this study were based on those used in previous research. The dependent variable is represented by the Human Development Index (HDI), which serves as an indicator of the extent to which the smart city initiative has been implemented. This index is used by the United Nations Development Programme (UNDP) to measure the level of human development in cities. The higher the index value, the higher the level of human development. The independent variables are represented by the Transparency/Corruption Index (TC) and the Citizen Engagement (CE) Index, as both indicators reflect levels of urban transparency. The following table presents the Human Development Index values for the study sample.

Table No. (01): Human Development Index (HDI) of the Study Sample.

Country	Smart City	2019	2020	2021	2022	2023	2024	2025
Switzerland	Zurich	0.965	0.963	0.968	0.966	0.970	0.989	0.994
Norway	Oslo	0.967	0.969	0.969	0.967	0.970	0.980	0.982
Australia	Canberra	0.947	0.950	0.954	0.952	0.958	0.980	0.976
Switzerland	Geneva	0.965	0.963	0.968	0.966	0.970	0.966	0.973
Singapore	Singapore	0.942	0.944	0.948	0.942	0.946	0.939	0.949
Denmark	Copenhagen	0.953	0.954	0.958	0.959	0.962	0.967	0.970
Switzerland	Lausanne	0.965	0.963	0.968	0.966	0.970	0.966	0.973
United Kingdom	London	0.941	0.930	0.941	0.946	0.946	0.973	0.984
Finland	Helsinki	0.947	0.947	0.949	0.946	0.948	0.960	0.961
U.A.Emirates	Abu Dhabi	0.915	0.909	0.903	0.921	0.940	0.911	0.937
Sweden	Stockholm	0.955	0.951	0.958	0.959	0.959	0.972	0.976
U.A.Emirates	Dubai	0.915	0.909	0.903	0.921	0.940	0.911	0.937
China	Beijing	0.781	0.786	0.794	0.796	0.797	0.907	0.905
Denmark	Hamburg	0.957	0.955	0.958	0.955	0.959	0.972	0.975
Czech Republic	Prague	0.903	0.898	0.901	0.911	0.915	0.960	0.965
Taiwan	Taipei City	0.916	0.923	0.926	0.925	0.934	0.916	0.925
South Korea	Seoul	0.927	0.928	0.933	0.928	0.937	0.952	0.961
Netherlands	Amsterdam	0.950	0.945	0.951	0.953	0.955	0.962	0.964
China	Shanghai	0.781	0.786	0.794	0.796	0.797	0.880	0.895

Country	Smart City	2019	2020	2021	2022	2023	2024	2025
China	Hong Kong	0.952	0.950	0.961	0.950	0.955	0.949	0.956

Source: Reports published by the International Institute for Management Development (IMD) and the World Competitiveness Centre (Smart City Index), covering the period from 2019 to 2025.

3. Statistical Description of the Study Variables:

After obtaining data for 140 observations (20 smart cities × 7 years), the study variables are described using EViews 12 software to calculate measures of central tendency, including the mean and median, as well as the standard deviation, maximum and minimum values. The distribution

is also examined in terms of the skewness and kurtosis coefficients, along with the Jarque–Bera statistic, as shown in the following table.

Table No. (02): Statistical Measures Describing the Distribution of the Variables.

	HDI	TC	CE
Mean	0.937107	0.207243	0.1588
Median	0.951	0.1725	0.1555
Maximum	0.994	0.456	0.311
Minimum	0.781	0.09	0.055
Std. Dev.	0.046231	0.102823	0.058671
Skewness	2.2046	0.908078	0.72875
Kurtosis	7.510806	2.589802	3.324916
Jarque-Bera	232.0986	20.22232	13.00762
Probability	0.0000	0.000041	0.001498

Source: Prepared by the researchers based on the outputs generated by EViews 12 software.

Based on the table, we observe that the probability value (Probability) of the Jarque–Bera test for all the study variables is less than 0.05, indicating that the distributions of these variables do not follow a normal distribution.

4. Testing the Stationary of the Study Variables

To determine the stationary of the variables at level, first difference, or second difference, the tests are conducted under three specifications: with both an intercept and a

trend, with an intercept only, and without either an intercept or a trend. The Levin, Lin and Chu (LLC) t^*t^* test, the Augmented Dickey–Fuller (ADF) test, and the Phillips–Perron (PP) test are applied, taking into account the panel data structure. By comparing the p-values with the significance level, the order of integration of the variables is determined, as shown in the following table.

E. Table No. (03): Stationary Tests of the Study Variables.

Variables	Type of Test	Statistic	Prob.**	Decision	
HDI	Levin, Lin & Chu t	20.9156	0.0000	Individual intercept	At First Difference
	ADF - Fisher Chi-square	113.452	0.0000		
	PP - Fisher Chi-square	147.650	0.0000		
TC	Levi , Lin & Chu t	4.18510	0.0000	Individual intercept	At Level
	ADF - Fisher Chi-square	64.1076	0.0091		
	PP - Fisher Chi-square	79.8141	0.0002		
CE	Levin, Lin & Chu t	2.17465	0.0148	Individual intercept	At Second Difference
	A F - Fisher Chi-square	78.2848	0.0003		
	PP - Fisher Chi-square	81.6750	0.0001		

Source: Prepared by the researchers based on the outputs generated by EViews 12 software.

Based on Table No. (03), the stationarity of the variables can be summarized as follows:

- Human Development Index (HDI): The variable becomes stationary at first difference, with an intercept only.
- Transparency/Corruption Index (TC): The variable is stationary at level, with an intercept only.

- Citizen Engagement (CE): The variable becomes stationary at second difference, with an intercept only.

5. Estimation of the Study Model:

Using EViews 12 software, the main models of the study were estimated, namely the Pooled Regression Model (PRM), the Fixed Effects Model (FEM), and the Random Effects Model (REM). The estimation results are presented in the following table.

Variable	Pooled OLS		Fixed Effects		Random Effects	
Coefficient	Prob	Coefficient	Prob	Coefficient	Prob	
TC	-0.142814	0.0001	0.081457	0.4666	-0.042903	0.5480
CE	0.105322	0.0975	0.517851	0.0125	0.279265	0.0296
C	0.949979	0.0000	0.837991	0.0000	0.901651	0.0000
R-squared	0.123605		0.848626		0.035474	
F-statistic	9.661100		31.50126		2.519349	
Prob(F-statistic)	0.000119		0.000000		0.084237	
Durbin-Watson	0.141181		0.913763		0.697098	

Source: Prepared by the researchers based on the outputs generated by EViews 12 software.

6. Model Comparison and Selection of the Appropriate Model:

To determine the most appropriate model for the study, the following tests will be conducted:

- A. **Chow Test:** This test is used to choose between the Pooled Ordinary Least Squares (Pooled OLS) model and the Fixed Effects Model (FEM). It tests the homogeneity

of the intercepts and slopes and is based on the following hypotheses:

- Null Hypothesis (H_0): The Pooled Ordinary Least Squares (Pooled OLS) model is the appropriate model.
- Alternative Hypothesis (H_1): The Fixed Effects Model (FEM) is the appropriate model.

F. Table No. (05): Results of the Chow Test.

Redundant Fixed Effects Tests				
Equation: Untitled				
Test cross-section fixed effects				
Effects Test		Statistic	d.f.	Prob.
Cross-section F		29.745951	(19,118)	0.0000
Cross-section Chi-square		245.848903	19	0.0000

Source: Prepared by the researchers based on the outputs generated by EViews 12 software.

Based on the results presented in Table No. (05), the p-value of the Chow test is 0.0000, which is less than 0.05. Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted, indicating that the Fixed Effects Model (FEM) is the appropriate model.

- B. **Hausman Test:** The Hausman test is used to choose between the Fixed Effects Model (FEM) and the

Random Effects Model (REM). It is based on the following hypotheses:

- **Null Hypothesis (H_0):** The Random Effects Model (REM) is the appropriate model.
- **Alternative Hypothesis (H_1):** The Fixed Effects Model (FEM) is the appropriate model.

G. Table No. (06): Results of the Hausman Test.

Correlated Random Effects - Hausman Test
Equation: Untitled

Test cross-section random effects			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	5.381811	2	0.0678

Source: Prepared by the researchers based on the outputs generated by EViews 12 software.

Based on the results presented in Table No. (06), the p-value of the Hausman test is 0.0678, which is greater than 0.05. Therefore, we fail to reject the null hypothesis,

indicating that the Random Effects Model (REM) is the appropriate model. Accordingly, the equation of the model best suited to the study is as follows:

$$HDI_{it} = 0.901651 + 0.279265CE_{it} - 0.042903TC_{it} + \varepsilon_{it}$$

H. IV Discussion of the Results:

Based on the findings of the study regarding the impact of transparency and citizen participation in decision-making on the implementation of the smart city initiative and the achievement of sustainability, the results can be presented and discussed from both theoretical and econometric perspectives as follows:

Theoretical Findings: The study reached the following conclusions:

- The theoretical framework confirms that smart city initiatives require citizen participation in the planning process through the involvement of residents in decision-making, which is essential to the success of smart city initiatives.
- Emphasis should be placed on supporting digital technologies, applications, and smart solutions for governance and sustainable urban development, while strengthening the role of citizens in participation and improving urban management to enhance quality of life.
- A clear vision and strong leadership are essential for guiding smart city projects. Investment in technology and infrastructure is also necessary to support the ambitious objectives of smart city development.
- Technological integration is essential: Successful smart cities leverage technology to enhance urban life; however, these technologies must be carefully integrated into existing systems.
- Emphasis on Sustainability: Each city should prioritize sustainability, ensuring that smart solutions contribute to achieving environmental objectives and improving residents' quality of life.
- Collaboration and Stakeholder Engagement: Cooperation and the involvement of various stakeholders, including government authorities, the private sector, and citizens, are crucial to the successful implementation of smart city initiatives.

I. Econometric Results

Based on the Hausman test used to select the appropriate panel data model, and the results presented in Table No. (04), which contains the estimation results of the study model, we observe that the selected Random Effects Model

(REM) has an R-squared value of 0.035474. This indicates that changes in the Human Development Index (HDI) are explained by changes in the transparency and citizen engagement variables by approximately 3.55%, while the remaining variation is attributable to other factors captured by the random error term.

Furthermore, the calculated F-statistic is 2.519349, with a p-value of 0.084237. This indicates that the model is statistically significant and acceptable at the 10% significance level. The estimation results reveal the following:

- There is no statistically significant effect of the Transparency Index on the Human Development Index at the 5% significance level, as the p-value for this variable is 0.5480, which is greater than 0.05. Therefore, the results do not provide sufficient evidence of an effect of the Transparency Index on the implementation of the smart city initiative and the achievement of sustainable development. Accordingly, the first hypothesis, which states that the Transparency Index has a statistically significant effect on strengthening the smart city initiative and achieving sustainable development, is rejected. In this respect, the findings of the present study differ from those of Giffinger et al. (2007), Albino et al. (2015), and Meijer and Bolívar (2016).
- There is a positive and statistically significant effect of the Citizen Engagement Index on the Human Development Index at the 5% significance level. Accordingly, an increase in the Citizen Engagement Index is associated with an increase in the Human Development Index of 0.279265. This finding indicates that citizen participation has an effect on the implementation of the smart city initiative and the achievement of sustainable development. Therefore, the second hypothesis, which states that citizen participation has a statistically significant effect on strengthening the smart city initiative and achieving sustainable development, is accepted. In this respect, the findings of the present study are consistent with those of Kitchin (2016) and Nam and Pardo (2011).

I. CONCLUSION

The study concludes that implementing the smart city initiative and achieving sustainable development require three fundamental pillars: the technological pillar, represented by information and communication technologies (ICT), such as the Internet and artificial intelligence; the environmental pillar, which involves the optimal use of renewable energy resources; and the social pillar, which encompasses transparency and citizen participation in decision-making.

Therefore, the development of smart cities does not depend solely on the implementation of technological tools and mechanisms; it also requires transparency and good governance in public administration. These, in turn, rely on integrating citizens into decision-making processes and encouraging their participation, as both are key drivers of sustainability in smart cities. The most important findings of the study are as follows:

- Investment in smart cities and infrastructure enhances sustainable development and urban planning.
- Implementing transparency through the provision and accessibility of data is an important factor in building investor confidence and attracting capital to support investment initiatives in smart cities.
- Citizen participation helps direct investments towards meeting the actual needs of the community, thereby improving investment efficiency in smart cities and reducing resource wastage.
- Promoting sustainable development in smart cities contributes to more efficient resource management.
- Investment initiatives in smart cities help reduce environmental pollution and promote environmentally friendly practices.
- The rapid availability of data in smart cities facilitates the timely delivery of services at the right place and time.
- Investment in smart cities stimulates economic growth, attracts businesses, and improves the quality of services provided.

A set of recommendations can be proposed to facilitate the transition towards smart cities and promote sustainable development, including the following:

- Developing incentive policies to encourage the use of smart technologies and sustainable practices in urban planning.
- Promoting public-private partnerships to finance and support the implementation of smart city initiatives.
- Investing in research and development to foster innovation and create technologies that facilitate the development of smart cities and promote sustainable development.
- Strengthening citizen and civil society participation in decision-making processes related to smart city development.
- Developing urban planning strategies that prioritize sustainable development and flexibility, while

improving the quality of services provided to citizens through the use of the Internet.

- Leveraging technological advances, such as the Internet of Things (IoT) and artificial intelligence (AI), to ensure efficient resource management and improve disaster response capabilities, which are essential for the development of smart cities.

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