smart cities

MDPI

Article

Getting Smarter: Blockchain and IOT Mixture in China Smart Public Services

Nada Mallah Boustani [1,*], Qing Xu [2,3] and Yan Xu [4]

[1] Faculty of Business & Management, Social Science Campus, Saint Joseph University, Beirut 1104-2020, Lebanon
[2] Faculty of Management, Economy and Sciences, Universite Catholique de Lille, 41 Rue Du Port Bureau, 59000 Lille, France
[3] Bureau WE B184, WeNov, 177 Allée Clémentine Deman, 59000 Lille, France
[4] Centre of Business Transformations and Centre for International Business and Innovation (CIBI), Department of Operations, Technology, Events and Hospitality Management, Faculty of Business and Law, Business School, Manchester Metropolitan University, Manchester M15 6BH, UK
* Correspondence: nada.mallahboustany@usj.edu.lb

Abstract: Due to tremendous technological breakthroughs, an increasing number of cities are transforming into "smart cities" utilizing the Internet of Things (IOT), artificial intelligence, or other information technologies. The Chinese government announced that the development of "digital cities smart cities" was a national priority. The goal of this study is to examine the success variables that can influence IOT service adoption aspirations while also serving as a mediator for enhanced security via blockchain technologies. A conceptual model is created with a strong theoretical underpinning and body of literature. The final sample consisted of 1008 participants. This study uses the partial least squares structural equation modelling (PLS-SEM model) to test and analyze the impact of identified variables on the continuous usage intention (CUI) of IOT-based public services. Our findings show that blockchain adoption in smart cities fully mediates the effect of the IOT on CUI and shed the light on the importance of the trust, empowerment, and social influence since the continuous usage intention of the IOT in smart cities is mainly influenced by these factors and enhanced by the application of blockchain.

Keywords: blockchain; IOT service adoption; structural equation modelling; continuous usage intention

check for updates

Citation: Boustani, N.M.; Xu, Q.; Xu, Y. Getting Smarter: Blockchain and IOT Mixture in China Smart Public Services. *Smart Cities* **2022**, *5*, 1811–1828. https://doi.org/10.3390/smartcities5040090

Academic Editors: Véronique Flambard, Sadia Benamrouz-Vanneste and Abir Karami

Received: 11 November 2022
Accepted: 16 December 2022
Published: 19 December 2022

1. Introduction

Technology has made considerable strides in recent years to support and regulate all facets of life and services. A fully digitized civilization is developing. Government officials want to develop smarter cities where individuals may build more interconnected gadgets and move beyond what was formerly thought to be the limits of human ability. The ways in which people engage and communicate over time, location, and distance are evolving.

The term "Internet of Things" (IOT) refers to a theory or a technology that links all devices and enables internet-based communication between them. IOT devices may be thought of as anything that can be linked to the internet. Researchers and scientists are working to advance the field by developing revolutionary networked systems that enable little items to instantly exhibit superintelligence. Representatives of the government continue to work on implementing policies that will enhance public safety and quality of life.

A city combines communication, water and energy distribution, transportation networks, and infrastructure. Reviewing different smart city definitions and practices throughout the world reveals that most smart cities are defined by three key characteristics: technology (hardware and software infrastructures), people (creativity, diversity, and education), and institutions (governance and policy). A "smart city" makes use of technology-based planning to modernize the quality of life and lower energy use.

The aim of this paper is to discuss the success elements of IOT-based smart technology innovations for the citizens' continuous usage intention of IOT-based public services in emerging nations and to answer the following research questions: What societal factors are common when IOT services are adopted? How might blockchain technology be utilized to enhance high levels of security perception for citizens? What are the results of important elements that increase the adoption of IOT-based public services by Chinese citizens?

The context of this study was triggered by the fact that the rising urbanization of the world's population raises several economic, environmental, and social problems that significantly affect the way of life and quality of life for a large number of people. The concept of a "smart city" provides a chance to address these difficulties and provide a greater quality of life through enhanced intelligent services given the high population density in urban regions; therefore, the Republic of China was chosen since, the Chinese government announced that the development of "digital cities smart cities" was a national priority [1–3].

As may be seen in Rudolf Giffinger's model, several models typically relate to the same elements. The Smart Economy, Smart Mobility, Smart Environment, Smart Habitats, Smart Lifestyle, and Smart Administration are the six pillars of the smart city. In urban regions with huge populations, mobility is one of the most difficult issues to deal with. By managing infrastructure and public policies connected to the whole transportation system more effectively, smart mobility is enhancing the comfort and safety of commodities and people [4]. It is quite common for people and linked objects to connect anytime, anywhere, with anybody, and with anything [5].

A smart community actively chooses to use technology as a catalyst to address its social and commercial concerns. Rebuilding and revitalizing a feeling of place and, consequently, a sense of civic pride, is the true potential of smart cities [6]. It is a city that connects its social, commercial, IT, and physical infrastructures in order to tap in to the city's collective intelligence [7]. A smart city develops connected, livable, and sustainable urban centers utilizing all available technology and resources in an intelligent and coordinated way [8]. In order to establish a sustainable, greener city, competitive and inventive commerce, and improved life quality, smart cities link people, information, and city aspects utilizing modern technology [9].

Strong stakeholder and public participation in the development of Smart Cities is the driving force behind the creation of suitable technological solutions that can best address citizen needs [10,11]. This study defines a "smart city" as one where technology, infrastructure, and social consequences all coexist in urban settings to create more useful technology that improves user experience.

Researchers have focused on topics related to blockchain systems and their integration with the IOT and cloud systems in recent years [12]. The B-IOT, or blockchain technology for the IOT, intelligent transportation systems, was described by Rateb et al. [13]. Mamoshina et al. (2018) [14] discussed integrating next-generation artificial intelligence technologies with the blockchain to decentralize and speed up medical research.

Even in our modern society, there is a growing need for Intelligent Transport Systems (ITSs), for instance, since private traffic's ease comes at a hefty cost in terms of depleting road resources. All areas of technology that ITS will fundamentally alter, such as traveler information management and vehicle control design, depend heavily on human aspects, which are essential to ITS [15].

Numerous researchers have concentrated on various blockchain-based applications. Panarello et al. [16], for instance, analyzed several application areas and divided usage patterns into either device manipulation or data management, development solutions, or difficulties linked to integrating the blockchain into the IOT. Boustani [17] analyzed the impact of blockchain on the banking sector causing a threat to the existing financial ground in a developing country. Blockchain-IOT security was evaluated by Banarjee et al. [18], who also found a variety of IOT dataset problems that need to be resolved. The authors investigated the current IOT security approaches in depth in terms of intrusion detection and prevention, application classification, network structure classification, predictive security, and self-healing before discussing the blockchain's potential use in securely exchanging data in IOT databases [19].

All modifications to patient information would be validated, merged with other transactions, and added as blocks to longer chains under this blockchain-based standard [20]. The blockchain can help combat dangers such as integrity-based assaults that are overgrowing. Although there is a movement to build a full blockchain node onto IOT devices [21,22], this is currently difficult because of the IOT's restrictions.

In this research, a conceptual model built on a solid body of literature and theoretical background is established in an effort to provide factors for the success of IOT services in the public sector and the mediating role played by blockchain adoption to increase the acceptance of the IOT in smart cities, which is a novel topic tested in Chinese smart cities. A questionnaire was developed in order to study the influence of identified components on continuous usage intention, and it was quantitatively evaluated on users of IOT services.

There are still few research contributions in the literature that focus on the influence of blockchain adoption in smart cities on the continuous usage intention of IOT-based public services. This paper is among the first known to test the mediation effect of blockchain adoption. Our analysis proves that the IOT is expected to have a positive influence on Continuous usage intention (CUI) through blockchain adoption in smart cities.

The authors first present the methods used, the models' variables, and hypothesis tested using SEM (structural equation modeling), and then analyze the impact of identified variables on the continuous usage intention, developed in Section 2. In Section 3, the authors present the results; then, in Section 4, a thorough discussion of the findings and several crucial elements for the fusion of blockchain technologies contributing to the creation of a secured smart society are presented. By establishing a conceptual model that emphasizes the role of perceived security and public value in enhancing the citizens' engagement with IOT services, the authors also discuss blockchain security enhancement solutions, summarizing the key points that can be used for developing various blockchain-based intelligent systems. Finally, the researchers conclude in Section 5 with potential future directions for the technology.

2. Materials and Methods

2.1. UTAUT and Blockchain Adoption

The authors developed a research model based on the Unified Theory of Acceptance and Use of Technology (UTAUT), one of the technology acceptance models [23]. The UTAUT has been used by many information success researchers in the past to pinpoint the factors that influence continuous usage behavior in EGS.

Our paper aims to discuss the successful elements of IOT-based smart technology innovations for citizens' continuous usage intention of IOT-based public services in emerging nations. The results of this study will aid the government in overcoming the socio-technical challenges of IOT-based public services' consequences in order to provide citizens with better e-services.

The government frequently brings up the Internet of Things (IOT) when discussing the potential uses of linked gadgets. If policymakers can convince citizens to participate in the discussion, governments are the best testing grounds for actual, practical, and useful IOT applications [24]. Understanding when and how these technologies will assist the government economically and socially is necessary in order to comprehend the significance of IOT in public services.

The actual benefit of the IOT for the public sector is the potential for data aggregation from several sources [25], allowing the government to gather information on citizens' living conditions. The Internet of Things (IOT) lends itself naturally to applications in smart buildings, smart transportation, and smart water management, as well as the capacity to monitor programs that can increase public safety. In densely populated cities, traffic congestion is a serious issue. IOT traffic applications have a lot of potential real-world solutions to this issue. Real-time data input is utilized by traffic signals to reduce traffic congestion [26].

Da Nang city's Internet of Things-based traffic initiative regulates traffic signals in accordance with traffic flow [27]. To gather, combine, and store traffic data, IOT frameworks employ traffic cameras and wireless networks. This information may be used to promptly solve various issues and accidents that cause traffic jams [28].

The Unified Theory of Acceptability and Use of Technology (UTAUT) is used to create the strongest link between the level of acceptance and ongoing use of the IOT by citizens [23]. It is now the most popular idea for determining whether new technology will succeed in terms of adoption and long-term usage intentions [29].

UTAUT has shown that it might be a valuable instrument for gauging the success and acceptability of new technologies such as the IOT because it is frequently used to assess the usage of information systems in public sector services within various geographic contexts. In order to acknowledge the high capacity of the UTAUT model in projecting the usage of the IOT, as well as its frequency of use in public sector research, we agreed to utilize the UTAUT model by expanding relevant variables in this study.

2.2. Data Collection

A questionnaire was designed to collect the data. Our questionnaire aimed to collect data to research the impact of the Internet of Things (IOT) in improving people's continuous usage intention of the IOT through blockchain adoption. A total of 1500 people were contacted by mail or phone and prompted to fill out the questionnaire. The final sample consisted of 1008 participants, eliminating unengaged respondents and questionnaires with missing values The participants were randomly chosen from a list on the Credamo platform (Credamo is a professional research and modelling integrated Chinese data platform). The Credamo platform is an online Chinese survey platform with more than 3 million registered participants. Data were collected from June to September 2022.

The construct was divided into:

Part 1: Sociodemographic (12 items)
Part 2: Information Privacy Value (4 items)
Part 3: Public Trust Value (4 items)
Part 4: Social Influence Value (4 items)
Part 5: Digital Society Affinity Value (4 items)
Part 6: Public Value (4 items)
Part 7: Continuous Usage Intention (4 items)
Part 8: Citizens Empowerment Value (4 items)
Part 9: Blockchain implementation impact (5 items)

A five-point Likert scale was used to measure the participants' opinions regarding the different variables under study: 1 (totally disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree), and 5 (strongly agree). For the purpose of this study, all the variables were carefully examined, tested, and studied using SmartPLS software to test the suggested partial least squares structural equation modelling (PLS-SEM) model and to analyze the impact of identified variables on the continuous usage intention.

2.3. Hypothesis Statements

2.3.1. Public Trust Value (PTV)

Public trust and acceptability in IOT services will be essential to create public value [30,31] as it enriches government performance [32]. Digital public sector platforms have entered many different cultures [33], and as diminished public trust eventually leads to diminished public perceptions of values, public trust values play a crucial part in the creation of a smart society. The likelihood of public trust is a valuable predictor of citizens' behavioral intention to utilize digital services [34]. According to Alshehri et al. [35], public trust is regarded as a potent construct in research studies on EGS and emphasizes the positive social interaction effect on citizens' propensity to utilize EGS. The acceptance of IOT services and their effective integration into digital societies depend on the general public's confidence in emerging technology.

H1a: *Public trust value (PTV) is a first-order dimension of the IOT.*

2.3.2. Social Influence Value (SIV)

Social influence presents a personal perception of some product or certain service that could be highly influenced by others' perceptions. The social influence could profoundly impact people's daily behavior, especially in technology adoption. According to the Unified Theory of Acceptance and Use of Technology (UTAUT), the social influence factor could impact consumer adoption of new technology. Some studies have shown that factors related to social influence could positively affect IOT technology adoption [36,37].

H1b: *Social influence value (SIV) is a first-order dimension of the IOT.*

2.3.3. Digital Social Affinity Value (DSAV)

Affinity was found to be a key factor influencing customers' probable usage intention in a study by Bigne et al. [38]. The current study explains digital society affinity as citizens' perceived importance of e-gov IOT services in the public sector. The word "affinity" describes how citizens views the importance of the media in their life [39]. It was created based on Rogers' [40] earlier concept of compatibility, which he described as "the extent to which a new idea is perceived to be compatible with prospective adopters' current beliefs, previous interactions, and needs." Governments all around the world are very concerned about how to incorporate public values into the technological and socioeconomic architecture of digital societies [33]. Affinity is defined in the current study as "the value or belief that people place on the digital society." Since it has the potential to be one of the most accurate metrics for the effectiveness of public sector IOT services in digital societies, the affinity with the digital society should be investigated.

H1c: *Digital social affinity value (DSAV) is a first-order dimension of the IOT.*

2.3.4. Public Value (PV)

Public value is the overall value created by the government for the people through various initiatives that involve the people in the value-generation process. Citizens' perceptions of the public benefit of using IOT services are implied when they think that IOT will significantly improve the effectiveness of public services. The perceived value of citizens against IOT utilization in the public sector will depend on how valuable and private they believe their information to be [41]. By boosting the effectiveness of IOT services, public trust enhances governmental performance [30,31], which may successfully result in the development of public value. According to a study of Harrison et al. [42], we have combined social influence with public worth. An individual's social identity qualities work together to form social influence, which has a substantial impact on how likely they are to use government services [42,43].

Previous research has demonstrated that some forms of public participation are more conducive to civic empowerment (i.e., public effect) than others, although agreement on these conclusions has been difficult to come by. According to Buckwalter [44], public participation is more conductive to public empowerment (i.e., public influence) and presents a special chance to enhance the way that citizens interact with the government.

According to Chatfield and Reddick [45], the IOT is a particularly popular feature in digital societies because it enables real-time sensing technologies that can unleash the potential of an intelligent government. AI and the IOT have the ability to offer beneficial public services in many different domains [46].

H1d: *Public value (PV) is a first-order dimension of the IOT.*

2.3.5. Citizen Empowerment Value (CEV)

Giving citizens participatory power in various areas of policymaking is what the concept of "citizen empowerment" is all about [47]. In addition, the ability of citizens to participate in developing IOT services for e-government is evaluated using this idea. Further, it would enable us to assess residents' ardent support for the development of citizen-centered service orientation [41,48]. The provision of communication tools, such as the internet, mobile applications, websites, and government portals, is not the sole factor in fostering citizen involvement. To citizens, civic culture continues to be a crucial component of the implementation of the participation process. Engaging citizens in the public policymaking process attempts to make a difference in society by fostering discussion and sharing individual opinions about public policy [49].

H1e: *Citizen empowerment value (CEV) is a first-order dimension of the IOT.*

2.3.6. Blockchain Applications

Blockchain applications play a vital role in numerous IOT-oriented applications, and IOT could utilize blockchain technology as a security solution to ensure the data's integrity [50,51]. Moreover, Blockchain application can enhance the usage of smart contract in insurance fields for instance or even during pandemics [52]. According to the study of Endale Mitiku Adere [53], the IOT is widely used, for instance, in smart home scenarios and the healthcare sector, and blockchain technology "reinforces IOT data's privacy, integrity, and security and improves the trust in transactions among untrusted IOT devices."

H2: *The IOT is expected to have a positive influence on blockchain adoption in smart cities.*

H3: *Blockchain adoption in smart cities is expected to have a positive influence on Continuous usage intention (CUI).*

H4: *The IOT is expected to have a positive influence on Continuous usage intention (CUI) through blockchain adoption in smart cities.*

2.4. The Conceptual Model

First, for the model, the IOT was taken as the independent variable, CUI was taken as the dependent variable, and blockchain adoption in smart cities was taken as the mediating variable.

Second, in the model, the IOT was taken as a high-order formative variable, and CUI and blockchain adoption in smart cities were taken as the reflexive variables. Therefore, for the formative variable IOT, five hypotheses, namely H1a to H1e, PTV, SIV, DSAV, PV, and CEV, the first-order dimensions of the IOT, were proposed to verify whether the IOT is a formative variable.

The proposed conceptual framework is presented in Figure 1 below:

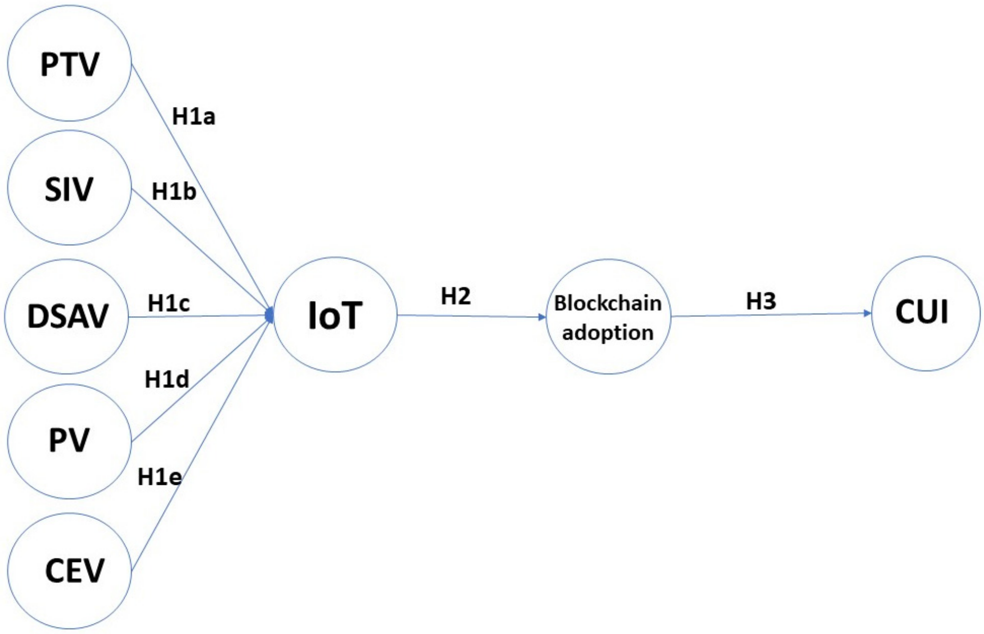

Figure 1. Conceptual Framework.

3. Results

3.1. Sample Characteristics or Sociodemographic

According to the sample of 1008 participants, 61.9% of participants were feminine, and 38.1% were masculine. Overall, 95% of the participants lived in urban areas of China. Most participants (78.17%) were educated with a bachelor's degree, and the majority (84.72%) were between the age of 18 and 39. The top three working fields of participants were manufacturing (18.45%), information and communication (15.97%), and education (11.31%).

3.2. Model Validation

3.2.1. Data Analysis Technique

This study used partial least squares (PLS) to estimate the proposed hypotheses. PLS is a multivariate approach adopted to assess the measurement scale's reliability and validity and estimate Structural Equation Models (SEM) [54]. PLS provides predictive tools to evaluate and validate exploratory models and efficiently estimates path models' coefficients characterized by small sample size [55]. PLS is an appropriate multivariate data technique due to its high capacity to achieve acceptable power at small sample sizes [56]. The path model in PLS has two components: a measurement model and a structural one. PLS enables the assessment of the reliability and validity of the constructs used and the estimation of the structural model path coefficients [54]. It uses bootstrapping, a resampling technique that generates a set of subsamples based on the original one, to calculate confidence intervals of the model parameters [55]. Smart-PLS 3 software with a bootstrapping of 5000 samples was used to conduct the statistical analysis [57].

Partial least squares structural equation modelling (PLS-SEM) is an alternative to the covariance-based structural equation modelling (CB-SEM) commonly used in Lisrel, AMOS, and EQS applications.

PLS-SEM is advocated when the research objective is to explore theoretical extensions of established theories, where latent variable models contain formative structures, and where sample sizes are relatively small but structural models are complex. It does not make distributional assumptions. It is argued that the highly statistical power of PLS-SEM enables better identification of the relationships between latent variables compared to CB-SEM [58].

3.2.2. Reflective Measurement Model Evaluation

The higher-order latent variable studied, the IOT, is a formative variable, and the underlying argument is that higher-order reflective variables are redundant [59]. It can be argued that the IOT should be considered as a formative variable using the decision rules developed by Jarvis et al. [60]. In this study, PTV, SIV, DSAV, PV, and CEV are the dimensions of the IOT. For example, changes in the structure (IOT) do not necessarily lead to changes in all structure dimensions.

The method for measuring relationship quality as a second-order formation variable in this study is that recommended by [61], namely the repeated indicator B model, in which all indicators of first-order variables used to form second-order variables are repeated as formation measures of second-order variables.

The validity and reliability of the measurement model for reflectively measured latent variables are examined first:

Assess internal consistency reliability using composite reliability (CR) scores. CR scores should exceed 0.6 for exploratory research, preferably 0.7 for established measurement scales [62]. Note that Hair et al. [58] recommend this as a better measure than Cronbach's Alpha (the alternative measure of internal consistency).

As for the Structural Model R2 Values, the R2 value is a measure of the model's predictive power in relation to endogenous variables (latent variables that are predicted by other latent variables). Values of 0.75, 0.5, and 0.25 can be described as substantial, moderate, or weak [58] From Table 1, it can be seen that substantial values were obtained, with CUI being slightly less than moderate.

Table 1. R2 in Structural Model.

	R Square	**R Square Adjusted**
Blockchain adoption in smart cities	0.549	0.549
CUI	0.423	0.423
IoT	0.990	0.990

Structural Model Effect Size f2 Values

The effect size metric indicates whether an exogenous (independent) latent variable has a significant effect on the R2 values of the model [62]. Values for f2 of 0.02, 0.15, and 0.35 are representative of small, medium, and large effects. The f2 values are summarized in Table 2 and small or greater effect sizes are highlighted in bold, showing the insignificant impact on R2 values and strongly corresponding to the insignificant paths identified above. Note that f2 values for formative variables should be ignored as formative variables have been fully explained previously.

Table 2. Structural Model Effect Size f2 Values.

Path	**f-Square**
IoT -> Blockchain adoption in smart cities	0.217
Blockchain adoption in smart cities -> CUI	0.734
CEV -> IoT	1.994
DSAV -> IoT	2.422
PTV -> IoT	2.335
PV -> IoT	3.036
SIV -> IoT	2.271

For Convergent Validity, the authors first looked at the outer loadings (known as indicator reliability) As a minimum, the outer loadings of all indicators should be statistically significant. In addition, the standardized outer loadings should be greater than 0.708. For "Formative Convergent Validity," the authors tested whether the formatively measured construct (IOT) is highly correlated with a reflective measure of the same construct using other measures. Ref. [58] stated that the strength of the path coefficient linking the two constructs is indicative of the validity of the designated set of formative indicators in tapping the construct of interest, such that the loading of the formative to the reflective construct is at least 0.7 and preferably > 0.80, which translates into an R^2 value of 0.64 (0.802 = 0.64)—or at least 0.50 (0.72 ≈ 0.50) [58]. Second, the authors looked at the Average Variance Extracted (AVE). AVE values should be greater 0.5 [58]. It can be seen that all variables in the measurement model have an AVE > 0.5.

The authors dropped several items that did not meet validity or reliability requirements. The table below shows scores for retained variables in terms of loadings, CR scores, and AVE scores. As can be seen from the Table 3, all the tests described in the methodology chapter regarding reliability and convergent validity were met (in particular, composite reliability scores all exceeded 0.7, and AVE scores all exceeded 0.5).

Table 3. Reliability and Convergent Validity of Reflective Measures.

Factor	Construct Items	Loading	*p* Values	CR	AVE
Public trust value (PTV)	Q2.2	0.778	0.000	0.817	0.598
	Q2.3	0.755	0.000		
	Q2.4	0.787	0.000		
Social influence value (SIV)	Q3.2	0.746	0.000	0.798	0.552
	Q3.3	0.750	0.000		
	Q3.4	0.764	0.000		
Digital social affinity value (DSAV)	Q4.1	0.815	0.000	0.843	0.642
	Q4.3	0.799	0.000		
	Q4.4	0.789	0.000		
Public Value (PV)	Q5.1	0.723	0.000	0.802	0.574
	Q5.2	0.744	0.000		
	Q5.4	0.804	0.000		
Citizen empowerment value (CEV)	Q8.1	0.786	0.000	0.820	0.603
	Q8.3	0.779	0.000		
	Q8.4	0.764	0.000		
Blockchain adoption in smart cities	Q7.1	0.784	0.000	0.833	0.625
	Q7.3	0.828	0.000		
	Q7.5	0.759	0.000		
Continuous usage intention (CUI)	Q6.1	0.755	0.000	0.786	0.551
	Q6.2	0.735	0.000		
	Q6.4	0.736	0.000		

Discriminant validity refers to the degree to which each latent construct is truly distinct from other constructs empirically, capturing phenomena or aspects of the model that are not captured by other constructs. Discriminant validity should be assessed using the HTMT criterion. HTMT values should all be below 0.9 [58]. Sometimes, for some variable pairs, the value may exceed 0.9. We can ignore any pairs, including a second-order formative variable [63]. We would deal with the problem by removing measures for variables in the remaining pairs which have weaker loadings [58] (or by changing the measurement model with new constructs [58]). Table 4 shows that the criteria are met.

Table 4. Discriminant Validity of Reflective Measures.

	Blockchain Adoption in Smart Cities	CEV	CUI	DSAV	IOT	PTV	PV
CEV	0.857						
CUI	0.209	0.382					
DSAV	0.899	0.463	0.866				
IOT	0.729	0.768	0.056	0.441			
PTV	0.850	0.633	0.670	0.815	0.343		
PV	0.651	0.560	0.150	0.884	0.791	0.578	
SIV	0.852	0.485	0.872	0.309	0.076	0.891	0.418

3.2.3. Formative Measurement Model Evaluation

For "Formative Convergent Validity," the authors tested whether the formatively measured construct (IOT) is highly correlated with a reflective measure of the same construct using other measures, such that the loading of the formative to the reflective construct is at least 0.7, and the R2 value of the reflective construct is at least 0.5, preferably >0.64. [58]. First, the authors looked at the outer loadings (known as indicator reliability) and added the adequate references as well. So, as a minimum, the outer loadings of all indicators should be statistically significant. In addition, the standardized outer loadings should be greater than 0.708 (generally, 0.70 is considered close enough to 0.708 to be acceptable) [58]. Ref. [58] stated that the rationale behind this rule can be understood in the context of the square of a standardized indicator's outer loading, referred to as the communality of an item. An established rule of thumb is that a latent variable should explain a substantial part of each indicator's variance, usually at least 50%; this means that an indicator's outer loading should be above 0.708 since that number squared (0.7082) equals 0.50 [58].

As illustrated in Figure 2 below, a minimum loading of 0.7 between the formative and reflective latent variables for the IOT was attained in accordance with Hair et al.'s [58] recommendations.

3.2.4. Structural Model Evaluation Results

The estimation results are presented in Figure 3. The estimation results of the path coefficients are shown in Table 4. The results show that PTV, SIV, DSAV, PV, and CEV had significant positive effects on the IOT and demonstrate that the IOT is a formative variable composed of them. This provides support for hypotheses H1a, H1b, H1c, H1d, and H1e.

Furthermore, Table 5 shows that the IOT has a significant positive effect on blockchain adoption in smart cities ($\beta = 0.741$, $p < 0.05$), and blockchain adoption in smart cities has a positive and significant effect on CUI ($\beta = 0.651$, $p < 0.05$). Hypotheses H2 and H3 are supported. Table 3 also shows that the IOT influences CUI through blockchain adoption in smart cities ($\beta = 0.482$, $p > 0.05$). Blockchain adoption in smart cities is assessed as mediating the influence of the IOT on CUI. H4 is supported.

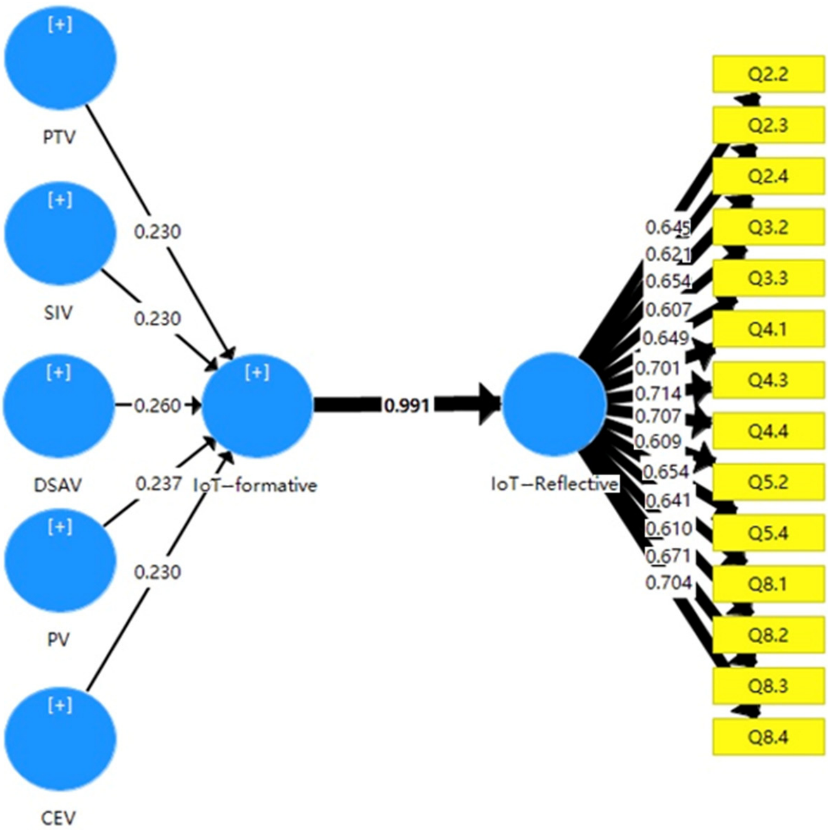

Figure 2. IOT Formative Convergent Validity.

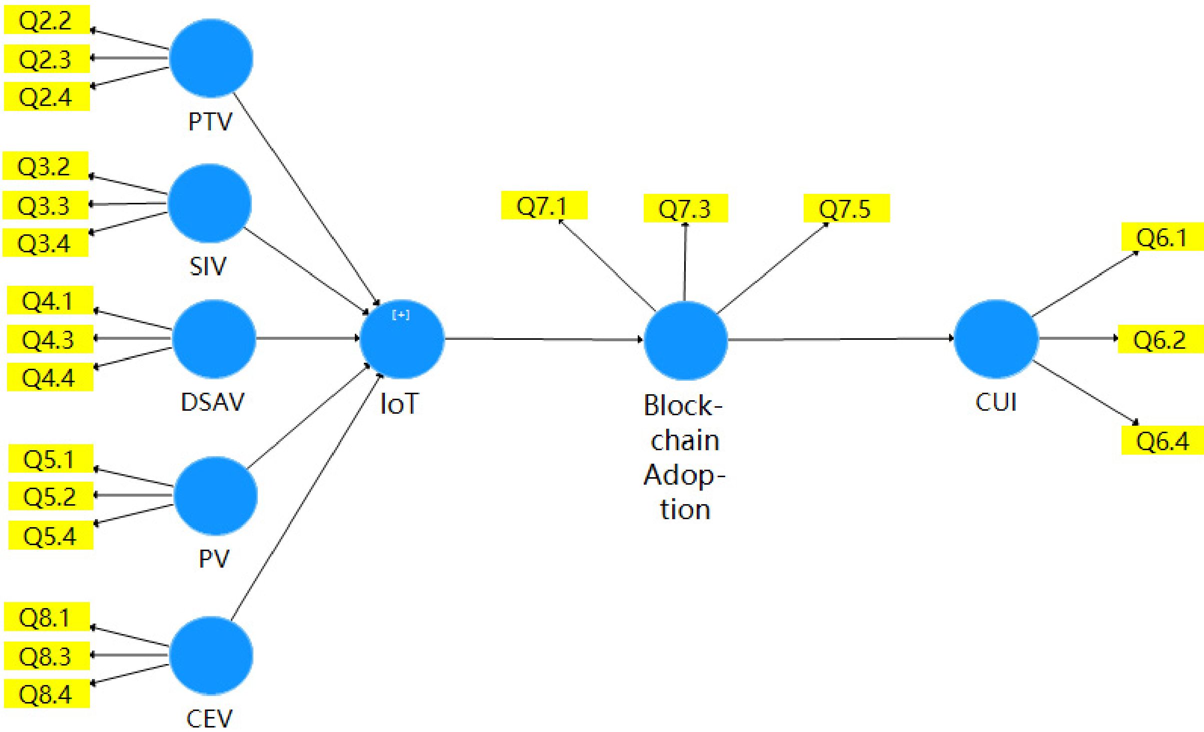

Figure 3. Estimation result.

Table 5. Structural Model Results.

Relationships	Hypothesis	Loading	Standard Deviation (STDEV)	*p* Value	Hypothesis Verification
PTV → IOT	H1a	0.222 ***	0.009	0.000	Supported
SIV → IOT	H1b	0.220 ***	0.009	0.000	Supported
DSAV → IOT	H1c	0.261 ***	0.012	0.000	Supported
PV → IOT	H1d	0.249 ***	0.011	0.000	Supported
CEV → IOT	H1e	0.231 ***	0.010	0.000	Supported
IOT → Blockchain adoption in smart cities	H2	0.741 ***	0.023	0.000	Supported
Blockchain adoption in smart cities → CUI	H3	0.651 ***	0.029	0.000	Supported
IOT → Blockchain adoption in smart cities → CUI	H4	0.482 ***	0.034	0.000	Supported

*** ($p < 0.001$).

The results of the mediating effect of each variable in the model through the other variables (individual paths). A mediating effect exists if the coefficient of the indirect effect is significant at $p < 0.05$. In particular, as shown in the Table 6, blockchain adoption in smart cities fully mediates the effect of the IOT on CUI.

Table 6. Mediation Analysis Results.

	Loading	Standard Deviation (STDEV)	T Statistics	*p* Values
CEV -> IOT -> Blockchain adoption in smart cities -> CUI	0.112 ***	0.007	16.826	0.000
DSAV -> IOT -> Blockchain adoption in smart cities -> CUI	0.126 ***	0.007	18.041	0.000
PTV -> IOT -> Blockchain adoption in smart cities -> CUI	0.107 ***	0.008	14.101	0.000
PV -> IOT -> Blockchain adoption in smart cities -> CUI	0.120 ***	0.012	10.220	0.000
SIV -> IOT -> Blockchain adoption in smart cities -> CUI	0.106 ***	0.008	13.402	0.000
IOT -> Blockchain adoption in smart cities -> CUI	0.482 ***	0.034	14.021	0.000

*** ($p < 0.001$).

4. Discussion

The Internet of Things (IOT) has arisen as a field with enormous potential influence with the development of smart networks such as smart homes and cities. According to the European Commission, it is expected that there will be between 50 billion and 100 billion devices connected to the Internet by 2020 [64]. First, IOT usage and its public nature raise some security and privacy issues. Integrity, confidentiality, location privacy, authentication, non-repudiation, confidentiality, anonymity, certificate revocation, and certificate verification are some of the difficulties that must be overcome.

According to questions related to social influence value, the authors found that (1) people with influential personality using IOT services will influence IOT services adoption; (2) IOT services adoption would help people feel accepted by the society; (3) peers' opinion is important to influence IOT services adoption.

Blockchain has contributed significantly to the effective improvement of connection through the IOT during the last few years. Blockchain technology confronts various technological obstacles, many of which are connected to security and privacy, trust, scalability, and commercial risks, even though it has enormous implications for future smart network settings. Numerous academics have concentrated on smart contracts' security issues, including those in Ethereum, bitcoin, and wallet contracts [65,66].

In addition, data may be gathered in real time from several different areas, simplifying the decision-making process [67,68]. This technology is becoming standard as time goes on, moving from being a premium feature. Every gadget will come with it pre-installed, and ultimately, people will feel pressured to acquire and incorporate it into their daily lives. Moreover, citizens will continue to use it, as found in this research, because they know the utility of blockchain implementation and its advantages.

On the security level, there are such a lot of unresolved problems and obstacles. Both physical presence and technology mechanisms and instruments are necessary for security, which might lessen the level of trust among users. Considering all the many people whose lives are influenced by technology as algorithms and AI are integrated into our daily lives, the mediating role of blockchain will increase their trust and reduce the perception of an unsecured environment, as shown in this paper, where most respondents are aware of the importance of technology, IOT in their e-services procedures, and blockchain adoption.

On a practical and empirical point of view, large corporations' security infrastructure may be strengthened with the help of the IOT and blockchain, as well as for data extraction and analysis. Open ledgers can enable the fault-proof integration of connected devices in smart networks with blockchain IOT solutions, removing problems such as data transparency and end-to-end process tracking, transaction automation and verification, real-time data exchange across the network, limitations of cloud-based IOT platforms (such as stress-free scalability), IOT data analytics, and network issues [69].

On the theoretical side, this model and the study's findings add to the literature already in existence [70,71] by developing a framework of IOT prolongation in public services and by effectively explaining the mediating effect of blockchain leading citizens' continuous usage behavior of the IOT in smart cities making them smarter.

It is essential to keep in mind that while many of the same security and privacy vulnerabilities still exist in today's smart cities, they do not happen as frequently as they do when these technologies are completely networked.

Stakeholders must work together to find solutions to the security and privacy problems smart cities confront to stop some issues from affecting the rest of the intelligent network. To help foster the development of the necessary smart technologies, ambitious security experts and smart city planners must take advantage of existing sustainable cities and initiatives. The current concerns and efforts to address these security difficulties and issues will determine the secure construction of the smart sustainable communities of the future. The usage of blockchain has a significant part in adding solutions to all these problems, and as seen in the research findings, the population perceived all blockchain technology to be advantageous.

According to the United Nations (UN), the rate of urbanization will surpass 60% in 2030. This development is the outcome of a change in living habits that makes it possible for many people to be more connected and knowledgeable. The perception of the space that enables people to appropriate the premises, particularly from a visual and auditory point of view, is a major factor in this phenomenon, which is where architects and urban planners come into play [71].

The area cannot be separated from its surroundings and can be impacted by them. This idea is true on a regional, national, and even worldwide level.

According to Galichet F. [72], the idea of security and trust is not only a concept that ensures both peace and the absence of crime, but it is also a condition of equilibrium in which a person may truly feel at peace with himself. In every aspect of a person's everyday existence, security is considered. Almost every element of life is impacted [73].

Axworthy L. [74] claimed that there are seven main components that make up human security: social security, individual security, national security, political security, environmental security, food security, and economic security. Layers of security are utilized to safeguard citizens and their possessions, which define human security.

Threats to security change with time and geography. New approaches to design, especially in the area of security, stimulate the designer to think differently. In addition to being regarded in terms of their security, incorporating new security technologies into daily life has altered how the world perceives trust and security [75].

Moreover, the power of AI has been extended into government services and city experiences to improve citizens' lives. Real-time data from connected devices, such as vehicles, for instance, in terms of position, speed, and acceleration, can reflect driving behavior and be useful in identifying aggressive driving.

Therefore, the increased advantages of the IOT through blockchain can be considered on different levels and have several implications in diverse sectors.

5. Conclusions

The challenges that the IOT faces in smart cities were covered in this paper, along with some possible blockchain-based solutions. Future IOT public services will need to be implemented more successfully and sustainably; hence, a framework for combining blockchain with the IOT was created based on the mediating role of blockchain in the conceptual model tested on Chinese citizens.

By strengthening the overlap between government and technology, an advancement and a new way of life will occur. Using IOT networks and sensors is a new approach to govern the physical world. Technology is a crucial instrument for improving the lives of individuals, and adding trust to its implementation and continuous usage through blockchain can add more advancement in the usage and application of e-services.

The smart city sector is transforming because of the convergence of blockchain and AI. Companies, governments, and even entire nations come together because of it. Due to its decentralized structure and peer-to-peer features, blockchain-AI technology is well known and highly regarded. By examining the numerous difficulties in various facets of sustainable smart cities, we explored the various security concerns and obstacles preventing blockchain-AI technology adoption in this study. Finally, we addressed some potential future paths for the technology, and we covered blockchain security solutions for smart cities.

The extraordinary rise of the Internet of Things (IOT) has created new opportunities for the community, including methods for accessing and exchanging information. However, a lack of confidence is one of these programs' most significant weaknesses. Due to flaws in the security and integrity of data transfers, businesses have encountered several difficulties adopting the IOT. This subject is unique because of all the characteristics mentioned above, making it innovative and worthy of this research. In addition, a return will be provided on the existing literature. Advancing co-design and systems engineering practices in smart cities in order to improve a prototype intelligent service system will not only be smarter but also kinder and more citizen-trust-centered.

The investigation of the advancing co-design and systems engineering practices in smart cities allowed us to:

- Evaluate the effectiveness of the new strategies aiming to ensure security in smart sustainable cities;
- Improve the safety of the individuals and their goods;
- Study the effect of environmental and lifestyle factors of the IOT and blockchain adoption;
- Determine the effects of the IOT in the society;
- Design and advocate for a more trusted Internet of Things to make cities and human settlements inclusive, safe, resilient, and sustainable.

6. Limitation and Future Work

This study suffers some limitations which can open the gate for a new stream of research. First, data and service security worries are becoming more prevalent. A person can suffer significant harm from even a small item that is lost, stolen, hacked, misplaced, or exposed. In future work, the authors will consider proposing a system based on the findings of [76] that successfully raises the cybersecurity of images against a variety of attacks in terms of robustness and efficacy in order to face and deactivate these issues when transmitting data in wireless broadcasting circumstances; this system will increase citizens' trust in the continuous usage of the IoT.

In addition, the Edge-Cloud architecture is made with dynamic properties and real-time reaction requirements in mind to achieve smart manufacturing by efficiently acquiring, processing, analyzing, and storing factory-generated data [77]. So, in order to increase smartness and efficiency, the authors aim to conduct another future study related to deep learning-based algorithm.

In line with the current study, it will be interesting to see how the introduction of certain disruptive changes, such as financial innovations, can change the traditional usage of public services or banking services in several countries [78]. It will also be interesting to increase the sample and include other less-developed countries to replicate the results and check whether differences exist. This study was conducted in the context of an emerging economy and was based on one country; this limits the capability to generalize the results to other countries, as the explanatory variables may vary across countries.

Moreover, this study adopted a quantitative approach. It would be interesting to add a qualitative approach to evaluate the real effect of the various factors included in the model on blockchain adoption in increasing the usage of the IOT.

Author Contributions: Conceptualization, N.M.B. and Q.X.; methodology, N.M.B., Q.X. and Y.X.; software, Y.X.; validation, N.M.B., Y.X. and Q.X.; formal analysis, Y.X.; investigation, Q.X.; resources, Q.X. and N.M.B.; data curation, Q.X.; writing—original draft preparation, N.M.B., Q.X., and Y.X.; writing—review and editing, N.M.B. and Q.X.; visualization, N.M.B. and Q.X.; supervision, N.M.B., Q.X. and Y.X.; project administration, N.M.B. and Q.X. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This research was implemented taking care to ensure all ethical standards and followed the guidelines of the Declaration of Helsinki. The development of the study by questionnaire survey was approved by the ethics committee of Saint Joseph University of Beirut (Reference No.USJ-2022-230).

Data Availability Statement: Data are available from the corresponding author upon request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. State Information Center; Smarter City Development and Research Center. China Smart City Long-Term Operation Research Report, 2021. Available online: https://urlzs.com/T6Vwh (accessed on 17 April 2022).
2. Dameri, R.P.; Benevolo, C.; Veglianti, E.; Li, Y. Understanding smart cities as a glocal strategy: A comparison between Italy and China. *Technol. Forecast. Soc. Chang.* **2018**, *142*, 26–41.
3. Kar, A.K.; Ilavarasan, V.; Gupta, M.P.; Janssen, M.; Kothari, R. Moving beyond Smart Cities: Digital Nations for Social Innovation & Sustainability. *Inf. Syst. Front.* **2019**, *21*, 495–501.
4. Benevolo, C.; Dameri, R.P.; D'auria, B. Smart Mobility in Smart City. In *Empowering Organizations*; Springer: Cham, Switzerland, 2016; Volume 11, pp. 13–28.
5. Guillemin, P.; Friess, P. Internet of Things Strategic Research Roadmap. The Cluster of European Research Project; Publisher: The Cluster of European Research Projects. Available online: https://www.semanticscholar.org/paper/Internet-of-Things-Strategic-Research-Roadmap-Vermesan-Friess/ff47de2d1b387f681bb452779c3de86faed31456 (accessed on 17 April 2022).
6. Eger, J.M. Smart growth, smart cities, and the crisis at the pump a worldwide phenomenon. *I-Ways. J. E-Gov. Policy Regul.* **2009**, *32*, 47–53.
7. Harrison, T.M.; Guerrero, S.; Burke, G.B.; Cook, M.; Cresswell, A.; Helbig, N.; Hrdinova, J.; Pardo, T. Open government and e-government: Democratic challenges from a public value perspective. *Inf. Polity* **2012**, *17*, 83–97. [CrossRef]
8. Barrionuevo, J.M.; Berrone, P.; Ricart, J.E. Smart cities, sustainable progress. *IESE Insight* **2012**, *14*, 50–57.
9. Bakıcı, T.; Almirall, E.; Wareham, J. A Smart City Initiative: The Case of Barcelona. *J. Knowl. Econ.* **2013**, *4*, 135–148.
10. Camero, A.; Alba, E. Smart City and information technology: A review. *Cities* **2019**, *93*, 84–94.
11. Ruhlandt, R.W.S. The governance of smart cities: A systematic literature review. *Cities* **2018**, *81*, 1–23.
12. Conoscenti, M.; Vetro, A.; Martin, J.C.D. Blockchain for the internet of things: A systematic literature review. In Proceeding of the 3rd International Conference on Computer Systems and Applications, Agadir, Morocco, 29 November–2 December 2016; pp. 1–6.

13. Jabbar, R.; Dhib, E.; Said, A.B.; Krichen, M.; Fetais, N.; Zaidan, E.; Barkaoui, K. Blockchain Technology for Intelligent Transportation Systems: A Systematic Literature Review. *IEEE Access* **2022**, *10*, 20995–21031. [CrossRef]
14. Mamoshina, P.; Ojomoko, L.; Yanovich, Y.; Ostrovski, A.; Botezatu, A.; Prikhodko, P.; Izumchenko, E.; Aliper, A.; Romantsov, K.; Zhebrak, A.; et al. Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. *Oncotarget* **2018**, *9*, 5665.
15. D'Orey, P.M.; Ferreira, M. ITS for Sustainable Mobility: A Survey on Applications and Impact Assessment Tools. *IEEE Trans. Intell. Transp. Syst.* **2013**, *15*, 477–493. [CrossRef]
16. Panarello, A.; Tapas, N.; Merlino, G.; Longo, F.; Puliafito, A. Blockchain and IoT Integration: A Systematic Survey. *Sensors* **2018**, *18*, 2575.
17. Boustani, N.M. Artificial intelligence impact on banks clients and employees in an Asian developing country. *J. Asia Bus. Stud.* **2021**, *16*, 267–278. [CrossRef]
18. Banerjee, M.; Lee, J.; Choo, K.-K.R. A blockchain future for internet of things security: A position paper. *Digit. Commun. Networks* **2018**, *4*, 149–160.
19. Halim, N.S.A.; Rahman, M.A.; Azad, S.; Kabir, M.N. Blockchain Security Hole: Issues and Solutions. In Proceedings of the International Conference of Reliable Information and Communication Technology, Johor Bahru, Malaysia, 23–24 April 2017; pp. 739–746.
20. Lord, R. Blockchain in Health Care: The good, the Bad and the Ugly. 2018. Available online: https://www.forbes.com/sites/forbestechcouncil/2018/04/13/Blockchain-in-health-care-thegood-the-bad-and-the-ugly/#4ce669f16278 (accessed on 17 April 2022).
21. Xu, R.; Nikouei, S.Y.; Nagothu, D.; Fitwi, A.; Chen, Y. BlendSPS: A BLockchain-ENabled Decentralized Smart Public Safety System. *Smart Cities* **2020**, *3*, 928–951. [CrossRef]
22. Alnahari, M.S.; Ariaratnam, S.T. The Application of Blockchain Technology to Smart City Infrastructure. *Smart Cities* **2022**, *5*, 979–993. [CrossRef]
23. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User Acceptance of Information Technology: Toward a Unified View. *MIS Q.* **2003**, *27*, 425–478. [CrossRef]
24. Prodanovic, K. The Public Sector Will Bring the IoT into the Mainstream, Truphone, 2019. Available online: https://medium.com/truphone/the-public-sector-will-bring-iot-into-the-mainstream-e6ddbf81d6a5 (accessed on 17 April 2022).
25. Chatterjee, S.; Kar, A.K.; Gupta, M. Success of IoT in Smart Cities of India: An empirical analysis. *Gov. Inf. Q.* **2018**, *35*, 349–361. [CrossRef]
26. Ismail, N. How IoT is Changing the Game in the Public Sector—Information Age. 2017. Available online: https://www.information-age.com/iot-changing-game-public-sector-123469870/ (accessed on 2 February 2020).
27. Kshetri, N. The economics of the Internet of Things in the Global South. *Third World Q.* **2016**, *38*, 311–339. [CrossRef]
28. Brooks, A. IoT Based Intelligent Traffic Management System for Smart City, 2019. Available online: https://www.iihglobal.com/blog/intelligent-traffic-management-system/ (accessed on 2 February 2020).
29. Venkatesh, V.Y.L.; Thong, J.; Xu, X. Consumer acceptance and use of information Technology: Extending the unified theory of acceptance and use of technology. *MIS Q.* **2012**, *36*, 157–178.
30. Chohan, S.R.; Hu, G.; Si, W.; Pasha, A.T. Synthesizing e-government maturity model: A public value paradigm towards digital Pakistan. *Transform. Gov. People Process Policy* **2020**, *14*, 495–522.
31. Chohan, S.R.; Hu, G. Success Factors Influencing Citizens' Adoption of IoT Service Orchestration for Public Value Creation in Smart Government. *IEEE Access* **2020**, *8*, 208427–208448. [CrossRef]
32. Mahmood, M.; Weerakkody, V.; Chen, W. The influence of transformed government on citizen trust: Insights from Bahrain. *Inf. Technol. Dev.* **2018**, *25*, 275–303. [CrossRef]
33. Van Dijck, J. Governing digital societies: Private platforms, public values. *Comput. Law Secur. Rev.* **2020**, *36*, 105377. [CrossRef]
34. Albesher, A.; Brooks, L. Trustworthiness as a source of long-term e-government adoption. In Proceedings of the Eighth Saudi Students Conference in the UK, London, UK, 31 January–1 February 2015; pp. 53–62. [CrossRef]
35. Alshehri, M.; Drew, S.; Alhussain, T.; Alghamdi, R. The effects of website quality on adoption of E-government service: An Empirical study applying UTAUT model using SEM, Australasian Conference On Information Systems. *arXiv* **2012**, arXiv:1211.2410.
36. AlHogail, A. Improving IoT Technology Adoption through Improving Consumer Trust. *Technologies* **2018**, *6*, 64. [CrossRef]
37. Gao, L.; Bai, X. A unified perspective on the factors influencing consumer acceptance of internet of things technology. *Asia Pac. J. Mark. Logist.* **2014**, *26*, 211–231.
38. Bigne, E.; Ruiz, C.; Sanz, S. Key drivers of mobile commerce adoption. An exploratory study of Spanish mobile users. *J. Theor. Appl. Electron. Commer. Res.* **2007**, *2*, 48–60.
39. Aldás-Manzano, J.; Ruiz-Mafé, C.; Sanz-Blas, S. Exploring individual personality factors as drivers of M-shopping acceptance. *Ind. Manag. Data Syst.* **2009**, *109*, 739–757. [CrossRef]
40. Rogers, E.M. *Diffusion of Innovations*; Free Press: New York, NY, USA, 1995.
41. El-Haddadeh, R.; Weerakkody, V.; Osmani, M.; Thakker, D.; Kapoor, K.K. Examining citizens' perceived value of internet of things technologies in facilitating public sector services engagement. *Gov. Inf. Q.* **2018**, *36*, 310–320. [CrossRef]
42. Harrison, C.; Eckman, B.; Hamilton, R.; Hartswick, P.; Kalagnanam, J.; Paraszczak, J.; Williams, P. Foundations for smarter cities. *IBM J. Res. Dev.* **2010**, *54*, 1–16.

43. Laila, A.-O.; Hosam, A.-S.; Ibrahim, A.A.; Nasser, A. Students' intention to adopt e-government learning services: A developing country perspective. *Libr. Hi Tech* **2020**, *39*, 308–334. [CrossRef]
44. Buckwalter, N.D. The Potential for Public Empowerment through Government-Organized Participation. *Public Adm. Rev.* **2014**, *74*, 573–584. [CrossRef]
45. Chatfield, A.T.; Reddick, C.G. A framework for Internet of Things-enabled smart government: A case of IoT cybersecurity policies and use cases in U.S. federal government. *Gov. Inf. Q.* **2019**, *36*, 346–357. [CrossRef]
46. Kankanhalli, A.; Charalabidis, Y.; Mellouli, S. IoT and AI for Smart Government: A Research Agenda. *Gov. Inf. Q.* **2019**, *36*, 304–309. [CrossRef]
47. Alshibly, H.; Aisbett, J.; Pires, G. A Characterisation of Consumer Empowerment Drawn from Three Views of Power. In *Developments in Marketing Science: Proceedings of the Academy of Marketing Science*; Springer: Berlin/Heidelberg, Germany, 2015; pp. 208–213. [CrossRef]
48. Giesbrecht, T.; Scholl, H.J.; Schwabe, G. Smart advisors in the front office: Designing employee-empowering and citizen-centric services. *Gov. Inf. Q.* **2016**, *33*, 669–684. [CrossRef]
49. Naranjo-Zolotov, M.; Oliveira, T.; Cruz-Jesus, F.; Martins, J.; Gonçalves, R.; Branco, F.; Xavier, N. Examining social capital and individual motivators to explain the adoption of online citizen participation. *Futur. Gener. Comput. Syst.* **2018**, *92*, 302–311.
50. Atlam, H.F.; Alenezi, A.; Alassafi, M.O.; Wills, G.B. Blockchain with internet of things: Benefits, challenges, and future directions. *Int. J. Intell. Syst. Appl.* **2018**, *10*, 40–48.
51. Minoli, D.; Occhiogrosso, B. Blockchain mechanisms for IoT security. *Internet Things* **2018**, *1–2*, 1–13. [CrossRef]
52. Boustani, N.M.; Elisabetta, M. Smart Insurance Contracts Shielding Pandemic Business Disruption in Developing Countries and Blockchain Solution. *FinTech* **2022**, *1*, 294–309. [CrossRef]
53. Adere, E.M. Blockchain in healthcare and IoT: A systematic literature review. *Array* **2022**, *14*, 100139. [CrossRef]
54. Hair, J.F.; Sarstedt, M.; Pieper, T.M.; Ringle, C.M. The Use of Partial Least Squares Structural Equation Modeling in Strategic Management Research: A Review of Past Practices and Recommendations for Future Applications. *Long Range Plan.* **2012**, *45*, 320–340.
55. Henseler, J.; Ringle, C.M.; Sinkovics, R.R. The Use of Partial Least Squares Path Modeling in International Marketing. In *New Challenges to International Marketing*; Sinkovics, R.R., Ghauri, P.N., Eds.; Emerald Group Publishing Limited: Bingley, UK, 2009; pp. 277–319.
56. Hair, J.F., Jr.; Sarstedt, M.; Hopkins, L.; Kuppelwieser, V.G. Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *Eur. Bus. Review* **2014**, *26*, 106–121.
57. Ringle, C.; Da Silva, D.; Bido, D. Structural equation modeling with the SmartPLS. Structural Equation Modeling with the Smartpls. *Braz. J. Mark.* **2015**, *13*, 56–73.
58. Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to use and how to report the results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24.
59. Lee, N.; Cadogan, J.W. Problems with formative and higher-order reflective variables. *J. Bus. Res.* **2013**, *66*, 242–247.
60. Jarvis, C.B.; MacKenzie, S.B.; Podsakoff, P.M. A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research. *J. Consum. Res.* **2003**, *30*, 199–218.
61. Becker, J.-M.; Klein, K.; Wetzels, M. Hierarchical latent variable models in PLS-SEM: Guidelines for using reflective-formative type models. *Long Range Plan.* **2012**, *45*, 359–394.
62. Hair, J.F., Jr.; Hult, G.T.M.; Ringle, C.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*; Sage Publications: New York, NY, USA, 2016.
63. Duarte, P.; Amaro, S. Methods for modelling reflective-formative second order constructs in pls: An application to online travel shopping. *J. Hosp. Tour. Technol.* **2018**, *9*, 295–313.
64. Sundmaeker, H.; Guillemin, P.; Friess, P.; Woelfflé, S. *Vision and Challenges for Realizing the Internet of Things*; European Commission: Brussels, Belgium, 2010.
65. Li, N.; Jain, J.J.; Busso, C. Modeling of driver behavior in real world scenarios using multiple noninvasive sensors. *IEEE Trans. Multimed.* **2013**, *15*, 1213–1225.
66. Zhang, F.; Cecchetti, E.; Croman, K.; Juels, A.; Shi, E. Town crier: An authenticated data feed for smart contracts. In Proceedings of the 2016 ACM sIGSAC Conference on Computer and Communications Security, Vienna, Austria, 24–28 October 2016; pp. 270–282.
67. Perera, C.; Zaslavsky, A.; Christen, P.; Georgakopoulos, D. *Sensing as a Service Model for Smart Cities Supported by Internet of Things*; Transactions on Emerging Telecommunications Technologies (ETT); Wiley: Hoboken, NJ, USA, 2013; Volume 25, pp. 81–93.
68. Zaslavsky, A.; Perera, C.; Georgakopoulos, D. Sensing as a service and big data. *arXiv* **2013**, arXiv:1301.0159.
69. Hong, J.; Wentao, L.; Shukuan, Z.; Yong, C. Technology standardization, competitive behavior, and 'enterprises' performance of innovation: A conceptual model. *Libr. Hi Tech* **2019**, *38*, 251–269. [CrossRef]
70. Ying, M.; Kang, P.; Chen, W.; Long, C.; Hui, S.; Dazhi, C. Artificial Intelligence powered Internet of Things and smart public service. *Libr. Hi Tech* **2019**, *38*, 165–179. [CrossRef]
71. Komninos, N. Intelligent City Strategies: Setting Global Innovation Environments. In *Intelligent Cities: Towards Interactive And Global Innovation Environments*; Inderscience: Geneva, Switzerland, 2009; pp. 343–347.
72. Galichet, F. *La sécurité, une Valeur Civique?* Éduquer: Digital Resources in the Humanities and Social Sciences: Paris, France, 2008; pp. 1–11. [CrossRef]

73. Ceyhan, A. *Analyser la Sécurité: Dillon, Waever, Williams et les Autres*; Cultures Et Conflits: Paris, France, 1998. [CrossRef]
74. Axworthy, L. *La Sécurité Humaine: La Sécurité Des Individus Dans Un Monde En Mutation*; Politique étrangère: Paris, France, 1999; Volume 64, pp. 33–42. [CrossRef]
75. Ceyhan, A. *Technologie et sécurité: Une Gouvernance libérale dans un Contexte d'incertitudes*; Cultures & Conflits: Paris, France, 2006; pp. 11–32. [CrossRef]
76. Wu, Y.; Zhang, L.; Berretti, S.; Wan, S. Medical Image Encryption by Content-aware DNA Computing for Secure Healthcare. *IEEE Trans. Ind. Inform.* **2022**, *19*, 2089–2098. [CrossRef]
77. Wu, Y.; Cao, H.; Yang, G.; Lu, T.; Wan, S. Digital Twin of Intelligent Small Surface Defect Detection with Cyber-Manufacturing Systems. *ACM Trans. Internet Technol.* **2022**. *accepted*. [CrossRef]
78. Boustani, N.M. Traditional Banks and Fintech: Survival, Future and Threats. In *ICT for an Inclusive World. Lecture Notes in Information Systems and Organisation*; Baghdadi, Y., Harfouche, A., Musso, M., Eds.; Springer: Cham, Switzerland, 2020; Volume 35. [CrossRef]