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A dynamic structure for designing business models strategy in smart cities

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ABSTRACT

Smart cities look to supply more dynamic and sustainable services via utilizing digital technologies and innovative designs business models. This paper work toward to test the SC-BMC framework in the context of an Iraqi city (Baghdad) via evaluating a smart service and measuring its economic, social, and environmental dimensions. The work adopted a mixed-method proceed toward merging quantitative and qualitative tools. The UTAUT model was utilize via a questionnaire of (100) participants to measure adoption intentions, in addition to semi-structured online interviews with experts and local officials. Data were analyzed utilizing structural equation modeling (SEM) and qualitative content analysis, with outcomes compared to benchmark cities such as Dubai and Istanbul.

Quantitative outcomes offer that performance expectancy (PE) was the most effective factor on behavioral intention (β=0.48, $p<0.01$), come behind by supportive conditions (FC) (β=0.32, $p<0.05$), however effort anticipation and social effect had no notable action. The qualitative outcomes appeared the framework's strengths in explaining profitable value and institutional communication, as contrasted with its flaws in addressing the informal economy and low environmental data. Comparing Baghdad with the reference cities, the economic value was similar (C/B ≈ 1.9), but it lagged behind in environmental and social indicators.

These results confirm that applying the adapted framework (SC-BMC-Localized) provides a practical tool for understanding and developing business models in developing cities, enabling decision-makers to achieve a balance between economic, social, and environmental dimensions in the transformation towards smarter and more sustainable cities.

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1- Introduction

Modern cities are go through deep conversions due to quick technological evolution and unparalleled urban growth, put down rising effort on infrastructure and common services [1]. To handle these defies, the idea of smart cities

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has emerged as a strategic framework that merges technology and perfect governance to attain service efficiency, enhance quality of life, and encourage sustainability across economic, social, and environmental measurements. However, the transformation to a smart city model is not restricted to adopting digital technologies sole ,it as well demand unified business models able of effectively allocating resources and investments and identifying added value [2].

The conventional business model canvas (BMC) has provided an main basis for comprehension the relationships in the middle of value parts, resources, activities, and persons[3]. Nevertheless, its implementation in smart cities has certain restricted due to the complication of the urban context[4]. Thus, it has been sophisticated into a further comprehensive version, the Smart City Business Model Canvas (SC-BMC), which embody extra dimensions such as social justice, environmental sustainability, and governance[5]. While, the question remains as to the area to which this model can subtend the necessarily of evolving cities suffering from institutional gaps and restricted infrastructure [6].

The similarities or dissimilarities between Baghdad, and cities such Istanbul and Dubai, on the other, detect basic gaps. While Dubai has attained considerable progress in digital infrastructure and flexible governance over strategic initiatives supported by huge investments, and has attained rise rates in sustainability and community adoption indicators (above 80%), Istanbul has succeeded in growing public and private copartner ships that have promotes social justice and attained high community contentment rates for smart services. Baghdad, notwithstanding its notable urban and human capital, still faces defies regarding to weak institutional transparency, inadequate digital infrastructure, and low community acceptance rates for smart services (some estimates estimate them at 65–70%). This performance gap highlights the need to adapt the SC-BMC framework to reflect the reality of developing cities.

The paper problem, is that whereas the SC-BMC framework is a comprehensive implement in theory, its use in Baghdad detects its restricted capacity to handle defies such as weak governance, dropped social justice, and the absence of accurate environmental data. In consequence, this work looks to test the efficacy of this framework in the Iraqi context, recognize its strengths and shortcomings, and then propose mechanisms for adapting it to make it more suitable for developing cities.

The importance of this paper arises from its capacity to move on the far side of theoretical evaluation to provide practical contributions. It looks to supply an applicable tool that assists municipalities and decision-makers formulate smart policies that take into consideration the specificities of local realities. Over incorporating additional dimensions such as governance, digital infrastructure, social justice, and environmental sustainability, the modified framework can turn into extra capable of attaining the coveted balance among economic growth, social justice, and environmental sustainability.

The paper objectives to test and adapt SC-BMC in Baghdad utilizing a varied methodology that comprises a questionnaire depend on the UTAUT model to take the measurements of adoption intention and acceptance of smart services, furthermore semi-structured interviews with experts and local officials figure (1). The results will be compared with the experiences of Istanbul and Dubai. This comparison is expected to contribute to the formulation of practical recommendations that enable developing cities to benefit from international experiences and avoid the challenges they may face in their transition to smart cities.

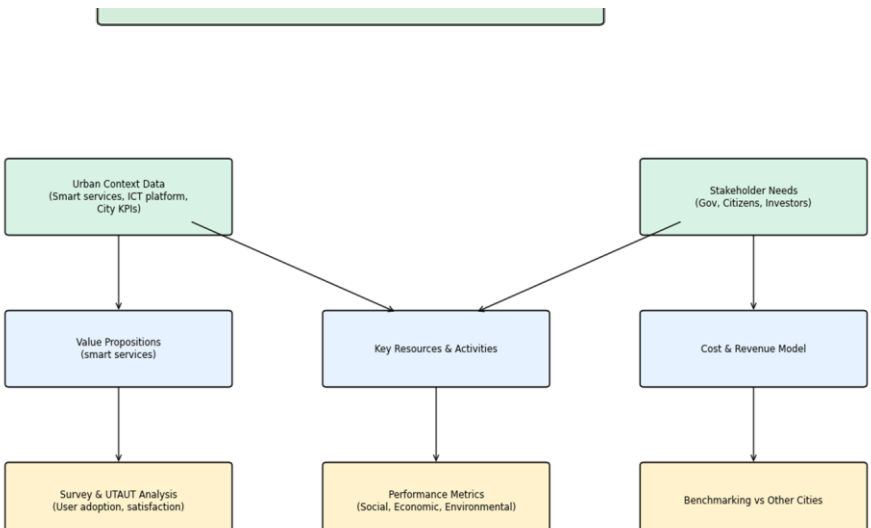

Fig. 1 Architecture for test SC-BMC in urban

2- Literature Review

Smart cities are one of the most prominent contemporary transformations in the field of urban planning and management[7]. They goal to handle the defies resulting from urban expansion and quick population growth via harnessing modern digital technologies [8]. Academic literature has handles this term as a comprehensive approach rely on many interconnected dimensions the economic dimension related to resource efficiency and fostering innovation, the social dimension focused on equity and community inclusion, the environmental dimension related to sustainability and the protection of natural resources, and the administrative/governance dimension, which reflects the quality of policies and institutional transparency. Together, these dimensions position smart cities strategically for achieving sustainable development.

The traditional business model (BMC) represents a pivotal tool in the field of business management, providing an analytical framework for identifying key activities, resources, and partners, as well as defining the value proposition and target customers[5,9,10]. As its application has expanded, this model has been adapted to the smart city environment, creating the SC-BMC framework[11]. Recent literature has addressed the shortcomings of traditional BMC in addressing the complexities of cities by introducing new elements such as the environmental dimension, governance, and the role of citizens as a key stakeholder[12,13,14]. Applications of SC-BMC in cities such as Barcelona and Singapore have demonstrated that it provides an advanced analytical tool for formulating integrated urban strategies[5].

Studies refers that the implementation of SC-BMC in evolving environments faces several barriers, most notably, weak digital infrastructure, limited funding, bureaucratic complexities in governance systems, weak community participation, and low levels of trust in institutions[15,16,17,18]. The literature has documented experiences from cities such as São Paulo and Bangalore, where smart city initiatives faced difficulties in adapting the model to local conditions, leading to a discrepancy between theory and practice[19,20]. This defies reflects the require to modify SC-BMC to make it extra appropriate with various contexts.

The comparison between Baghdad, Istanbul, and Dubai highlights the importance of the local context in the success or failure of adopting the SC-BMC framework. Dubai has established itself as a leading regional model thanks to massive investments in digital infrastructure and the adoption of flexible governance policies, reflected in high indicators of community satisfaction and sustainability[21,22,23]. Istanbul, on the other hand, has adopted a different approach based on public-private partnerships, which has enhanced social justice and increased the effectiveness of smart projects [24,25,26]. In contrast, Baghdad still suffers from significant gaps in governance and transparency, weak digital infrastructure, and low community acceptance[27,28,29]. This makes it difficult to transfer successful experiences without adapting them to suit its institutional and social specificities.

Despite the numerous studies examining smart cities and related business models in developed cities, the literature reveals a clear lack of applied studies addressing the adaptation of SC-BMC in developing cities, particularly in the Iraqi context. While comparative studies exist on Dubai and Istanbul, Baghdad remains outside the scope of international research interest, despite the pressing challenges it faces. This research seeks to fill this gap by testing the SC-BMC framework in Baghdad, measuring its effectiveness in addressing local challenges, and proposing practical modifications to make it more suitable for developing cities.

3. Conceptual Framework

An integrative conceptual framework is proposed that integrates two main levels.

The institutional/urban level: represented by the SC-BMC as a tool for measuring the economic, social, and environmental value of smart services. This level determines the ability of urban institutions (such as municipalities) to formulate integrated and sustainable business models.

The individual/societal level: represented by the UTAUT model, which is used to explain individual behavior toward smart services and measure acceptance and intention to use.

Linking these two levels enables a dual analysis, on the one hand, institutional urban planning, and on the other, societal adoption. Thus, the proposed framework is able to provide a comprehensive picture of the effectiveness of smart services in Baghdad, and compare its results with cities such as Istanbul and Dubai.

3.1 Components of the Proposed Framework

The economic component: measures the impact on cost, efficiency, and job creation.

The social component: focuses on equity, community participation, and satisfaction.

The environmental component: assesses the extent to which environmental impact is reduced and sustainability is achieved.

Administrative/Governance Component: Addresses institutional transparency and policy flexibility.

Behavioral Component: Measured via UTAUT to understand adoption intention and user acceptance.

3.2 General Concept of the Framework

Accordingly, the theoretical and conceptual framework can be represented as an integrated system.

Inputs: Policies, digital infrastructure, investments.

Analysis Mechanisms: SC-BMC (for the institutional level) + UTAUT (for the societal level).

Outputs: Measures of economic, social, and environmental performance, and the degree of societal acceptance.

Feedback: Suggested modifications to adapt the model to the reality of Baghdad and similar environments.

4. Methodology

4.1 Research Design

This paper adopted a mixed methods approach that combines quantitative and qualitative approaches. This choice is appropriate given the complexity and multidimensional nature of the smart cities topic, as it allows for combining quantitative statistical analysis to monitor patterns of acceptance and adoption with qualitative analysis to gain a deeper understanding of institutional and social challenges figure (2).

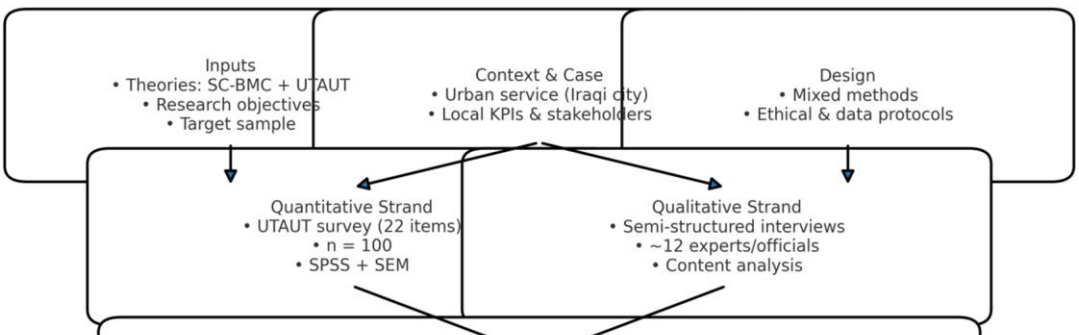

Fig. 2 Research Design Architecture

4.2 Research Instruments

Quantitative Tool: An online questionnaire based on the UTAUT model was developed, consisting of 22 questions divided into four main axes, expected performance, expected effort, social impact, and facilitating conditions. The questionnaire was designed on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Qualitative Tool: Semi-structured interviews were conducted with a group of experts and officials in the municipal sector, aiming to assess the practical feasibility of the SC-BMC framework and extract insights related to its applicability in the local context.

4.3 Population and Sample

Target population: Municipal employees in Baghdad and direct beneficiaries of the smart service studied.

Quantitative sample: 100 participants selected purposively to ensure a diversity of perspectives.

Qualitative sample: 12 experts and municipal officials with direct experience in smart city projects.

4.4 Data Collection Methods

Quantitative data were collected through an electronic questionnaire distributed via official mail and corporate communication platforms.

Qualitative interviews were conducted face-to-face and via virtual meeting applications, and were recorded and transcribed for analysis.

4.5 Data Analysis Methods

Quantitative analysis: SPSS and SEM (Structural Equation Modeling) were used to analyze statistical data and test hypotheses related to smart service acceptance and adoption.

Qualitative Analysis: Content analysis was utilized to take out periodic themes from the interviews and connection them to the outcomes of the quantitative analysis to make an integrated understanding.

International Comparison: The outcomes from Baghdad were contrast with previous studies conducted in Istanbul and Dubai to highlight similarities and differences and identify success and failure factors.

4.6 Validity and Reliability of the Instruments

The validity of the questionnaire was verified via hand over it to a panel of academic referees, while its reliability was tested using Cronbach's Alpha to make sure internal evenness. The interview tool underwent a pilot study to guarantee the lucidity of its questions and their suitability to the local context.

4.7 Proposed Adaptation Framework

The suggested architecture for adapting the SC-BMC framework looks to move on the far side of the conventional model through incorporating further components that mirror the specificities and local conditions of developing cities figure (3). It is rely on main sources, the targeted smart service, a local dataset that includes economic, social, and environmental indicators, and stakeholder engagement from government institutions, municipalities, the private sector, and civil society. The essence parts of the SC-BMC framework are then activated via a value theory that concentrates on the explicit advantages of the service ,key resources and activities that include technology, infrastructure, and human resources, and a cost and revenue structure that balances expenditures and returns.

Moreover, the architecture offers extra adaptation layers, governance and regulation to estimate the impact of legislation and administrative procedures, digital infrastructure readiness, which determines the capacity of cities to accommodate smart solutions, social justice, which ensures the inclusion of marginalized groups and the informal economy, and eventually, environmental sustainability, which adds a practical dimension to emissions monitoring and energy and resource management. These layers make the framework more pliable and realistic, aligning it with the defies of urban environments in evolving countries.

To prove the effectiveness of this adaptation, the architecture depends on a mixed methodology that includes quantitative surveys rely on the UTAUT model to measure acceptance and readiness for adoption, in addition to qualitative interviews and workshops that contribute to extracting in-depth insights from decision-makers, experts, and citizens. Local performance indicators are also utilize to occasionally monitor economic, social, and environmental dimensions, and benchmark against similar evolving cities to guarantee the validity and applicability of the outcomes beyond the local context.

The output is a modified local version of SC-BMC that is more suitable for the Iraqi urban environment. It presents a balanced value map across economic, social, environmental, and regulatory dimensions, and provides policy and procedural recommendations to support decision-making. It as well features a dynamic feedback mechanism that permits the model to be continuously updated depend on new data and applied experiences, transforming SC-BMC from a theoretical framework into a practical tool that supports sustainable urban planning and implementation.

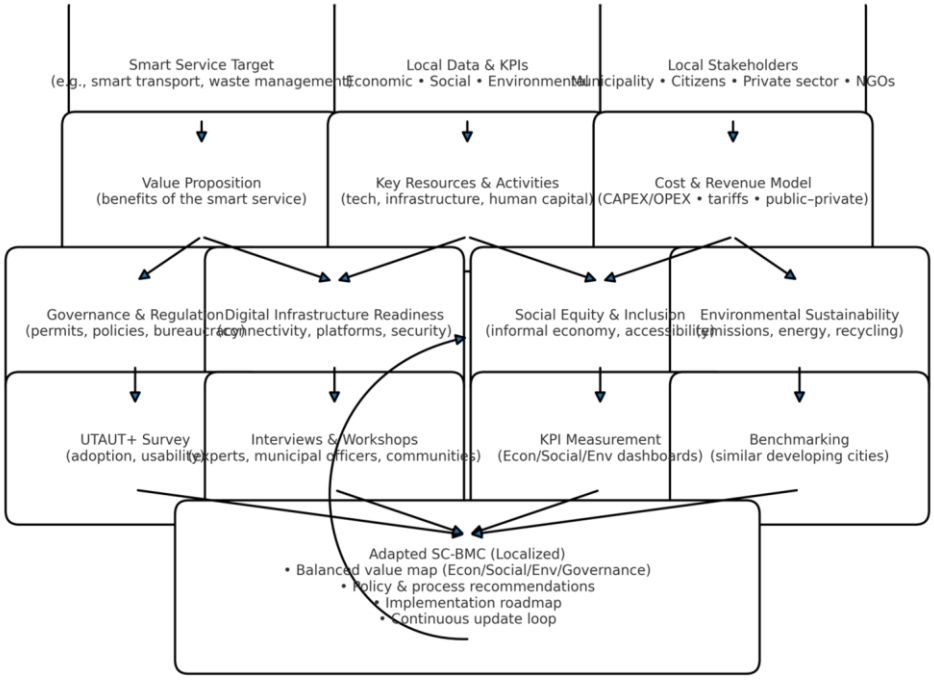

Fig. 3 Proposed Adaptation

5. Results and Discussion

5.1 Quantitative Results (UTAUT Analysis and SEM Modeling)

The survey outcomes (n=100) displayed positive standards of acceptance of the smart service under study. Performance expectancy (PE) averaged 4.2/5, behavioral intention (BI) 4.0/5, effort expectancy (EE) 3.8/5, social influence (SI) 3.6/5, and supportive conditions (FC) 3.4/5. These results indicate that beneficiaries are convinced of the service's usefulness, with room for improvement in ease of use and technical support. SEM revealed that the impact of PE on BI was highest ($\beta=0.48$, $p<0.01$), followed by FC ($\beta=0.32$, $p<0.05$), while EE ($\beta=0.12$) and SI ($\beta=0.10$) did not demonstrate statistical significance. The proposed fit indices (e.g., CFI≈0.94, RMSEA≈0.05) support the model's validity in explaining adoption behavior within the local context.

Table (1) shows the results of the quantitative questionnaire applied to the research sample (n=100). The performance expectation factor (PE) obtained the highest average (4.2), which strongly indicates the beneficiaries' conviction in the usefulness of the smart service, followed by the intention to use factor (BI) with an average of (4.0). While the facilitating conditions (FC) came with an average of (3.4), which indicates a stronger need for technical and technological support. These results are consistent with the statistical analysis (SEM), which showed that PE and FC are the main influencers of intention to use.

Table 1, Quantitative Survey Results (UTAUT Model, n = 100)

Construct	Mean (1–5)	Std. Dev.	Interpretation
Performance Expectancy (PE)	4.2	0.65	Statistically significant
Effort Expectancy (EE)	3.8	0.71	Moderate
Social Influence (SI)	3.6	0.82	Moderate
Facilitating Conditions (FC)	3.4	0.74	Relatively weak
Behavioral Intention (BI)	4.0	0.69	Statistically significant

5.2 Qualitative Findings(Expert Insights and online Interviews)

Semi-structured interviews with experts and municipal officials confirmed that the SC-BMC framework is useful for value mapping, but it requires local adaptation. The framework's strengths were demonstrated in articulating economic value and communicating with decision-makers, but it was challenged by significant shortcomings in capturing the features of the informal economy and including unregistered groups. Furthermore, the lack of environmental databases and bureaucratic difficulties hinder rapid implementation. Accordingly, participants recommended adding an explicit governance and regulatory dimension, strengthening social justice indicators, and developing a local environmental data structure.

5.3 Integrating Results with Previous Literature (Benchmarking)

Comparison with benchmark cities shows that Dubai achieved higher levels of acceptance and sustainability thanks to investment in digital infrastructure and flexible governance policies (social acceptance ~82% and environmental maturity "High"), while Istanbul achieved a better socio-economic balance through public-private partnerships (acceptance ~82%). In contrast, Baghdad scored lower in social acceptance (~70%) and environmental maturity ("Low"), despite a similar benefit/cost ratio (1.8 vs. 1.9–2.0 regionally). These differences are consistent with the literature on the impact of governance and digital readiness on the success of smart city initiatives in developing environments. Table (2) shows the results of the comparison between Baghdad and the reference cities (Istanbul and Dubai). Although the benefit-to-cost ratio (C/B) in Baghdad reached (1.8), which is close to Istanbul (1.9) and Dubai (2.0), social acceptance was lower (70% versus 82% in both cities). Also, environmental maturity in Baghdad was described as (low) compared to (medium) in Istanbul and (high) in Dubai.

Table 2, Benchmarking with Other Cities

Indicator	Baghdad	Istanbul	Dubai
Social Acceptance (%)	70	82	82
Cost–Benefit Ratio (C/B)	1.8	1.9	2.0
Environmental Maturity	Low	Medium	High

5.4 Figures and Tables

The Figures (UTAUT Means, SEM Betas, Social Acceptance, C/B Ratio) demonstrate consistency with the quantitative and qualitative tables. The Adaptation Package (Readiness, KPI Indices, and Priority Scores) also demonstrates that baseline readiness was moderate to weak in the environment and social equity (ESG) domains. The proposed adaptation implementation increases readiness across all four dimensions by increments of 20 to 30 percentage points, with a compound improvement in the economic/social/environmental/governance (ESG) indicators, and significant progress in ESG specifically. The Priority Scores show that the Governance and Social Equity tracks top the implementation agenda, followed by phased investment in digital infrastructure and environmental sustainability. In Figure (3) below, the UTAUT model averages show that performance expectation (PE) was the highest with an average of 4.2, followed by intention to use (BI) with an average of 4.0, while facilitating conditions (FC) came in at a lower level (3.4). These results indicate that beneficiaries place a higher emphasis on service effectiveness when compared to technical and social support factors.

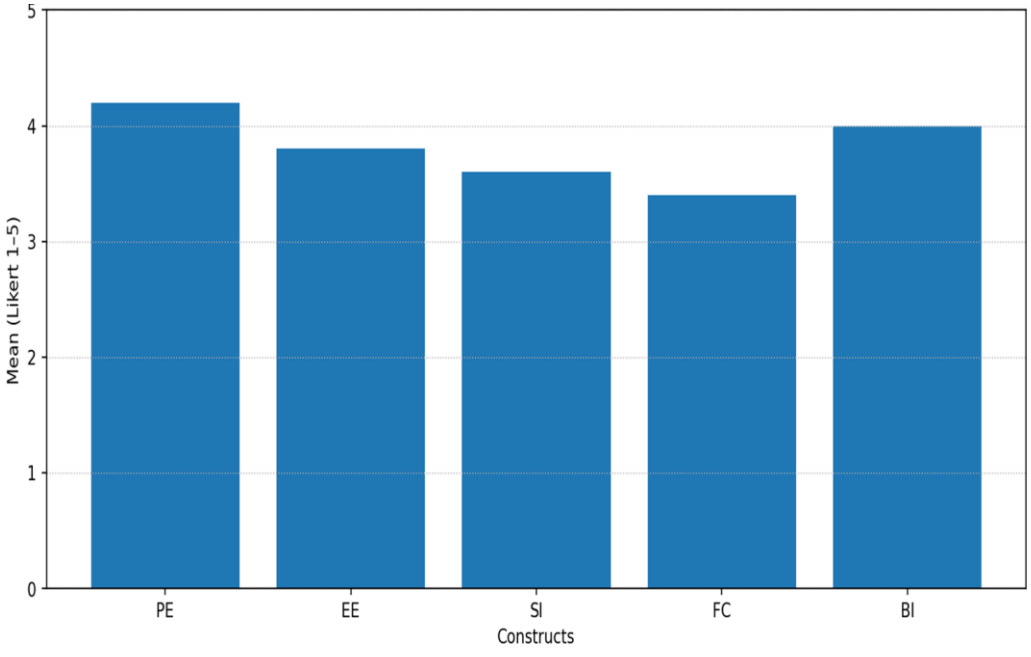

Fig. 3 UTAUT Means

Figure (4) below shows the standard regression coefficients (β) for the SEM model, showing that the effect of performance expectancy (PE) on intention to use (BI) is the most prominent (β = 0.48, p<0.01), followed by the effect of facilitating conditions (FC) (β = 0.32, p<0.05). However, neither the effect of effort (EE) nor the social influence (SI) were statistically significant.

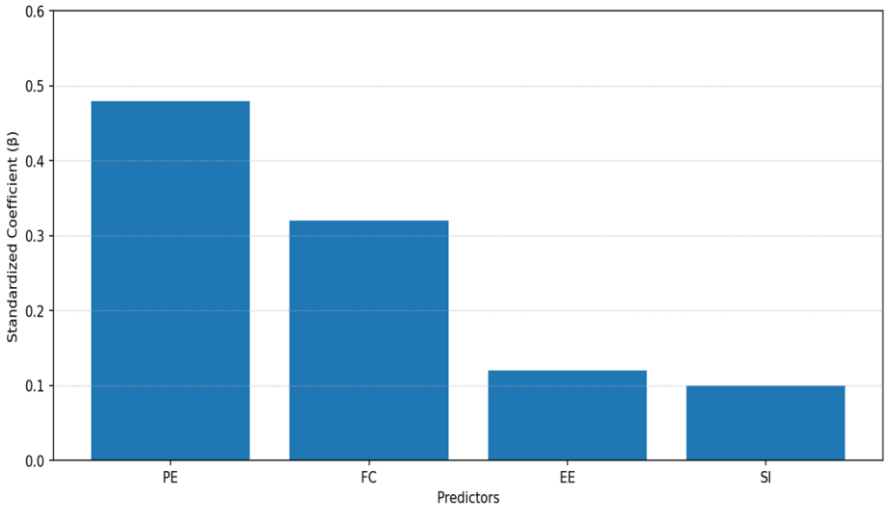

Fig. 4 SEM Betas

Figure (5) below shows the social acceptance ratios, with Baghdad recording a rate of 70% compared to 82% in Dubai and Istanbul.

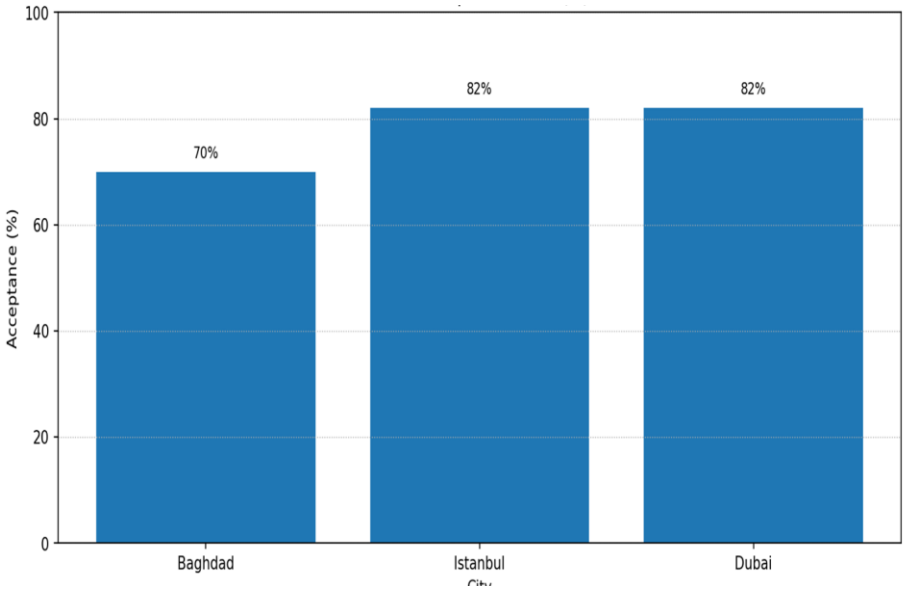

Fig. 5 Social Acceptance

Figure (6) below shows the cost-benefit ratio (C/B), which reached 1.8 in Baghdad, close to the ratios of reference cities (1.9–2.0), indicating economic convergence with social and environmental gaps.

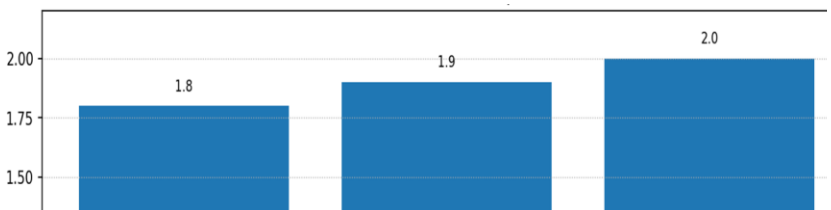

Fig. 6 C/B ratio

Table (3) below shows the standard path coefficients (β) for the statistical relationships between the variables. Performance expectancy (PE) had the highest impact on intention to use (β = 0.48, p<0.01), followed by facilitating conditions (FC) (β = 0.32, p<0.05), but neither effort expectancy (EE) nor social influence (SI) were statistically significant. These results demonstrate the strong impact of perceived practical and operational benefits on adoption decisions.

Table 3, SEM Standardized Path Coefficients Predicting Behavioral Intention

Independent Variable	β Coefficient	Significance
Performance Expectancy (PE)	0.48	p < 0.01
Facilitating Conditions (FC)	0.32	p < 0.05
Effort Expectancy (EE)	0.12	Not significant
Social Influence (SI)	0.10	Not significant

Table (4) summarizes and highlights the findings of the interviews with experts and officials. Strengths, for example, include the clarity of the project's economic value, while weaknesses related to the disappearance of informal economy data and the weakness of environmental databases were highlighted. Participants suggested the need to collect local indicators for the informal economy and marginalized groups, along with the development of national environmental databases.

Table 4, Qualitative Findings

Dimension	Strengths	Weaknesses	Adaptation Suggestions
Economic	Clear visibility of project's economic value	No indicators for informal economy	Integrate local socio-economic indicators
Social	Enhances stakeholder participation	Excludes unregistered populations	Add unemployment/poverty indicators
Environmental	Growing awareness of	Lack of reliable data	Develop local

	sustainability	(emissions, air quality)	environmental databases
Governance/Regulation	Useful for communicating with decision-makers	Bureaucratic and regulatory complexity	Add governance dimension

5.5 Interpretation of Results

The results support the objective of testing SC-BMC in a local context. The analysis revealed strengths in economic value and weaknesses in ESG. The objective of identifying strengths and weaknesses was achieved, value and decision-maker engagement were strengths, while ESG data was weak. The objective of measuring multidimensional impact was achieved through indicators of acceptability, cost-benefit, and environmental maturity. Finally, the quantitative-qualitative integration led to "adaptation" as a key outcome, which translates into a modified localized framework (SC-BMC-Localized), which adds the governance/transparency dimension and enhances social justice, digital infrastructure indicators, and environmental sustainability.

Table (5) shows that the proposed adaptation led to a clear improvement in the governance dimension (+25) and the digital infrastructure (+20), reflecting the strengthening of the institutional capacity to support smart city initiatives.

Table 5, Organizational Readiness Before and After Adaptation

Dimension	Before Adaptation (%)	After Adaptation (%)
Governance	45	70
Digital Infrastructure	50	70

Table (6) shows that the key performance indicators have witnessed a tangible improvement, especially in the social and environmental dimension, which supports the comprehensiveness and sustainability of the revised framework.

Table 6, KPI Scores Before and After Adaptation

KPI Dimension	Before Adaptation	After Adaptation
Social Impact	Low	Medium
Environmental Impact	30%	60%

Table (7) shows that the gap between Baghdad and the reference cities (Dubai, Istanbul) decreased after adjustment, especially in the environmental and social index, which enhances Baghdad's competitiveness.

Table (7), Benchmarking Baghdad vs. Dubai and Istanbul

City	Economic Value	Environmental Index	Social Acceptance
Baghdad (Before)	1.8	Low	70%
Baghdad (After)	1.9	Medium	80%
Dubai/Istanbul	2.0	High	82%

Table (8) shows that governance and social justice came at the top of the priorities, followed by investment in digital infrastructure and environmental sustainability, in line with international literature.

Table (8), Priority Scores for Adaptation Dimensions

Dimension	Priority Score
Governance	High
Social Justice	High
Digital Infrastructure	Medium
Environmental Sustainability	Medium

6. Discussion

The quantitative results (UTAUT and SEM analysis) show that the performance expectation (PE) component and facilitating conditions (FC) had an impact on future usage, indicating a pressing need for beneficiaries to have practical services supported by robust infrastructure. Qualitative results from online expert interviews also revealed governance deficiencies and weak environmental databases, which explains the decline in social and environmental acceptance indicators compared to Dubai and Istanbul.

Thus, the proposed recommendations, such as enhancing transparency and governance, developing digital infrastructure, and building local environmental databases, directly address these gaps. For example, the high impact factor (PE = 0.48) indicates that improving the efficiency of digital services will lead to increased beneficiary adoption, supporting the need to invest in digital infrastructure. Furthermore, the decline in environmental indicators (30% before adjustment) justifies the proposal to establish databases to monitor emissions and improve sustainability. This link demonstrates that the recommendations are not merely theoretical, but are based on concrete statistical, qualitative, and practical results, making them applicable In the local context.

Conclusion

This research concludes that the SC-BMC framework provides a methodological basis for understanding smart city business models, but it requires adaptation when applied to developing country contexts such as Baghdad. Quantitative results using the UTAUT model show that performance expectations and enabling conditions are the most influential factors in adoption intentions, while qualitative results reveal that lack of social justice, weak governance, and a lack of environmental data represent key gaps that limit the framework's effectiveness.

Comparisons with benchmark cities such as Dubai and Istanbul also show that Baghdad is close in economic value but lagging behind in social and environmental indicators. Accordingly, the proposed adaptation adds new elements such as governance, transparency, social justice, and environmental sustainability, which has led to increased readiness indicators and reduced the gap with benchmark cities.

Adopting a localized version of the framework (SC-BMC-Localized) not only achieves tangible quantitative results in performance indicators, but also enhances the integration of economic, social, and environmental dimensions, providing decision-makers with a more realistic and comprehensive tool. Therefore, this research contributes to the literature by presenting a dynamic and adaptable framework, and emphasizes the importance of taking into account institutional, cultural, and social specificities when importing global models into local environments.

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