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Designing a Model of Cultural Citizenship in a Smart City Using Structural Equation Modeling Approach

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Abstract

In a smart city, the concept of citizenship acquires a new level of importance, as citizens play a crucial role in shaping the city's future. With the integration of technology and data-driven decision-making, the voices, opinions, and needs of citizens become more prominent than ever before. As active participants, citizens contribute to the creation of a more sustainable, resilient, and responsive city by engaging in urban planning, participating in public consultations, and providing feedback on services and infrastructure. This empowered citizenship fosters a sense of ownership and responsibility, enabling citizens to collaborate with urban authorities to enhance quality of life and turn smart cities into true reflections of collective vision. The present study aims to further explore the concept of cultural citizenship and the existing studies in this field, and to propose a comprehensive model for assessing the level of cultural citizenship using the structural equation modeling (SEM) approach. The statistical population of this study includes all urban management experts in Tehran. To collect research data, a questionnaire consisting of 49 items on a five-point Likert scale was used. The results of the model implementation indicated that the variables of multicultural citizenship, name-based citizenship, and educated citizenship had the most significant roles in explaining variations in cultural citizenship, and the research model was able to account for over 99% of these variations.

Keywords: Smart city, cultural citizenship, structural equation modeling (SEM)

1. Introduction

Most advanced cities around the world pursue the development of information and communication technology (ICT) through comprehensive programs within the framework of smart cities. In a smart city, given the expansion of urban areas, population growth, and the limitations of energy and economic resources, relying on outdated systems with limited efficiency is no longer a viable approach (König, 2021; Simonofski et al., 2021). In today's world, with the increasing population, a major challenge facing urban management in the near future is addressing the complexities arising from this demographic growth. This situation necessitates new and creative solutions to problems such as overcrowding, excessive energy consumption, resource management, and environmental protection. Many cities are tackling such challenges by adopting solutions such as the development of optimal transportation systems, transitioning toward sustainable environments, constructing smart buildings, and promoting knowledge-based economies. Since many of these solutions are grounded in the use of new technologies, particularly ICT, cities operating on this basis are referred to as smart cities (Simonofski et al., 2021).

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The "real" smart city is not a unified entity. It is neither guided by a global logic nor developed in a standardized way. As recent research argues, the spatial, material, and political contexts of cities significantly influence what smart urbanism looks like in practice (Daneshvar et al., 2022; Sargolzai & Khodadadi Didani, 2024). Cities inherently face interconnected and extensive challenges. Among them, the rapid growth of urban populations often outpaces the development of infrastructure, placing increasing pressure on urban systems. In addition, one of the most complex issues is citizens' adaptability to the smart transformation of cities and its processes. In other words, prior to implementing smart city strategies, the cultural and social capacity of citizens to accommodate such changes must be cultivated. Otherwise, citizens may suffer from the unintended negative consequences of these transformations. Thus, traditional institutions and governance methods often conflict with the complex and rapidly changing nature of the information society (Grum, 2024; Ji, 2024). On the other hand, the lifestyle of citizens—shaped by religious and cultural values and forming the foundation of individual and collective life—plays a key role in accepting or rejecting societal changes. In other words, the prevailing citizenship culture of a society reflects its broader worldview, beliefs, and values, and is embodied in people's ways of life and their genuine convictions. Therefore, the adoption of new lifestyles by society necessitates examining citizens' readiness to embrace the smart city paradigm (Delli, 2024). Sadowski and Maalsen (2020) argue that three distinct approaches to smart urbanism will be utilized in different societies, each based on the interests of a dominant actor (institution, structure): corporate-driven, citizen-driven, and planner-driven. These different models may coexist within a single city. At times, these three actors may have divergent logics that pull the city in different directions. However, they can also collaborate to shape smart city initiatives (Ayo-Odifiri et al., 2021).

For various reasons, including increased migration, large city administrators in recent decades have witnessed a blending of diverse cultures. This has posed challenges to urban governance, including racial, ethnic, linguistic, and traditional conflicts. In the past, urban sociology theories attempted to address these urban conflicts through classifications based on social class, occupation, education levels, and urban climate, aiming to derive universally applicable social laws. However, this approach proved insufficient for addressing all issues and thus faced criticism. As a result, socio-cultural analytical models have to a large extent replaced earlier universalist paradigms (Zeng et al., 2023; Гнедіна, 2023).

Today, in light of recent decades' transformations in communication technologies and mass media, attention to the cultural dimension of citizenship has become essential, and the discourse around citizens' cultural rights has emerged (Chataut et al., 2023; Gunesch, 2019). In essence, citizenship is a status that defines individuals' rights and responsibilities within a society, and awareness of it is vital both for citizens and for administrators. A review of existing studies indicates that in order to analyze this social phenomenon, attention must be paid to civil, political, and socio-economic rights. However, in today's globalized context—with the proliferation of mass media and new technologies—cultural rights have also come to the fore. These cultural rights are particularly significant in societies marked by cultural, ethnic, linguistic, and religious diversity. Scholars use the concept of cultural citizenship to explore the cultural rights of people within a society (Ayo-Odifiri et al., 2021; Chataut et al., 2023; Ghaffari et al., 2023). Therefore, the present study aims to propose a comprehensive model for assessing the degree of cultural citizenship using the structural equation modeling (SEM) approach.

2. Methods and Materials

This study is applied in terms of its objective and descriptive-survey in terms of data collection. Considering its time frame, it is a cross-sectional study, and based on the identified relationships among research variables, it is correlational in nature. The statistical population consists of urban and cultural management experts in Tehran Province, along with all associate and full professors from public and Islamic Azad universities who possess sufficient expertise in urban management, information and communication technology, and citizenship rights. Due to the broad scope of the population, a sample of 385 individuals was selected using random sampling. Demographic findings show that over 60% of the respondents held bachelor's and master's degrees, and more than 65% had more than 10 years of work experience. The theoretical framework of the research was developed through a literature review; thus, to complete the theoretical foundations and construct a conceptual model, library sources including books, Persian and English articles were used, and data collection was conducted via a questionnaire.

The questionnaire used in this study consisted of 49 items related to the indicators of the conceptual model and employed a five-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree) to measure the targeted variables. The items

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were derived based on theoretical foundations in the field of cultural citizenship. To ensure content and face validity, the questionnaires were reviewed by five subject-matter experts. After revisions and final approval by the academic advisor and supervisor, the questionnaires were distributed and collected. Furthermore, the measurement models were assessed using three criteria: discriminant validity, convergent validity, and composite reliability. For reliability analysis, factor loadings and composite reliability indices were utilized.

3. Findings and Results

As noted in the previous section, structural equation modeling (SEM) is a powerful multivariate analysis technique within the family of multivariate regressions that enables researchers to test a series of regression equations simultaneously. SEM provides a framework to evaluate hypothetical models involving direct and indirect relationships among a set of observed and latent variables. Essentially, SEM combines elements of path analysis and confirmatory factor analysis (Hair et al., 2021). This section addresses the research questions and hypotheses based on the validation of the initial model, as explained earlier.

According to the analysis presented in Table 1, the significance levels of the data for all research variables were less than 0.05. Therefore, at a 95% confidence level, the null hypothesis is rejected, indicating that all variables follow a non-normal distribution. As a result, the Smart PLS software must be used for inferential analysis.

Table 1. Kolmogorov–Smirnov Test

Variable	Causal Conditions	Contextual Conditions	Intervening Conditions	Cultural Citizenship Phenomenon in Smart City	Main Strategies and Actions	Outcomes
Sample Size	385	385	385	385	385	385
Mean	3.599	3.693	3.851	3.222	3.849	3.885
Standard Deviation	0.719	0.685	0.766	0.909	0.704	0.790
Kolmogorov–Smirnov Statistic	0.083	0.092	0.214	0.287	0.188	0.227
Significance Level	0.001	0.000	0.000	0.003	0.000	0.000

In studies aimed at testing a specific model of relationships between variables, the structural equation modeling (SEM) method is utilized. Partial Least Squares Path Modeling (PLS-PM) is one of the approaches within SEM. A complete PLS path model comprises two main components: the measurement model (outer model) and the structural model (inner model). The measurement model evaluates the relationship between items and their respective constructs, while the structural model examines the relationships among the constructs to test the proposed hypotheses. Given the non-normal distribution of the data, Smart PLS software is used for the analysis. In PLS models, two types of models are tested: the outer model, equivalent to the measurement model, and the inner model, corresponding to the structural model in SEM.

In PLS modeling, measurement models or constructs are classified as either reflective or formative. In the present study, all measurement models are reflective. In assessing the reliability of these models, the unidimensionality of blocks must be established. Cronbach's alpha is used to determine the unidimensionality of measurement models. Typically, the first criterion examined in reflective measurement models is internal consistency reliability. The traditional indicator for assessing this is Cronbach's alpha, which provides an estimate of reliability based on internal correlations among indicators. If Cronbach's alpha exceeds 0.70, internal consistency and unidimensionality of the block are confirmed. In addition to Cronbach's alpha, composite reliability is also used in PLS path models to evaluate internal consistency and unidimensionality of the blocks. If the composite reliability exceeds 0.70, the model's reliability is confirmed. Composite reliability is considered a more appropriate indicator than Cronbach's alpha for determining unidimensionality, as Cronbach's alpha assumes tau-equivalence of observed variables—i.e., that each observed variable contributes equally to the latent variable. However, composite reliability does not impose this assumption and is based on the results of the model (i.e., factor loadings), thereby reflecting the actual correlations among observed indicators in the dataset. Essentially, Cronbach's alpha provides a lower-bound estimate of reliability. The results of composite reliability and Cronbach's alpha are presented in Table 2.

Table 2. Reliability of Indicators

Variable	Composite Reliability	Cronbach's Alpha
Intervening Conditions	0.844	0.833
Main Strategies and Actions	0.871	0.858
Causal Conditions	0.915	0.900

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Outcomes	0.801	0.783
Cultural Citizenship Phenomenon in Smart City	0.903	0.895
Contextual Conditions	0.886	0.884

As shown, the values obtained for both Cronbach's alpha and composite reliability exceed 0.70, indicating satisfactory reliability for the study's variables. These indicators assess overall reliability by examining internal correlations or factor loadings among indicators. However, due to differences in indicator reliability, each indicator's reliability must also be assessed individually. Researchers argue that a latent variable should explain a substantial portion of the variance in its indicators—typically at least 0.50. Therefore, the absolute value of the correlation between a construct and each of its observed variables—i.e., the standardized outer loadings—should exceed 0.70.

The first form of validity assessed to confirm the adequacy of measurement models is convergent validity. Convergent validity refers to the degree to which a set of indicators accurately represents the intended construct (Fornell & Larcker, 1981). Face validity was confirmed by relevant subject-matter experts. Additionally, the Average Variance Extracted (AVE) is recommended as a criterion for assessing convergent validity. An AVE value of at least 0.50 indicates sufficient convergent validity, meaning that a latent variable explains more than half of the variance in its indicators on average (Azar et al., 2012).

Table 3. Assessment of Convergent Validity in the Measurement Model

Variable	AVE
Intervening Conditions	0.620
Main Strategies and Actions	0.565
Causal Conditions	0.579
Outcomes	0.633
Cultural Citizenship Phenomenon in Smart City	0.540
Contextual Conditions	0.506

According to Table 3, the AVE values for the latent variables all exceed 0.50, thus it can be concluded that the convergent validity of the measurement models is satisfactory.

To analyze the internal structure—or in other words, the construct validity of the questionnaire—and to identify the factors forming each observed variable, confirmatory factor analysis (CFA) was used. The strength of the relationship between a factor (latent variable) and an observed variable is indicated by the factor loading. Factor loadings range between 0 and 1. If the loading is below 0.30, the relationship is considered weak and is typically disregarded. Loadings between 0.30 and 0.60 are deemed acceptable, and those above 0.60 are considered highly desirable (Kline, 1994). The results of the confirmatory factor analysis of the items or questions in the research questionnaire are summarized in Table 4. The factor loadings for each construct or questionnaire item were statistically significant at both the 99% and 95% confidence levels. Therefore, the studied constructs possess strong validity.

Table 4. Factor Loadings of Questionnaire Items

Item	Causal Conditions	Contextual Conditions	Intervening Conditions	Cultural Citizenship in Smart City	Main Strategies and Actions	Outcomes
Q1	0.620					
Q2	0.750					
Q3	0.703					
Q4	0.841					
Q5	0.867					
Q6	0.700					
Q7	0.939					
Q8	0.758					
Q9		0.751				
Q10		0.647				
Q11		0.697				
Q12		0.826				
Q13		0.815				
Q14		0.710				
Q15		0.771				
Q16		0.924				
Q17			0.857			

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Q18			0.692			
Q19			0.884			
Q20			0.636			
Q21			0.773			
Q22			0.780			
Q23			0.725			
Q24			0.781			
Q25				0.889		
Q26				0.731		
Q27				0.760		
Q28				0.812		
Q29				0.785		
Q30				0.716		
Q31				0.610		
Q32				0.725		
Q33					0.750	
Q34					0.826	
Q35					0.750	
Q36					0.905	
Q37					0.681	
Q38					0.760	
Q39					0.838	
Q40					0.705	
Q41						0.671
Q42						0.916
Q43						0.797
Q44						0.711
Q45						0.782
Q46						0.815
Q47						0.604

Table 5. Significance Coefficients of Factor Loadings for Research Items

Item	Causal Conditions	Contextual Conditions	Intervening Conditions	Cultural Citizenship in Smart City	Main Strategies and Actions	Outcomes
Q1	39.735					
Q2	48.852					
Q3	46.825					
Q4	56.952					
Q5	58.976					
Q6	44.811					
Q7	60.951					
Q8	50.870					
Q9		47.862				
Q10		42.757				
Q11		46.812				
Q12		53.937				
Q13		52.926				
Q14		47.820				
Q15		48.881				
Q16		61.935				
Q17			52.970			
Q18			46.814			
Q19			50.995			
Q20			41.747			
Q21			47.885			
Q22			47.890			
Q23			44.836			
Q24			46.891			
Q25				59.913		
Q26				48.842		

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Q27	48.871		
Q28	49.922		
Q29	46.896		
Q30	45.827		
Q31	39.720		
Q32	44.836		
Q33		46.860	
Q34		50.937	
Q35		48.861	
Q36		49.916	
Q37		42.790	
Q38		44.870	
Q39		51.948	
Q40		48.817	
Q41			40.781
Q42			59.527
Q43			50.715
Q44			43.831
Q45			46.891
Q46			52.925
Q47			38.651

According to the results of the confirmatory factor analysis presented in Table 4, it can be concluded that all questionnaire items possess acceptable construct validity. Specifically, based on the factor loadings and their corresponding significance coefficients in Tables 4 and 5, the loadings of all research items were statistically significant at the 95% confidence level.

After testing the outer model and confirming both its validity and reliability (i.e., the measurement models of the study), the inner model—or structural model—is evaluated. The structural model is used to examine the research hypotheses. To evaluate the model, key metrics such as the *t*-statistic, coefficient of determination (R^2), and path coefficients are employed.

The tested conceptual model in the standardized state using the PLS algorithm and the path coefficients is presented in Figure 1. The numbers displayed on the paths between constructs are referred to as path coefficients. These represent the standardized beta values in regression or the correlation coefficients between two constructs, and they indicate the extent of the direct effect of one variable on another. The values on the paths between constructs and indicators in reflective models indicate factor loadings. The numbers inside each circle represent the coefficient of determination (R^2) for the latent construct, which ranges between zero and one. The higher the R^2 value, the better the regression line explains the variation in the dependent variable as attributed to the independent variable (Hair et al., 2021).

Most R^2 values in PLS path models are considered substantial (Azar et al., 2012). The R^2 values for the latent variables in the model are presented in Table 6. As shown, R^2 values are not reported for exogenous or independent variables.

Table 6. R^2 Values for Research Variables

Variable	R^2
Intervening Conditions	0.583
Main Strategies and Actions	0.559
Causal Conditions	–
Outcomes	0.833
Cultural Citizenship Phenomenon in Smart City	0.855
Contextual Conditions	0.825

To test the significance of the hypotheses, the *bootstrap* (BS) method was used, and the partial *t*-value statistic was applied. The *t*-values for the research model are shown in Figure 2. Based on the figure and the levels of significance, a *t*-value greater than 1.96 or less than -1.96 is required to confirm or reject the hypotheses at the 95% confidence level. Values between -1.96 and 1.96 indicate no statistically significant difference between the calculated regression weights and zero at the 95% level. It is important to note that, for better clarity and visualization of the model's relationships, the coefficients of individual questionnaire items are hidden in the model; however, their factor loadings are detailed in Table 4.

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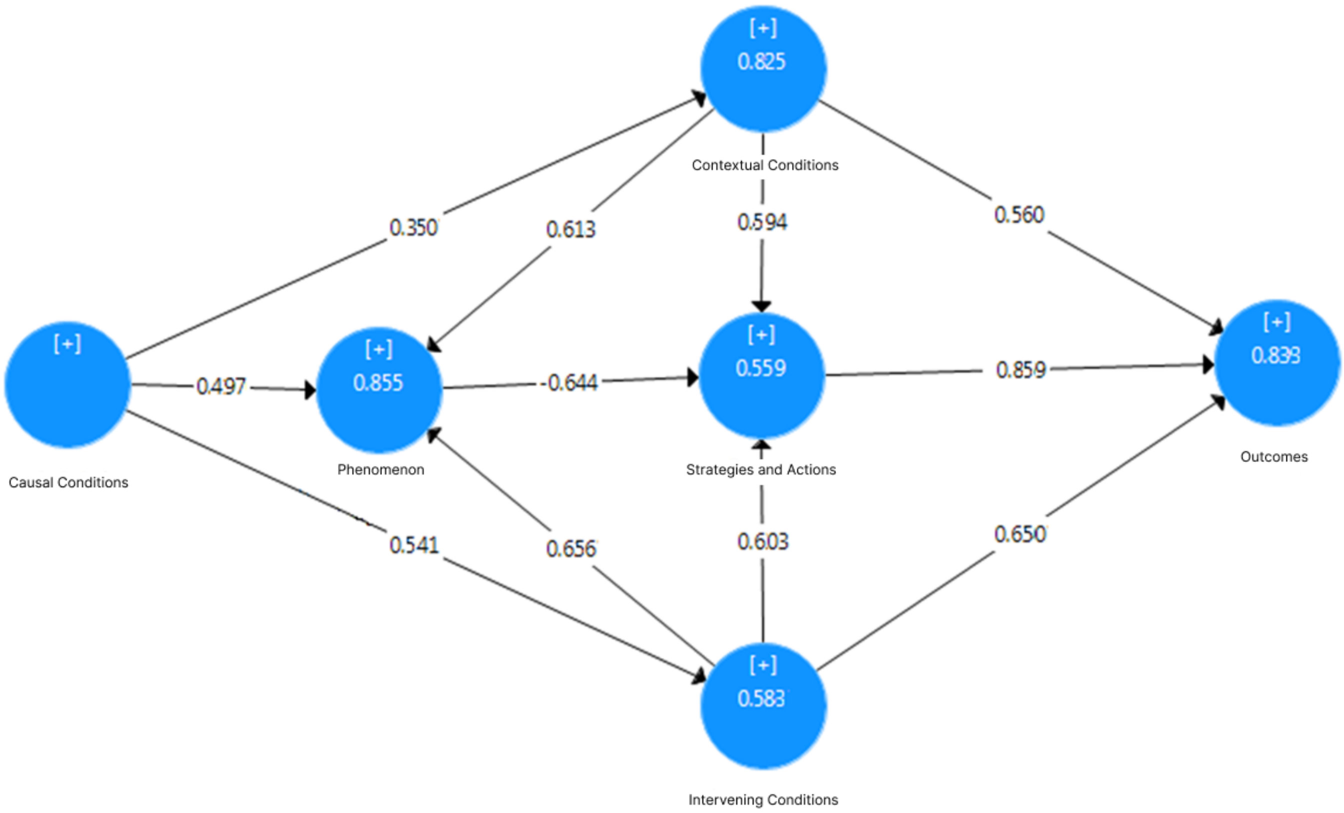

Figure 1. Standardized Structural Model

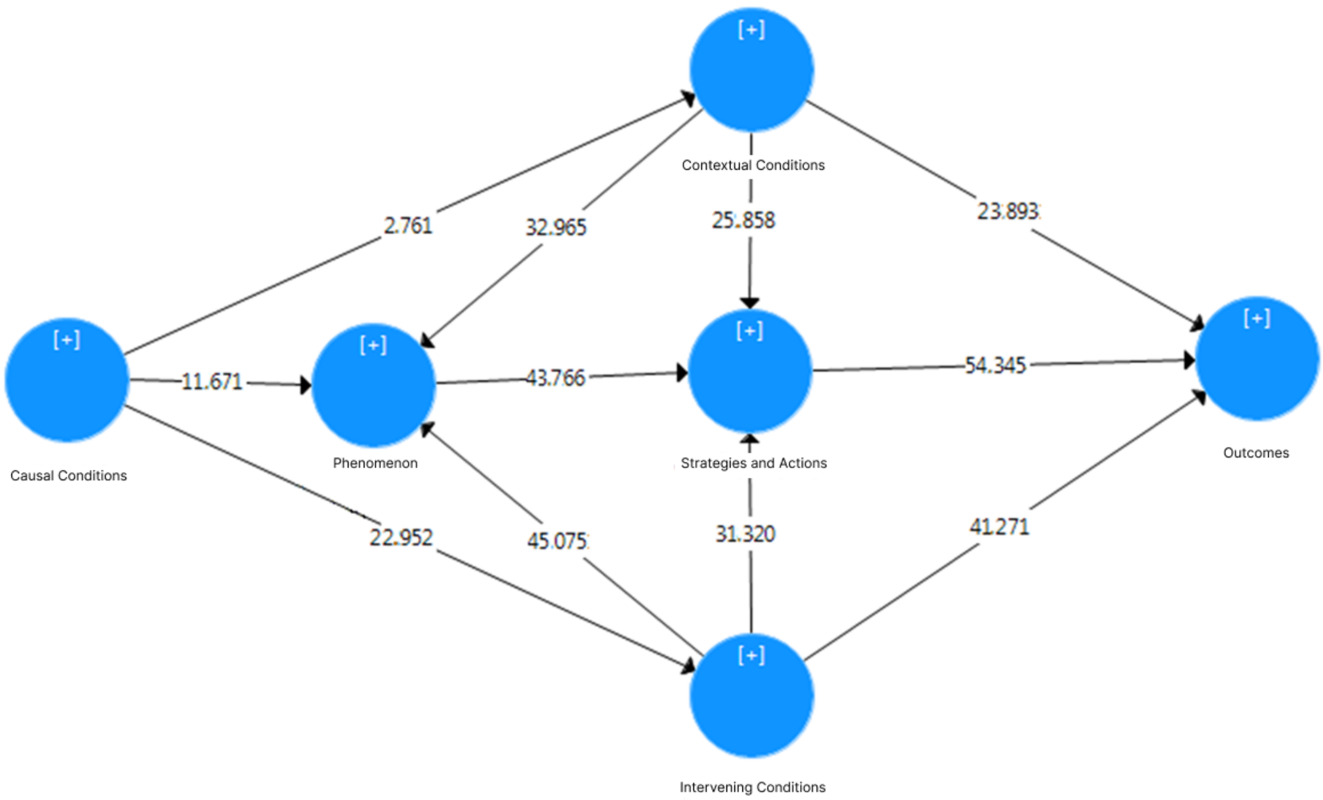

Figure 2. Structural Model with Significance Levels

Table 7. Hypothesis Testing Results

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Hypothesis	Path Coefficient (β)	*t*-Value	Hypothesis Outcome
Causal conditions have a positive effect on the cultural citizenship phenomenon based on cultural rights in the smart city.	0.497	11.671	Confirmed
Causal conditions have a positive effect on intervening conditions in the model of cultural citizenship based on cultural rights in the smart city.	0.541	22.952	Confirmed
Causal conditions have a positive effect on contextual conditions in the model of cultural citizenship based on cultural rights in the smart city.	0.350	2.761	Confirmed
Contextual conditions have a positive effect on the cultural citizenship phenomenon based on cultural rights in the smart city.	0.613	32.965	Confirmed
Contextual conditions have a positive effect on strategies and actions of cultural citizenship in the smart city.	0.594	25.858	Confirmed
Contextual conditions have a positive effect on the outcomes of cultural citizenship in the smart city.	0.560	23.893	Confirmed
Intervening conditions have a positive effect on the cultural citizenship phenomenon based on cultural rights in the smart city.	0.656	45.075	Confirmed
Intervening conditions have a positive effect on strategies and actions of cultural citizenship in the smart city.	0.603	31.320	Confirmed
Intervening conditions have a positive effect on the outcomes of cultural citizenship in the smart city.	0.650	41.271	Confirmed
The cultural citizenship phenomenon based on cultural rights in the smart city has a positive effect on strategies and actions.	0.644	43.766	Confirmed
Strategies and actions of cultural citizenship in the smart city have a positive effect on outcomes.	0.859	54.345	Confirmed

4. Discussion and Conclusion

The results obtained from the statistical tests indicate that the variations in the dependent variable are significantly influenced by the independent variables. This confirms the importance and responsiveness of the elements of cultural citizenship outcomes—based on cultural rights in a smart city—to the components defined in the paradigm model.

A smart city is one in which information and communication technologies are utilized to improve operational efficiency, share information with all stakeholders, and enhance the delivery of public services to citizens. However, numerous challenges confront smart cities, including ensuring cultural rights and fostering cultural citizenship. An exclusive focus on efficiency may lead to a narrow perspective on social values such as social cohesion, urban quality of life, and sustainability dimensions. In reality, within a smart city, cultures too must undergo "smart transformation" and be expanded, while the behaviors associated with cultural citizenship should be cultivated.

Overall, the findings derived from testing the research hypotheses suggest that urban management authorities should adopt well-defined and precise programs and visions to foster development, considering the positive impacts that cultural citizenship based on cultural rights and smart city growth can have on urban prosperity. These authorities should aim to alleviate existing constraints and barriers that hinder the practical application of knowledge and ideas in this domain. By supporting specialists and encouraging innovative ideas from experts and elites, they can create the necessary groundwork to capitalize on the existing knowledge and potential in the field. Strategic planning should aim toward furthering national smartification, enhancing cultural citizenship, and ensuring the protection of citizenship rights—thus improving the social landscape, management decisions, and governance policies. Given the growing importance of culture and cultural citizenship in urban development, and the urgent need for smart cities, urban management should be optimized to consider the cultural diversity among population groups. By expanding appropriate cultural values and increasing public awareness, cities can better define their urban development programs and strategies, thereby promoting overall urban and national progress.

Beyond methodological distinctions between this research and similar studies—which count as innovations—differences also exist in terms of the model and its components. Very few studies have specifically focused on cultural citizenship based on cultural rights in the context of smart cities, which adds to the uniqueness of this study. Due to the limited number of prior studies in this area using similar methodologies, the structural components of most previously proposed models are not aligned with those of the current model. Nevertheless, conceptual parallels and comparisons can be drawn. Accordingly, the present findings show partial consistency with several prior studies, some of which are summarized below:

Finally, the findings of the current study align with the prior research (Ayo-Odifiri et al., 2021; Chataut et al., 2023; Ghaffari et al., 2023; Gunesch, 2019; Sargolzai & Khodadadi Didani, 2024; Shahbazi & Shabani, 2024).

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Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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