Knowledge-based Smart City Management in the Context of Hofstede's Culture Dimensions

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Abstract: This study aims to examine the relationships between Hofstede's cultural dimensions and the adoption of knowledge-based solutions in city management. The cultural context of effective smart city management has been investigated based on a city's position in the global smart cities ranking (the IMD Smart City Index). Multiple regressions were used to identify the relationships between the independent variables (the values of the culture dimensions defined by Hofstede: power distance, individualism, masculinity, uncertainty avoidance, and long-term orientation) and the dependent variable – the value of the IMD Smart City Index. The IMD Smart City Index was chosen for its thematic relevance to the issue of adapting knowledge-based solutions in smart city management, as it reflects current results across several indicators that are priority indicators of the city's technological and innovative development. Smart cities were selected based on their rankings in the IMD Smart City Index. This study demonstrates that elevated levels of long-term orientation and individualism, coupled with low uncertainty avoidance, positively impact the adoption of knowledge-based city management. In contrast, the anticipated relationships between power distance and the adoption of smart city solutions, as well as between masculinity and their adoption, alongside effective knowledge-based smart city management, were not substantiated and warrant further examination. The proposed connections between specific dimensions of national culture and effective smart city management are pertinent to the cities featured in the IMD Smart City Index. The literature pays little attention to the cultural determinants of smart city management, particularly organisational and managerial solutions, during the transition from a classic city to a smart city. The paper explored the role of cultural factors in city management and urban development. The motivation for this study is to identify the relationship between Hofstede's cultural dimensions and the level of adaptation of knowledge-based solutions in city management and to examine their influence on a city's position in the global smart cities ranking. Future investigations should aim to explore additional variables that may affect the adoption of smart city solutions and the overall performance of city management.

Keywords: Smart city, Knowledge-based city management, Smart city solutions, Culture, Hofstede's culture dimensions

1. Introduction

A city today is a complex system characterised by many interconnected citizens, businesses, various modes of transportation, communication networks, services, and utilities. In their appearance, smart cities are the answer to this challenge. Smart cities were featured as an alternative to the traditional model, leveraging new technologies (especially ICTs) to address various challenges. It is believed that culture influences how people use information systems and accept and adopt information technology, thereby shaping knowledge-based smart city management.

National culture has long been considered a contextual factor influencing economic behaviour, including innovation and technology acceptance. The influence of cultural factors on new technology adoption has been recognised as a highly relevant field for exploration by many scientists. Notably, the transition from conventional urban environments to smart cities has not received adequate scholarly attention to the cultural determinants that underpin smart city management, particularly in terms of organisational and managerial solutions (Neves, 2025; Avis et al., 2025). Thus, this study aims to elucidate how cultural elements influence urban development and the broader discipline of city management.

The existing literature exhibits a notable deficiency in addressing the cultural determinants of smart city management, particularly regarding the organisational and managerial solutions required for transitioning from traditional urban frameworks to smart city paradigms. This paper critically examines the influence of cultural factors on urban management and development processes. The impetus for this study is to investigate the relationship between Hofstede's cultural dimensions and the extent of technological adoption in smart city management and the subsequent impact on a city's standing in global smart city rankings.

The motivation behind this study is to explore the relationship between Hofstede's cultural dimensions and the effective knowledge-based management of smart cities, as well as their influence on a city's standing in the global smart cities ranking.

This study aims to investigate the intricate relationships between Hofstede's cultural dimensions and the efficacy of smart city management, with a focus on a city's standing in the global smart cities ranking, as determined by the IMD Smart City Index.

The structure of the paper is as follows: after this introduction, the next section presents a literature review that includes a discussion of the research model and the development of hypotheses. The research methodology is elaborated upon in detail. Lastly, the research findings are presented and discussed, the implications examined, and the limitations and avenues for future research identified.

2. Literature Review

The concept of smart cities has undergone a significant evolution, initially characterised by the integration of advanced technologies such as sensors, high-speed internet infrastructure, and big data analytics platforms (Özdoğan et al., 2025; Audretsch et al., 2025). The contemporary city is a knowledge-based, smart city because its management requires the collection, processing, and use of large amounts of data.

The first dimension identified by Hofstede (1980), power distance, relates to the extent of accepted inequality among individuals within a given culture.

Power distance refers to the extent to which a society accepts formal power and status differences among its members. Hofstede (2011) posits that societies with diminished power distance are more inclined to adopt new technologies and foster innovative practices. In contrast, high levels of centralisation and formalisation tend to correlate negatively with the rates of innovation adoption. Nikolov and Krumova (2019) assert that power distance is a strong predictor, particularly in European nations, of specific aspects of e-governance in smart cities. Thus, the first hypothesis of this inquiry can be articulated as follows:

H1: *Knowledge-based smart city management is positively impacted by low power distance.*

This hypothesis posits that a reduced level of power distance can positively influence the efficacy of knowledge-based smart city management.

The constructs of individualism and collectivism represent a spectrum that reflects varying degrees to which societies endorse self-reliance over group integration (Hofstede, 1980).

In individualistic societies, individuals are encouraged to act autonomously, question authority, and take initiative, traits that align with entrepreneurship and knowledge creation. Individualism reflects the extent to which a society allows gratification and enjoyment while also facilitating them. There exists a positive correlation between individualism and technology acceptance (Escandon-Barbosa et al., 2022).

Furthermore, Masimba, Appiah, and Zuva (2019) have confirmed a significant positive relationship between individualistic orientations and technology adoption rates. These societies exhibit enhanced levels of innovation. Additional empirical evidence suggests that cultures classified as individualistic are more inclined to adopt technological innovations. A positive correlation is also identified between elevated individualism and indicators of innovation. Consequently, societies with stronger individualistic orientations are likely to exhibit greater innovation. Greater individualism among urban populations correlates with greater efficacy in managing smart cities. Individualism is posited to stimulate innovative thinking and personal accountability, both of which are essential attributes in the development and implementation of smart technologies and urban policies. As citizens engage more actively in their communities, their unique perspectives and contributions may yield more adaptive and responsive governance structures, ultimately resulting in improved outcomes for smart city initiatives. This relationship underscores the importance of cultivating individualistic values in fostering collaborative, technology-driven urban environments (Marchesani, 2023). Individuals in these societies feel empowered to voice their opinions, making them more inclined to innovate and embrace new concepts. Thus, individuals in individualistic cultures often exhibit self-reliance and independent thinking, which is anticipated to foster creativity and, by extension, heightened levels of innovation and the adoption of knowledge-based solutions (Dirsehan and Zoonen, 2022). In light of this comprehension, the second hypothesis posited in this study is articulated as follows:

H2: *Knowledge-based smart city management is positively affected by greater individualism.*

The dichotomy of masculinity versus femininity serves as a critical framework for understanding how various societies prioritise distinct values traditionally associated with gender. Feminine cultures place greater emphasis on relational dynamics. Research indicates that cultures with a feminine orientation are generally more supportive of the adoption of new technologies, as they are influenced by subjective norms and positive behavioural intentions (Neves et al., 2025).
On the other hand, Sunny, Patrick, and Rob (2019) attest that masculine societies may tend to have negative attitudes towards technological innovations. Masculinity alone may not serve as a definitive predictor of

technology acceptance, particularly concerning smart city initiatives (Okafor et al., 2023). Research by Meyer-Waarden et al. (2021) suggests that femininity moderates uncertainty avoidance, thereby enhancing trust in smart solutions that promote individuals' subjective well-being. Whereas masculinity often undermines collaboration and social openness, which are crucial for long-term innovation success (Prim et al., 2017).

In summary, Hofstede (2001) posits that organisations within masculine cultures are predominantly orientated towards performance recognition and rewards, alongside individual development, traits commonly associated with innovation. Therefore, this study proposes a positive correlation between masculinity and the propensity for innovation within smart city management contexts.

H3: *A higher level of masculinity has a positive influence on knowledge-based smart city management.*

Uncertainty avoidance is a critical cultural dimension that delineates the extent to which societies endeavour to mitigate unpredictability in their environments. The implementation of new technologies inherently entails a degree of uncertainty, particularly when their functionality is validated, but their economic viability remains contentious. This underscores the importance of economic risk as a primary concern in technology adoption.

Venkatesh and Zhang (2010) found that adopting new technology can engender uncertainty, culminating in heightened perceived stress and discomfort in cultures characterised by elevated uncertainty avoidance. Furthermore, research conducted by Mutambik (2024) identified uncertainty avoidance as a robust predictor of technology acceptance, particularly in the context of smart city initiatives. Supporting this premise, studies by Meyer-Warden et al. (2021) reveal that individuals originating from cultures with high uncertainty avoidance manifest heightened anxiety when confronted with transformative changes and the introduction of novel technologies, accompanied by an increased need for control.

Consequently, uncertainty avoidance emerges as a vital dimension that distinguishes societies by their propensity to embrace risk. According to Hofstede (2011), cultures marked by low levels of uncertainty avoidance exhibit a greater willingness to engage in risk-taking behaviours and to entertain divergent viewpoints, both of which are instrumental in fostering innovation and the adoption of new technologies. In contrast, societies characterised by high uncertainty avoidance exhibit a pronounced reluctance to experiment with unproven solutions in smart city initiatives. Risk-averse populations often require substantial assurances regarding privacy, security, and reliability before consenting to adopt such innovations. Therefore, the fourth hypothesis of this study can be articulated as follows:

H4: *A lower level of uncertainty avoidance positively impacts the effectiveness of knowledge-based smart city management.*

Long-term orientation represents a significant cultural dimension that encompasses a multifaceted understanding of temporal perspectives, integrating considerations of the past, present, and future. Cultures characterised by long-term orientation exhibit a societal time perspective influenced by enduring cognitive frameworks, wherein technology and situational evaluations are grounded in both present and prospective implications, rather than exclusively prioritising immediate, short-term outcomes (Tian et al., 2021). This dimension of long-term orientation pertains to the value a culture places on its traditions and the degree to which it emphasises historical and future considerations. Long-term orientation positively influences the functional, social, and emotional values attributed to emerging technologies, thereby fostering technology acceptance. Cultures with higher long-term orientation tend to be more receptive to adopting innovations and novel technologies. The rate of technology adoption is expected to be higher in nations with a lower long-term orientation than in those with a more pronounced one. Long-term orientation has been associated with innovation through a focus on future-oriented investment, persistence, and adaptive change. Furthermore, societies that score high on long-term orientation are inclined to invest significantly in sustainable, future-oriented smart city infrastructures, such as Internet of Things (IoT)-based environmental monitoring systems and predictive analytics. This propensity leads to a higher adoption rate of such solutions (Wang and Zhou, 2022). Accordingly, the following hypothesis emerges from this analysis:

H5: *A higher level of long-term orientation has a positive influence on knowledge-based smart city management.*

Culture significantly influences the management of smart cities, as demonstrated by numerous studies. This impact arises from culture's ability to foster either a conducive or a challenging environment for innovation. Smart cities should prioritise enhancing the quality of life alongside improving the efficiency and quality of services provided by government entities and businesses (Mutambik and Almuqrin, 2024).

3. Research Design and Methodology

Multiple regressions were employed to explore the relationship between the independent variables, cultural dimensions as defined by Hofstede, including power distance, individualism, masculinity, uncertainty avoidance, and long-term orientation (https://www.hofstede-insights.com/country-comparison-tool), and the dependent variable, which is the value of the IMD Smart City Index 2026. The IMD Smart City Index 2026 was chosen for its timeliness and thematic significance, as it captures current outcomes across several key indicators relevant to a city's development. Smart cities were selected based on their rankings within the IMD Smart City Index 2026 (https://www.imd.org/smart-city-observatory/home/).

The study makes use of the IMD Smart City Index 2026, which is the internationally accepted database released jointly by the International Institute of Management Development, along with the Singapore University of Technology and Design. The IMD Smart City Index is a vital tool for evaluating and enhancing the performance of cities worldwide in their journey toward becoming smarter and more sustainable. By assessing various dimensions of urban life, the index provides valuable insights that inform policy decisions, promote public accountability, and guide strategic planning. Through benchmarking, policy guidance, public accountability, and strategic planning, the IMD Smart City Index helps cities leverage technology to improve the quality of life for their residents and address the challenges of modern urbanisation. This index provides a more complete comparison of cities by ranking them not just on their economic performance but also by considering other important factors that influence their relative strengths (Ivaldi et al., 2026; Alshubiri, 2026).

The IMD Smart City Index is used widely by academics. It aims to measure how effectively a city uses technology and smart solutions to improve its citizens' quality of life and city management. It applies a combined weighting and scoring approach based on survey data collected from residents (Ruangwicha and Tuamsuk, 2026).

The IMD Smart City Index is a comprehensive tool developed to evaluate and rank cities worldwide based on their implementation of smart city initiatives. Created by the Institute for Management Development (IMD) in partnership with the Singapore University of Technology and Design, the index assesses various dimensions of urban life, providing valuable insights into how cities leverage technology to enhance the quality of life for their residents. The index covers multiple categories and indicators, reflecting the multifaceted nature of smart cities (Unal and Dursun, 2026).

Smart city performance is measured almost exclusively via citizens' views on the impacts of urban infrastructure and technology on their daily lives. The index captures the globe's smart cities based on the perceptions of their citizens regarding how they utilise technology to increase the quality of their lives. While a limited number of contextual indicators are included, the index is predominantly based on standardised perception-based measures collected from city residents. Based on the conceptual framework for the maturity of a smart city, the original IMD indicators were categorised into five domains representing major dimensions of the development of a city. Each set represents a certain dimension of the transformation of a city, which may be technology, infrastructure, environment, society, and economy, and comprises a set of perception indicators supplied by the citizens residing in the cities (Pavanini et al., 2026). The IMD Smart City Index relies on individuals' opinions collected through surveys. The perceptions of 120 residents for each city are assessed by the availability of infrastructure and technological services. Both are judged concerning five dimensions: health and safety, mobility, activities, opportunities, and governance. Weights of the five areas are not predetermined: respondents are asked to select five city priorities from 15 indicators. The weight of each category in the final calculation is adjusted based on the number of selected indicators that fall within that category. Thus, no indicator is thought to be the most influential on smartness in overall assessments. The final score for each city is calculated using weighted data from the past three years: the most recent year's weight is 3, and the least recent year's weight is 1 (Belizaire, 2026).

The IMD Smart City Index 2026 provides a holistic assessment of the world's 148 cities. Smart cities for this study were selected based on their rankings in the IMD Smart City Index 2026. The 49 cities with the highest ranking were included in the analysis. The following cities were taken into consideration: Zurich, Oslo, Geneva, London, Copenhagen, Dubai, Lausanne, Canberra, Singapore, Abu Dhabi, Helsinki, Seoul, Prague, Stockholm, Hamburg, Beijing, Amsterdam, Ljubljana, Munich, Shanghai, Hong Kong, Sydney, Auckland, Riyadh, Taipei City, Tallinn, Wellington, Vienna, Berlin, Bilbao, Warsaw, Vilnius, Hail, Doha, Boston, Tianjin, Madrid, Bratislava, Washington D.C., Zhuhai, Seattle, Luxembourg, Dusseldorf, Gothenburg, New York, Manchester, Riga, Toronto, and Dublin.

The top cities in the IMD Smart City Index 2026 overall have strong scores across all five categories. Not only do they make important economic contributions to the global economy, but they are also hubs of education and

business innovation, and they invest in the infrastructure necessary to maintain a high quality of life with a focus on the environment and effective governance.

4. Results and Discussion

Multiple regression analysis was employed to examine the relationship between Hofstede's cultural dimensions and the IMD Smart City Index 2026. The impact of cultural factors on the adoption of new technologies is increasingly recognised as a critical area of research. Studies that utilise and validate Hofstede's national culture dimensions demonstrate that these constructs are both relevant and significant, indicating that variations in national cultures significantly influence a wide range of organisational and individual behaviours and outcomes across different cities. The results of the regression analysis are presented in Table 1.

Table 1: The results of the regression analysis

Independent variables - national culture dimensions	**Standardized coefficients**	**t**	**Significance level**
	Beta		
Low power distance	0.083	0,372	0,640
Individualism	0.491	4,358	0,000
Masculinity	0.076	0,364	0,620
Low uncertainty avoidance	0.267	3,659	0,000
Long-term orientation	0.519	4,287	0,000
Dependent variable: the value of IMD Smart City Index 2026 $R^2 = 0.831$, F = 29.167, significance level = 0.01.			

Source: own study based on https://www.imd.org/smart-city-observatory/home/ and https://www.hofstede-insights.com/country-comparison-tool.

The reliability assessment utilised in this study was Cronbach's alpha, which revealed that all research variables exceeded 0.8. This indicates a high level of internal consistency, suggesting that the measures employed are reliable and that the evaluation instrument is suitable for research purposes.

The findings indicate that the R-squared value was 0.831, demonstrating that the independent variables explain 83.1% of the variance in the adoption of smart city solutions, as measured by the IMD Smart City Index 2026. Furthermore, the linear relationship between Hofstede's cultural dimensions and the adoption of smart city solutions was statistically significant (F = 29.167, p = 0.01), thereby affirming the model's suitability for this study.

The following research hypotheses, listed below, demonstrate the relationship between Hofstede's cultural dimensions and the level of adaptation of knowledge-based solutions in city management and examine their influence on a city's position in the global smart cities ranking:

H1: *Knowledge-based smart city management is positively impacted by low power distance.*

H2: *Knowledge-based smart city management is positively affected by greater individualism.*

H3: *A higher level of masculinity has a positive influence on knowledge-based smart city management.*

H4: *A lower level of uncertainty avoidance positively impacts the effectiveness of knowledge-based smart city management.*

H5: *A higher level of long-term orientation has a positive influence on knowledge-based smart city management.*

Analysis of individual hypotheses yielded the following results: low power distance (beta = 0.083) did not establish a statistically significant relationship with the IMD Smart City Index 2026, as evidenced by a significance level of 0.640, which exceeds the 0.05 threshold; therefore, Hypothesis 1 is rejected.

Conversely, the significance level for individualism in the IMD Smart City Index 2026 was 0.000, well below 0.05, validating Hypothesis 2. The coefficient for individualism was notably substantial (beta = 0.491), thereby indicating that higher levels of individualism positively influence the adoption of innovative solutions.

Further analysis revealed that masculinity (beta = 0.076) did not demonstrate a statistically significant relationship with the adoption of smart city solutions, with a significance level of 0.620, leading to the rejection of Hypothesis 3. The significance level for low uncertainty avoidance in relation to the IMD Smart City Index 2026 was set at 0.000, thus confirming Hypothesis 4. The beta value for this variable is 0.267, suggesting that lower uncertainty avoidance is associated with a significant positive effect on the adoption of smart city solutions.

Moreover, the significance level for long-term orientation in relation to the adoption of smart city solutions was also 0.000, confirming Hypothesis 5. This test indicated that long-term orientation has the highest coefficient (beta = 0.519) among the cultural dimensions, indicating its predominant positive impact on the adoption of smart city solutions.

The outcomes of this investigation yield some unexpected insights. Notably, power distance and masculinity were found to be insignificant predictors in this model. In contrast, long-term orientation, individualism, and low uncertainty avoidance emerged as the three cultural dimensions that exhibited significant correlations. As hypothesised, long-term orientation positively influences the adoption of smart city solutions and the IMD Smart City Index 2026. Alongside this, both low uncertainty avoidance and individualism demonstrated significant and favourable effects on the adoption of smart city solutions. Consequently, hypotheses 1 and 3 are rejected, while hypotheses 2, 4, and 5 are confirmed.

These results offer a noteworthy discussion of the role of cultural dimensions in the adoption of smart city solutions. Specifically, the analysis reveals that power distance does not play a critical role in the adoption process, thereby challenging the expected impact of this cultural dimension on effective smart city management. Similarly, the masculinity dimension appears to be irrelevant in this context, suggesting that the values typical of masculine and feminine cultures exert an uncertain influence on the adoption of smart city solutions. For instance, while masculine values such as achievement and motivation may suggest a correlation to positive outcomes in innovation adoption, feminine cultures, characterised by values of equality and cooperation, may foster a more favourable environment for the acceptance of new technologies in urban management.

In terms of long-term orientation, the study affirms that cities in nations with higher levels of this dimension achieve higher scores on the IMD Smart City Index 2026. National cultures with a pronounced long-term orientation are generally more receptive to innovative ideas and solutions, demonstrating practical problem-solving skills that facilitate the adoption of new technologies in urban management. The hypothesised positive relationship between uncertainty avoidance and the IMD Smart City Index 2026 has also been substantiated; this finding posits that risk aversion, among other factors, may influence a culture's innovation capacity and readiness to implement modern technologies.

Finally, the confirmed positive association between high levels of individualism and the adoption of smart city solutions reinforces the assertion that more individualistic societies are predisposed to embracing innovative approaches in urban management.

Effective management in smart cities is profoundly influenced by both national and local cultural dimensions, notably individualism, uncertainty avoidance, and long-term orientation. These dimensions are fundamental in shaping organisational strategies and enhancing citizen engagement. A thorough understanding of these cultural factors enables policymakers and urban administrators to develop interventions that improve adoption rates and ensure equitable outcomes across diverse urban environments.

5. Conclusion

The findings of this study indicate that the adoption of smart city solutions is significantly influenced by cultural dimensions, specifically higher levels of individualism and long-term orientation, alongside a reduced level of uncertainty avoidance. However, the hypothesised relationships between masculinity and the adoption of smart city solutions, as well as the impact of low power distance, remain unsubstantiated and warrant further empirical investigation.

The main limitation of this study is the relatively small sample size of cities included in the analysis. Despite this limitation, the research has made progress towards achieving its primary research objective by substantiating that certain relationships between selected national culture dimensions and the adoption of smart city solutions are valid, as evidenced in the cities analysed within the context of the IMD Smart City Index. Conversely, the study raises pertinent questions about the relationship between masculinity and power distance and their respective influences on the adoption of smart city solutions, underscoring an urgent need for future scholarly

inquiry. One proposition for subsequent research is to expand the sample to encompass a broader range of national cultures and to analyse differing clusters of these cultures.

Individualism, uncertainty avoidance, and long-term orientation are key cultural dimensions that influence effective management in smart cities. These factors are essential for developing organisational strategies and encouraging public participation. Policymakers and city managers can create interventions that not only increase adoption rates but also foster equitable outcomes in a variety of urban settings by having a thorough understanding of these cultural factors.

Future investigations should aim to explore additional variables that may affect the adoption of smart city solutions and the overall performance of city management. Subsequent studies must strive to validate the findings by leveraging a larger sample. As the performance of smart cities cannot be fully elucidated through cultural dimensions alone, future research will also need to examine other elements that contribute to creating a conducive environment for enhancing smart city management. Additionally, as this study has illustrated, applicable technological solutions are present across the selected cities. A more comprehensive, diverse comparative analysis involving other urban areas would be beneficial for identifying broader trends in city management practices.

Ethics Declaration: This study utilised publicly available online data and did not involve direct interaction with participants. All data were anonymised, and no personally identifiable information was collected.

AI Declaration: No AI tools were used in the development of the paper. All work, including the analysis, interpretation and writing, was conducted solely by the author.

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