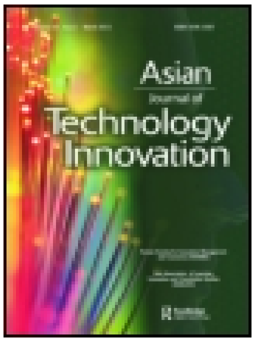

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Does IoT service orchestration in public services enrich the citizens' perceived value of digital society?

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ABSTRACT

The continuous growth of digital transformation aims to leverage the changes and opportunities for IoT technologies in public sector, which has created an impact on the sustainability of digital societies. The Internet of Things (IoT) contains significant challenges such as citizens' perceived value towards intention to use in public services that could stand in a way of realizing its potential benefits. Our study aims to investigate the influencing factors of citizens' usage intention concerning IoT service orchestration in public services along with the mediation influence of perceived value. A comprehensive public IoT Perceived Value Model (IoT-PVM) was enumerated to provide success factors for IoT service orchestration. This model was analytically tested by PLS-SEM approach. The results highlighted that perceived value has a mediation effect in IoT public service intentions to use with 59% perceived variance. The success of government IoT services is best measured by the perceptions of citizens, therefore, this study contributed to identifying the factors concerning public engagement with IoT service orchestration along with describing the positive role of digital society affinity. In terms of practical significance, a use case IoT model was presented with provides an intersectional perspective of citizens concerning IoT service orchestration in public services.

KEYWORDS
Internet of Things (IoT); public services; perceived value; digital society affinity; smart government

1. Introduction

As the public sector seeks to innovate, embrace emerging technologies, and embark on the technology journey, integration becomes the smart path to success. The increasing growth of information and communication technology (ICT) has motivated the government to present innovative technologies in public services (Bolívar & Manuel, 2016; Chohan & Hu, 2020a; Todisco et al., 2020). Digital online platforms have significantly penetrated every field of society (van Dijck, 2019) especially in digital initiatives of smart government, to develop innovative models of service distribution by integrating physical, digital, and

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public environment (Rochet & Correa, 2016; Scholl & Scholl, 2014). It is projected that 68% of the world population will live in urban areas (United Nations, 2018) in near future and this will need to advance urban management through ICT-enabled innovative services. Therefore, governments around the globe are in a quest to transform old traditional public service delivery mechanisms to modern technological public services.

Internet of Things (IoT) are the objects which combine advancement in sensing (Ang & Seng, 2019), can communicate with each other without human interference (Chatterjee et al., 2018), and are recently becoming highly important and ubiquitous. IoT service orchestration is a concept used to describe the convergence into a common service management network of separate systems, applications, and sensors (Ahmad & Kim, 2020; Nguyen et al., 2017). This orchestration of resources has the opportunity to align IoT with current business workflows and processes (Rafique et al., 2020) such as public services delivery systems (Chohan & Hu, 2020b). IoT has the potential to reduce the time and cost of human activities regarding public services management. The innovative field of IoT in public services will help the public administration to replace the traditional structures with IoT service orchestration (Wirtz et al., 2019). IoT service orchestration is being introduced all over the world to address some of the most important global problems. Despite of the perceived potential, smart government IoT service orchestration has little or no effect unless citizens continue to use such services (Chatterjee et al., 2018). IoT is becoming increasingly popular and affordable nowadays, which makes this technology extremely attractive for governments to encourage their citizens towards practicing IoT in public services (Kshetri, 2017).

The increasing interest of citizens in digitally transformed societies (Mergel et al., 2019) has enforced the state to ensure national digital initiatives aligned with new digital technologies (Hanna, 2018). The International Monitory Fund (IMF) recommends that economic growth in developing countries can be enhanced through the digital revolution (Mühleisen, 2018). The concept of public value was introduced by (Moore, 1997), which assumes that public sector organisations make decisions that create public value for citizens through the exponential technology change. The same as the literature of (Cook & Harrison, 2014; Cresswell, 2010) suggest that governments should design a conceptual schema for explaining the government activities in the context of ICT investments. New technological transformation is seen as a paradigm shift and often defined as a technology revolution (Perez, 2010). Innovative public sector technology developments are shifting citizens' perceptions of the capacity of governments to provide high-value digital services (Mergel et al., 2019). The IoT technologies provide people with opportunities to participate and engage more in different activities within society and the perceived importance of such technologies is yet to be appreciated by them (El-Haddadeh et al., 2019). IoT is also a significant technological foundation, providing a unique structure for government to interact with citizens (Guenduez et al., 2020) and in this way, it attempts to examine citizens perceived value concerning IoT service orchestration. These innovative activities have motivated to continue this study to investigate the influencing factors of citizens' usage intention concerning IoT service orchestration in public sector services along with the mediation influence of perceived value. Previous studies normally focus on the initial stages of IoT in public services (Chatterjee et al., 2018; Tang & Ho, 2019) or have discussed the major emphasis on the use of IoT in smart city perspectives (Almeida et al., 2018; Santos et al., 2018) but relatively very few studies are conducted in IoT public services perceived values and intention to use. To the best of our knowledge very limited studies are pursued in this context but no such study exists which mediates perceived value in citizens' usage intention. Therefore, our study objectives are:

1. To investigate the relative advantage and success factors of perceived value concerning IoT service orchestration in smart government.
2. To investigate the mediation of perceived value against the intention to use between public trust and digital social affinity.
3. To investigate the impact of digital society affinity and IoT service orchestration on digital society sustainability.

In quest of the research objectives, we have conducted a study on the conceptual phenomena of Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), and Theory of Planned Behaviour (TPB). The success of IoT service orchestration in the public sector requires the integration of citizens' trust (Bahutair et al., 2019; Nelson & Gorichanaz, 2019) and digital social affinity (Bigné et al., 2007; Manca et al., 2019). We have developed a conceptual model IoT-PVM after formulating the research hypotheses and it was subsequently tested through PLS-SEM. Our study finding contributes to the existing literature of (Chatfield & Reddick, 2019; El-Haddadeh et al., 2019; Kankanhalli et al., 2019; Tang & Ho, 2019) by developing a framework of IoT prolongation in the public sector by explaining the perceived value as a mediator to facilitate the citizens' intention to use. Furthermore, our study results provide insights and elucidate the mechanism through which IoT in the public sector affiliates the citizens' perceived value and intention to use.

2. Literature study

There are various conceptual studies regarding Information System (IS) success and adoption, i.e. IS success model (Delone & McLean, 2003), Technology Acceptance Model (TAM) (Davis, 1989) which was further modified as UTAUT (Venkatesh et al., 2003) and Theory of Reasoned Action (TRA) (Montano et al., 2008). These particular theories were adopted by many IS researchers in the context of citizens' intention to use public sector services (Alshehri et al., 2012; Chohan & Hu, 2020a; Hu et al., 2019; Liang et al., 2017). In this section, we provide an overview of the literature on smart government service, IoT service orchestration, digital society affinity, and public perceived value. Subsequently, we outline the hypotheses and develop the research model for this study.

2.1. Citizens perceived value concerning public services

The increasing digital public services and the use of ICT have changed the approach of citizens accessing public services (Hardill & O'Sullivan, 2018). The term smart government is generally conceptualised as the use of ICTs by the government to improve the mechanism of operations through the technological change process (Twizeyimana & Andersson, 2019). Additionally, the smart government helps to improve the quality and efficiency of government services while reducing the operational cost and increasing transparency, public trust, and public participation (Al-Mushayt, 2019). Electronic services strengthen the relationship between stakeholders (citizens) and innovators (government) escorting value to citizens and society (Ng et al., 2019). In marketing literature, the term 'perceived value' is used to highlight the significant perception of customers regarding the product or service (Salehzadeh & Pool, 2017). This study is adopting this notion as citizens' perceived value concerning smart government services. The question is how the service value is perceived or created by a citizen? To answer this question we have employed the concept of citizens' perceived value towards the IoT service orchestration in public services. The concept of public value was introduced by (Moore, 1997), which assumes that public sector organisations make decisions that create public value for citizens. The same as the literature of (Cook & Harrison, 2014; Cresswell, 2010) suggest that governments should design a conceptual schema for explaining the government activities in the context of ICT investments. Citizens' satisfaction is the key parameter for public service organisations when deploying IoT services and this will motivate the citizens to use such services. In a comprehensive literate study by (Twizeyimana & Andersson, 2019) three dimensions of the e-government services (EGS) public values were identified as depicted in Figure 1.

2.2. IoT service orchestration in public services

Internet of Things (IoT) is a ubiquitous network of interconnecting objects that can not only produce information from the environment (sensing) and but can also use prevailing internet standards to provide services along with the interaction to the physical world (Kim et al., 2017a). IoT interaction can be developed between people to people, people to

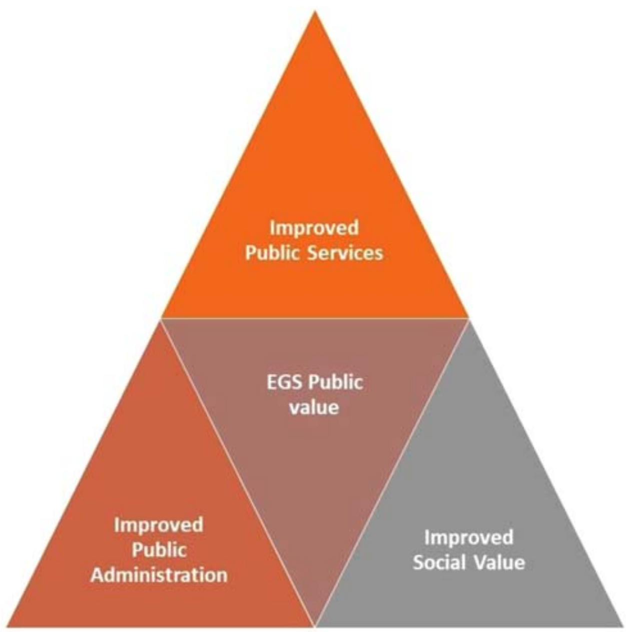

Figure 1. The EGS public value domains (Twizeyimana & Andersson, 2019).

things, and things to things (Chatterjee et al., 2018). Several IoT applications can be grouped into various public sectors services such as agriculture, health, traffic, and smart cities (Čolaković & adžialić, 2018). Some of the practical scenarios of IoT service orchestrations in the public sector are: collecting sensors data concerning IoT in public services, increase citizens' safety in mass transit inconsistencies, secure and responsive touchpoints to create trust and public engagement, real-time traffic status on road to reduce congestion in mass transit, improve surveillance and security with the help of controlled self-driven drones, innovative sector of IoT in waste management, IoT and big data have significantly influenced the public healthcare sector. In e-commerce intelligent logistics self-service applications systems powered by IoT and cloud platforms can provide government and individuals an improved, efficient, and intelligent delivery systems (Yang et al., 2017). To ensure the seamless integration and collaboration between IoT and public services the important challenge is the universal adoption of open standards (Mendhurwar & Mishra, 2019). Despite various challenges, the main benefit of IoT diffusion in public services remains normative and adoption of such services is continuing to emerge, therefore, governments need to embrace IoT technological development to realise its benefits in creating a public value paradigm.

2.3. IoT orchestration concerning digital society affinity

Societies around the globe are increasingly digitised and becoming an integral part of citizens' everyday life (Dufva & Dufva, 2019) such as cleaning robots, driverless cars, remote control aircraft, smartphones, and virtual reality, etc. Digital society is an information society dependent on the provision of information generated through the digital technologies deployed in a society (Berry, 2016). Affinity with digital society should be investigated and it can potentially become one of the most authentic rubrics for public sector innovative services. Digital platforms affinity has deeply penetrated society and they are transforming social and public practices (van Dijck, 2019). In the development and integration of digital societies, IoT is one of the key digital transformation technology. Governments around the globe are digitally transforming towards smart governments and offering new services that can enhance citizens' satisfaction (Al-Mushayt, 2019; Chatfield & Reddick, 2019). The ultimate goal is to maximise the benefits of IoT while minimising the risks, so the citizens' engagement, dialogue, and collaboration are required to plot the most effective outcome towards digital societies.

2.4. Limitations and challenges of the existing literature

IoT in public services is still in its early stages, therefore, there exist very few frameworks especially tailored for public perceived value. It is insufficient in the literature that how to incorporate public value thinking in the government decision-making process especially in the context of IoT service orchestration. Previous work on public sector ICT implementation suggests that the approaches introduced mostly fail to create substantial public sector value (Choung et al., 2016; Ebad, 2018). Although the value of IoT service orchestration in the public sector frequently seems apparent and the goal is to build social value, provide services and enhance citizens' quality of life through offering solutions that have a direct effect on citizens' perceived value. Many recent research studies on IoT include research challenges associated with technical research (Hussein, 2019; Stankovic, 2014) and business model research (Dijkman et al., 2015). In this scenario, very few studies accentuate citizens perspectives such as: in a study (Wirtz et al., 2019) examine relevant components of an integrative public IoT framework for smart government and in another study (Lee, 2019) that IoT-based services are used by the users and customers to improve their business operations and customer services. Similarly, a research study by (Nicolescu et al., 2018) discusses the concept of IoT value from three different perspectives of economic, technical, and social. Yet, this study has not emphasised the public value perspective. Analysing current IoT literature provides a very imbalanced and heterogeneous view of IoT in public services. The integrative IoT public perceived value contributes to the academic literature by providing theoretical insight into the citizens' intention to use and it also supports the government in designing an IoT service orchestration for the citizens.

3. Theoretical development and research hypotheses

In the subsequent section, we explain the attributes that contribute to public trust and digital society affinity. Furthermore, the IoT-perceived value model (IoT-PVM) was conceptualised based on public perceived value regarding the use of IoT services orchestration in the public sector.

3.1. Public trust to intensify the perceived value

Public trust in digital services is interrelated to the expectations about possible motives of the government in delivering IoT service orchestration. Public trust in emerging technologies is mandatory for IoT acceptability and successful integration in a digital society because without trust it is very challenging for society to accept the technology (Nelson & Gorichanaz, 2019). Performance expectancy is a degree of individual belief concerning IoT public service and it is also considered to be a key influencing factor of public acceptance and usage intentions (Hu et al., 2019). The individual citizens' adoption behaviour regarding smart government services is influenced by various factors and the most important factors are performance expectancy and trust (Liang et al., 2017). This is hypothesised as

> **H1a:** Performance expectancy of smart government IoT service orchestration will positively influence the public trust

Information privacy is considered another important aspect in smart government IoT services orchestration, which can be discussed as citizens' control over the information provided during the use of IoT service (Bahutair et al., 2019). Citizens are sometimes reluctant to provide personal information over the internet (Moqbel & Bartelt, 2015), and the same in the case of IoT where a host of convenient smart devices continuously gather, process, and send data to perform various services which have magnified the threat of information privacy. In a study of EIU, 92% of respondents consider information privacy concerns as the biggest challenge to adopt IoT services (Paul, 2018). Therefore, in the public sector innovative services, it is required to address information privacy concern, which is hypothesised as

H1b: Information privacy of smart government IoT service orchestration will positively influence the public trust

Trust in government is the degree to which a citizen perceives that government is trustworthy and generous (Tam, 2019). Trustworthiness is a substantial conception in digital government research, which has the power to influence the relationships between citizens and governments (Janssen et al., 2018). Trust in service providing agency is incorporated as trust in government which plays a critical role in the adoption of smart government services (Gupta et al., 2016). The preliminary condition of using smart government service is the trust in government (Ranaweera, 2016). Therefore, in the usage intentions behaviour of smart government IoT service orchestration, it is required to build trust in the service provider agency, which is hypothesised as

H1c: Trust in government addressing smart government IoT service orchestration will have a positive influence on public trust

The adoption of smart government IoT service mostly depends on the direct effect of IoT trust in the smart government service provider. The technological aspect is employed by information privacy attribute, which is often paired with information security and trust in IoT environment to cope with the cooperation and integration of the services (Si et al., 2019). A study (Mahmood et al., 2019) identified public trust as a major contributor to the success of smart government systems in digital societies. Online public sector platforms are deeply penetrated in a society (van Dijck, 2019) and loss in public trust ultimately results in the loss of smart government system perceived values, therefore, the public trust plays a very important role in the development of digital society affinity. The public trust in the sincerity of the government toward providing information, solving problems, and offering suggestions are very important. Therefore, constructs can thereby be hypothesised as follows:

H3: Public trust affects positively the perceived value of smart government IoT service orchestration

H6: Public trust affects positively digital society affinity concerning smart government IoT service orchestration

3.2. Digital society affinity to intensify the perceived value

The term affinity was conceptualised as the perceived importance of the medium in the life of an individual (Aldás-Manzano et al., 2009). In this study affinity is conceptualised as 'the degree of importance that citizens build on digital society'. In addition to components of information system success theory (Delone & McLean, 2003), affinity with digital society should be investigated and it can potentially become one of the most authentic rubrics for public sector services success in smart government. We have associated three constructs as social influence, citizens' empowerment, and facilitating conditions with digital society affinity. The social influence is related to the citizens that get influenced by other citizens in society and develop a negative or positive impact to use IoT services, it generally focuses on the citizens in a society affected by their peers' behaviour (Manca et al., 2019). It is considered to be a powerful construct in many types of research regarding smart government services (Alshehri et al., 2012), which highlights the positive social interaction influence on citizens' intentions to use smart government services. Another study by (Singh et al., 2020) explores social influence as one of the key factors influencing users' recommendation to use e-government mobile wallet services. Therefore the construct is hypothesised as

H2a: Citizens' social influence will positively affect the digital social affinity

The concept of empowerment deals with delivering the power in a specific domain to citizens by the government (Alshibly et al., 2015). It is a construct used to measure the perceived citizens' willingness to participate in the design process of smart government IoT service orchestration. It will also help us to measure the effective contribution of citizens in the development of citizen-centric service orientation (Giesbrecht et al., 2016). Citizens' empowerment processes for service development and delivery are essential as it will make such service inclusive and accessible by all segments in society including vulnerable groups (United Nations, 2014). Empowerment construct will be examined for its influence on digital society affinity to enrich the perceived value of smart government IoT service orchestration. We have hypothesised this construct as:

H2b: Citizens' empowerment will positively affect the digital social affinity

Another construct incorporated with digital society affinity is facilitating conditions which are elaborated in this study as citizens believe that proper administrative and technical infrastructure is present to support the services (Venkatesh et al., 2003). It is an important factor concerning our study and it represents that facilities should be available for citizens to use IoT services. Facilitating conditions represent a larger ecology than the public directly connected to participate in the system under consideration (Nuggehalli & Prokopy, 2009) and in our case the connected system is IoT. Facilitating conditions shows that whether the government and citizens have all facilities to use IoT service orchestration in smart government services and this factor directly affects the technological use behaviour intentions. The construct can thereby be hypothesised as follows:

H2c: Facilitating conditions will positively affect the digital social affinity

H4: Digital society affinity affects positively the perceived value of smart government IoT service orchestration

3.3. Perceived value to intensify citizens' IoT usage intentions

Perceived value concerning citizens' IoT usage intentions is implicated as citizens believe that smart government IoT service orchestration can make important contributions to improve the quality of public services. Various studies have contributed to the aspects of perceived value in terms of customer loyalty in repurchase intentions (Floh et al., 2014; Yang & Jolly, 2009). User perceived value is strongly influenced by perceived usefulness and information security (Wang, 2014), this can be incorporated into smart government IoT service orchestration perceived value where citizens intention to use may be increased. IoT technologies offer opportunities for citizens to engage more in different activities within their communities (El-Haddadeh et al., 2019). This will provide a new vision that enriches the scope of smart government IoT technology acceptance research. Therefore, it is reasonable to suggest that citizens perceive IoT service orchestration provides a high value to them and continuance intentions towards the usage of such services will be enhanced. It has been hypothesised as follows:

H5: Perceived value will have a positive influence on citizens' intention to use smart government IoT enabled services in the public sector

3.4. Digital society affinity to intensify citizens' IoT usage behaviour

In addition to components of IS success theory (Delone & McLean, 2003) affinity with digital society should be investigated and it can potentially become one of the most authentic rubrics for public sector innovative services in smart government. It was investigated in the study of (Bigné et al., 2007) that affinity is an important factor influencing consumers' future use intentions. In this current study, digital society affinity is conceptualised as citizens' perceived importance of IoT service orchestration in the public sector. IoT is ubiquitous in digital societies (Chatfield & Reddick, 2019), it enables real-time sensing capabilities which can unlock the potential of smart government. IoT and AI can develop valuable public services in various domains (Kankanhalli et al., 2019). The scope of user (citizen) engagement towards new products can lead to new ventures in the market (society) (Zhang et al., 2018). Digital social affinity will affect the citizens' perception of the importance of smart government IoT service orchestration, therefore, we propose the following hypotheses:

H7: Digital society affinity will have a positive influence on citizens' intention to use IoT services

3.5. IoT-PVM conceptual model

Previous researches explain the citizens' behaviour towards the use of smart government services (AlAwadhi & Morris, 2008; Carter & Bélanger, 2005; Mahadeo, 2009) and limited studies explains citizens service usage intentions of new technology especially in public services (Liang et al., 2017; Mahadeo, 2009). Generally, the perceived value was used to explain the citizens' intention to use new technology in information system research but to the best of our knowledge very limited studies are pursued in this context of mediating perceived value in citizens' intention to use. To fill this gap, this study incorporates the social, technological, personal, and contextual attributes influencing citizens' usage behaviours to conceptualise the IoT-PVM. The role of perceived value in the intention to use is important to understand, therefore perceived value is used as a mediator in our study. Figure 2 represents the proposed conceptual model (IoT-PVM).

4. Research methodology

This study is based upon the deductive approach of moving from a general level to a specific one. This approach starts with the theories of whatever phenomenon emerge in the previous studies leading to research hypotheses and thereafter endorsing or rejecting the hypotheses (Azungah, 2018; Collis & Hussey, 2014). We followed the deductive approach that starts with the theory leading to research hypotheses and subsequently

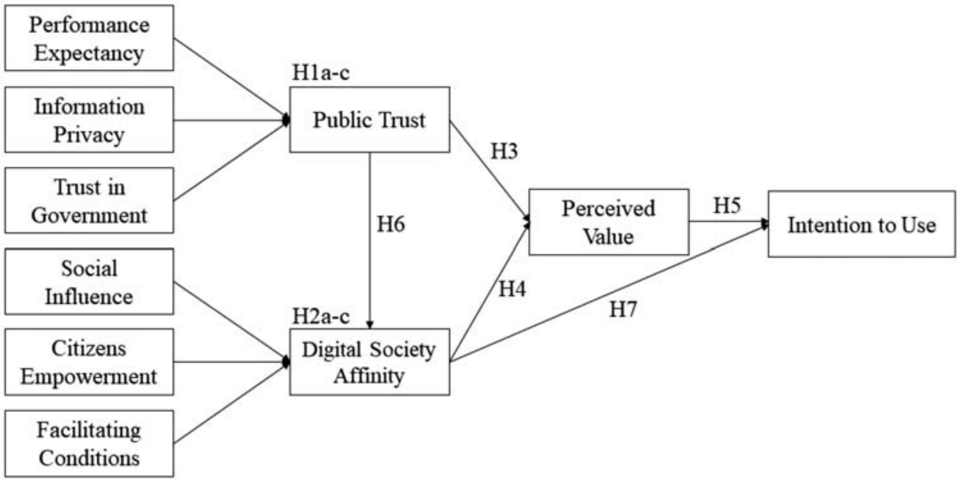

Figure 2. The conceptual IoT perceived value model (IoT-PVM).

accepting or rejecting the hypotheses (El-Haddadeh et al., 2019). The content validity of this study was satisfied by adapting constructs and measurement items from the previous researches. All the items were measured by using a five-point Likert scale, with the anchor being '1=strongly disagree and 5=strongly agree'. Experts from the e-government and ICT industry were requested to evaluate the significance of each construct and measurement item. We have revised the questionnaire statements suggested by the experts before conducting the pilot group study to ensure the content and convergent validity. A pilot study was conducted to ensure the reliability and validity of the survey items, Cronbach's α was calculated as 0.802 in the pilot group study implying the reliability of the measurement tool. Construct validity was evaluated by using factor analysis, and all the items loaded on their expected constructs.

4.1. Sample population

In this research study, we have targeted citizens from Pakistan who has experienced the use of IoT technologies in their daily life. The demand for IoT products increasing at an exponential rate and developing countries like Pakistan have an opportunity to capitalise on this growing trend. In the quest for reliable data, we needed our sample group to understand the concepts of e-government and IoT services. Younger citizens are the target sample population for this study as many e-government research highlights that the young population not only shows a high rate of internet use (Warkentin et al., 2018) and is more likely to actively use technology and social media (Spada et al., 2016). The non-probabilistic purposive sampling method was used to gather data. The minimum acceptable sample size is $50 + 8k$ where k is the prediction variable (Jacob et al., 2013), in this particular study there are 8 variables, so the minimum sample size was at least 114. A total of 421 responses were received at a success rate of 81.52%. A preliminary data analysis was carried out after gathering the data to search for any missing data, indecisive responses, and deviation. The questionnaire was sent twice with the same

IP address or finished within a limited amount of time or the same score was considered on all items that were excluded from the study. As a result, 380 responses were considered valid for further analysis. We have used chi-square tests to examine the nonresponse bias, in which the demographic characteristics are used to conduct the test, which has resulted in no significant difference. The sample description for the study is depicted in Table 1.

4.2. Descriptive statistics

Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Table 2 shows the standard deviation, mean, min, and max values of the dataset (N = 380). The mean score for all items of the constructs is greater than the neutral point (np = 3) (El-Haddadeh et al., 2019; Ning & Khuntia, 2019; Xie et al., 2019) which notes that the respondents agreed mainly with the items. This is depicted in Figure 3.

5. Research analysis

Currently, there are numerous modern statistical research methods available and they are also enriched with sophisticated multivariate methods, e.g. structural equation model (SEM) (Goggins & Xing, 2016). Due to the predictive nature of the research study, we have used PLS-SEM to test the structural model using SmartPLS.

5.1. Construct reliability and validity

We used Exploratory Factor Analysis (EFA) to measure the construct validity. KMO and Bartlett's Test is used to check the construct validity (Kaiser, 1970; McDonald, 1981). The average estimated KMO value is 0.772 which is well above the threshold value of 0.6 representing the feasibility of factors. The chi-square value is above 6812 showing the significance at $p < 0.001$. Then, Confirmatory Factor Analysis (CFA) method was used to perform structure validity analysis. To measure the construct internal consistency reliability, we used Cronbach's α and composite reliability with a threshold value

Table 1. Respondents samples description.

Sample description	Categories	N	%	Acc. %
Gender	Male	201	52.89	52.89
	Female	179	47.11	100
Age	<21	134	35.26	35.26
	21–30	126	33.16	68.42
	31–40	89	23.42	91.84
	>40	31	8.16	100
Educational level	Undergraduate	159	41.84	41.84
	Postgraduate	221	58.16	100
Experience with smart government system	<1 Year	114	30.00	30.00
	2–4 Years	194	51.05	81.05
	5 or above years	72	18.95	100
Smart government and IoT knowledge	Yes	337	88.68	88.68
	Average	37	9.74	98.42
	No	6	1.58	100

Table 2. Samples descriptive statistics (N = 380).

Items	Mean	Std. D	Min	Max	Items	Mean	Std. D	Min	Max
PE1	3.70	1.11	2	5	CE1	3.01	1.10	1	4
PE2	3.67	1.10	1	5	CE2	3.09	1.07	1	5
PE3	3.82	1.25	1	5	CE3	3.15	1.12	1	5
IP1	3.90	1.23	1	5	PV1	3.62	1.11	1	5
IP2	3.74	1.16	1	5	PV2	3.76	1.10	1	5
IP3	3.57	1.28	1	5	PV3	3.51	1.25	1	5
IP4	3.76	1.28	1	5	PV4	3.46	1.23	1	5
DSA1	3.75	1.32	1	5	PT1	3.71	1.08	1	5
DSA2	3.81	1.28	2	5	PT2	3.73	1.25	1	5
DSA3	3.57	1.28	1	5	PT3	3.46	1.19	1	5
GT1	3.54	1.32	1	5	PT4	3.59	1.16	1	5
GT2	3.47	1.16	1	5	FC1	3.83	1.28	1	5
GT3	3.52	1.13	1	5	FC2	3.65	1.38	1	5
SI1	3.59	1.25	1	5	FC3	3.46	1.32	1	5
SI2	3.82	1.32	1	5	IU1	3.51	1.11	1	5
SI3	3.55	1.28	1	5	IU2	3.57	1.10	1	5
SI4	3.65	1.28	2	5	IU3	3.81	1.25	1	5
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>0.70 (McDonald & Ho, 2002). The convergent validity is tested as the average variance extract with a recommended value >0.50 (Sam et al., 2020). Table 3 represents the results.

5.2. Confirmatory factor analysis

As suggested in various studies (Albino et al., 2015; Hair et al., 2006), the measurement model was tested using CFA. In this study, we have used seven goodness of fit indicators. The model fit indices of measurement model results are shown in Table 4. In the second step, we have validated the CFA results through convergent and discriminant validity. We have compared the square roots of AVEs with the correlations among the constructs and found that more variance was shared between the construct and its indicators than with other constructs (Fornell & Larcker, 1981). The results are tabulated in Table 5 with a significant level of discriminant validity.

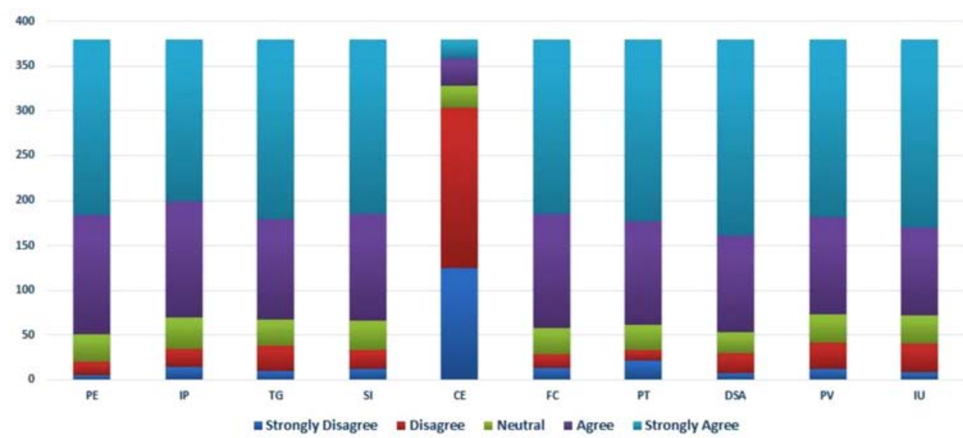

Figure 3. Respondents level of agreement.

Table 3. Reliability and validity test.

Constructs	CBα	CR	AVE	KMO
Performance Expectancy (PE)	0.812	0.902	0.893	0.811
Information Privacy (IP)	0.720	0.864	0.808	0.813
Trust in Government (TG)	0.798	0.779	0.890	0.781
Social Influence (SI)	0.832	0.875	0.806	0.767
Citizens Empowerment (CE)	0.846	0.888	0.883	0.742
Facilitating Conditions (FC)	0.904	0.811	0.827	0.812
Public Trust (PT)	0.921	0.784	0.813	0.826
Digital Society Affinity (DSA)	0.875	0.873	0.847	0.711
Perceived Value (PV)	0.911	0.856	0.828	0.738
Intention to Use (IU)	0.892	0.823	0.834	0.718

CBα = Cronbach's α; CR = Composite Reliability; AVE = Average Variance Extract; KMO = Kaiser-Meyer-Olkin.

5.3. Structural model testing

Structural model testing is used to measure the variables that create a construct and the relationship between these constructs (Morin et al., 2013; van den Boer et al., 2017). The structural model was tested using absolute, incremental, and simple fitness tests. The fitness measures and fit indices indicate that the structural model exhibited adequately fits towards the observed data and that is tabulated in Table 6.

After establishing the goodness of fit for the structural model, the eleven research hypotheses are tested using the bootstrapping technique by analysing the path significance of each relationship. The path coefficient (β) along with the amount of variance (Warkentin et al., 2018), the critical ratio (t-value) and p-value with a standardised estimate value of >1.96 and <0.05 respectively are tested to check a significant relationship of (β) at 5% error probability. The path analysis results supported all hypotheses except H2b, which is not supported as the t-statistics and p-value are below the standardised estimate value. The conceptual IoT-PVM results revealed that IoT intention to use can be predicted as $R^2 = 0.612$. Additionally, the results verified that public trust, digital society affinity, and perceived value can be determined by the IoT-PVM with a variance of $R^2 = 0.567$, $R^2 = 0.512$, and $R^2 = 0.597$ respectively. The test results are summarised in Table 7.

The path coefficient between PE to PT is ($\beta = 0.113$, $p < 0.018$), IP to PT is ($\beta = 0.221$, $p < 0.000$), and TG to PT is ($\beta = 0.301$, $p < 0.010$) which support out a hypothesis as H1a, H1b, and H1c respectively. The PV is significantly affected by PT ($\beta = 0.351$, $p < 0.000$) which explained 56% of PT variance, therefore H3 is supported; furthermore, H5 is supported as PV to IU is ($\beta = 0.362$, $p < 0.001$) which explained 59% of PV variance. Then the path coefficient between SI to DSA is ($\beta = 0.242$, $p < 0.010$) and FC to DSA is ($\beta = 0.318$, $p < 0.012$) satisfying H2a and H2c respectively, the path coefficient between CE to DSA is ($\beta = 0.046$, $p < 0.092$), which is failed and H2b is not supported. The PV

Table 4. Measurmeent model fitness test results.

	Absolute fitness			Incremental fitness			Simple fitness
Fit Indices	*RMSEA*	$P\chi^2$	*GFI*	*TLI*	*CFI*	*IFI*	χ^2/df
Reference values	<0.80	>0.05	>0.8	>0.8	>0.9	>0.8	1–2
Test values	0.61	0.029	0.83	0.926	0.95	0.941	1.74

Table 5. Convergent and discriminant validity.

	PE	PT	IU	SI	DSA	FC	IP	CE	PV	GT
PE	**0.844**									
PT	0.393	**0.837**								
IU	0.304	0.636	**0.816**							
SI	0.259	0.184	0.223	**0.852**						
DSA	0.328	0.352	0.367	0.626	**0.791**					
FC	0.412	0.623	0.621	0.541	0.322	**0.723**				
IP	0.207	0.403	0.243	0.582	0.412	0.603	**0.803**			
CE	−0.167	0.363	0.432	0.436	0.352	0.498	0.508	**0.794**		
PV	−0.491	0.696	0.732	0.324	0.511	0.546	0.551	0.412	**0.871**	
GT	0.249	0.268	0.234	0.472	−0.321	0.499	0.48	0.436	0.324	**0.784**

is significantly affected by DSA ($\beta = 0.301$, $p < 0.005$) which explains the 51% of DSA variance along with supporting H4. Finally, DSA to IU is ($\beta = 0.117$, $p < 0.007$) and PT to DSA is ($\beta = 0.235$, $p < 0.001$), hence supporting H7 and H6 respectively. The study results of the conceptual model using SmartPLS is presented in Figure 4.

6. Results and discussion

The citizens' post-adoption behaviour has been one of the most interesting research topics in the information systems domain. The originality of IoT is especially apparent when one realises that there has been hardly any specific model available which mediates public perceived value between public trust and intention to use. Previous studies normally focus on the initial stages of IoT in public services (Chatterjee et al., 2018; Tang & Ho, 2019) or have discussed the major emphasis on the use of IoT in smart city perspectives (Almeida et al., 2018; Santos et al., 2018) but relatively very few studies are conducted in IoT public services perceived values and intention to use. To fill this research gap, we aim to investigate the influencing factors of citizens' intention to use IoT service orchestration in public services along with the mediation influence of perceived value. This empirical study results reveal that perceived value can play a major role in affecting citizens' decision towards intention to use IoT service orchestration. It also explains that public trust and digital society affinity influence citizens' perceived value, which in return will eventually influence the IoT services intention. Additionally, digital society affinity significantly and directly affects intention to use IoT service orchestration in public sector services. IoT service orchestration enhanced by the innovation process must meet the expectations of the new wave of citizens that cannot separate their daily activities from the use of smart technologies. The proposed IoT-PVM provides public perceived value on IoT especially in context of creating and delivering value through IoT service orchestrations and this could raise the public perceived value creation process of government services.

Table 6. Structural model fitness test results.

	Absolute fitness			Incremental fitness			Simple fitness
Fit Indices	*RMSEA*	*P*χ^2	*GFI*	*TLI*	*CFI*	*IFI*	χ^2/df
Reference values	<0.80	>0.05	>0.8	>0.8	>0.9	>0.8	1–2
Test values	0.64	0.023	0.83	0.932	0.943	0.944	1.732

Table 7. Path analysis and hypothesis testing.

Hypothesis	Path	Path coefficient (β)	t-statistics	*p*-value	Test Result
H1a	PE → PT	0.113	2.268	0.018	Supported
H1b	IP → PT	0.221	2.403	0.000	Supported
H1c	TG → PT	0.310	8.900	0.010	Supported
H3	PT → PV	0.351	5.665	0.000	Supported
H6	PT → DSA	0.235	4.468	0.001	Supported
H2a	SI → DSA	0.242	4.785	0.010	Supported
H2b	CE → DSA	0.046	1.391	0.092	Not Supported
H2c	FC → DSA	0.318	2.403	0.012	Supported
H4	DSA → PV	0.301	5.536	0.005	Supported
H5	PV → IU	0.362	8.901	<0.001	Supported
H7	DSA → IU	0.117	5.545	0.007	Supported

According to our research objectives, we have investigated the key factors which might influence the perceived value of IoT service orchestration in the public sector, i.e. performance expectancy, information privacy and trust in government are factors that create public trust, which was hypothesised as H1(a-c). The results show a significant relation to our hypotheses and are consistent with the previous studies of (Bahutair et al., 2019; Liang et al., 2017; Ranaweera, 2016; Tam, 2019). These factors are considered important to create public trust concerning IoT public services. Trust is related to citizens' perception that smart government services increase their sense of belongingness with the government and improve their influence and contingency powers. The other factors were social influence, citizens' empowerment, and facilitating conditions which can influence the digital society affinity. They were hypothesised as H2(a-c). The results of H2a and H2c are significant, however, the results of H2b ($\beta = 0.046$, $p < 0.092$) is not significant. The CE → DSA insignificance might have occurred because IoT service orchestration in public services is still in the introductory stages. The population of the targeted segment area is still not involved in the participatory process of such services. Moreover, the

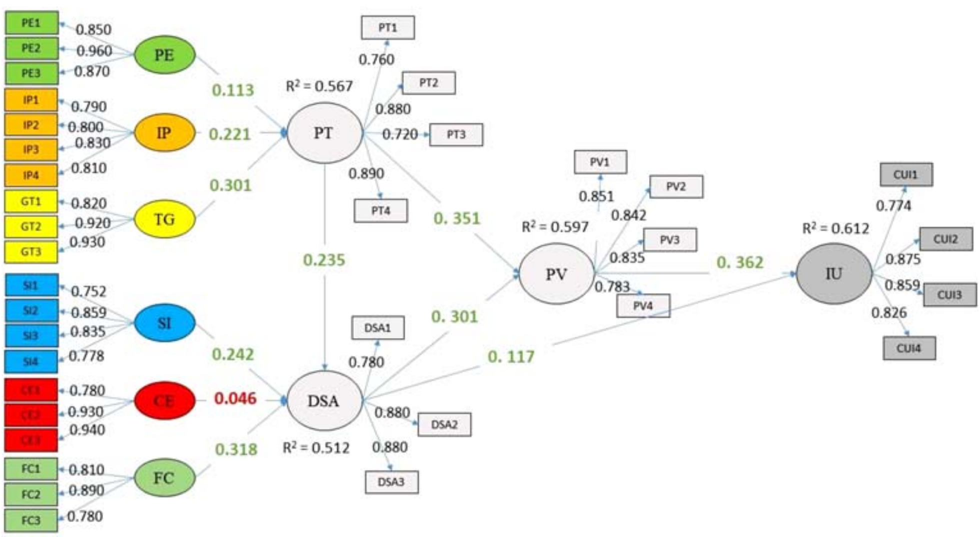

Figure 4. PLS-SEM result of conceptual IoT-PVM.

public IoT service orchestration still faces the problem of the regulatory bottleneck (Kim & Kim, 2016) which can be a hurdle to citizens empowerment.

The mediation of perceived value in the relationship between public trust and digital social affinity towards intention to use was empirically evidenced by the significant results of H3, H4, and H5. Furthermore, results highlight that perceived value provided a considerable amount of explanatory power as 59% on the intention to use. The public trust had a stronger relationship with the perceived value which implies that stronger trust in smart government services will create the more perceived value of such services, which is consistent with the studies of (Bahutair et al., 2019; Mahmood et al., 2019). The impact of digital society affinity on IoT usage intention was hypothesised as H7 and its result was significant as ($\beta = 0.117$, $p < 0.007$) which implies that digital society affinity is an important factor influencing citizens' future use intention. In this current study, digital society affinity is conceptualised as citizens' perceived importance of smart government IoT service orchestration, which is ubiquitous in digital societies (Chatfield & Reddick, 2019). Summarising the discussion, the digital transformation of public services with the use of IoT service orchestration helps citizens to interact with government efficiently and study results demonstrate new insights on understanding the citizens' attractions to adopt an IoT service orchestration lays at one's feet by the government. Based on the study observation, it can also be implied that citizens are currently the users of public IoT service orchestration and still they are not the active member for public value co-creation, therefore, participation and collaboration between government-citizens must be meaningful, citizens' inputs as visible stakeholder and ample government feedback requires to create public perceived value towards IoT service usage intention.

A preliminary study was conducted to validate IoT-PVM by ICT officials in Pakistan, during the study officials have given positive feedback. It is important to mention that the purpose of the preliminary study was to validate IoT-PVM and receive feedback rather not to get the official statements and validation scores. The primary objectives of the preliminary study were to (1) validate the model and its linked paradigms in a controlled environment (2) test the applicability of IoT-PVM in public agencies. A sample of six diverse public agencies was selected based on their core public sector services and ICT innovations in such services. The key domain areas were based on management capabilities, i.e. ICT, operational and human resources. We invited a minimum of one representative from said management areas to participate in the preliminary study. During the study period, four workshops were organised for each agency to incorporate IoT-PVM and to gather their feedback. During the workshop, the participants validate the model constructs and their capacity to generate citizens' perceived value and intention to use. Moreover, a scale of 1–5 was defined for each variable in the model. Collectively 82% relevance level was measured by participants and based on the feedback. We have generated the IoT government-citizens use case diagram, which is presented in Figure 5. In the course of the preliminary study and validation process, we have come up with an IoT value loop process as discussed by the expert in connection to conceptual IoT-PVM, which is graphically presented in Figure 6.

7. Conclusion

The main objective of this study was to investigate the mediation of perceived value in the relationship between public trust and digital social affinity along with the identification of

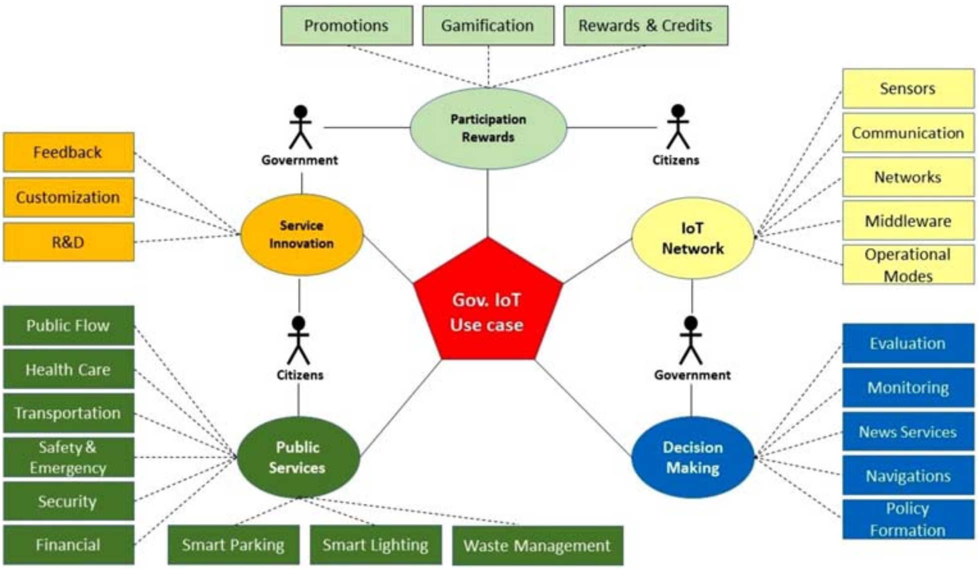

Figure 5. An IoT in public services use case.

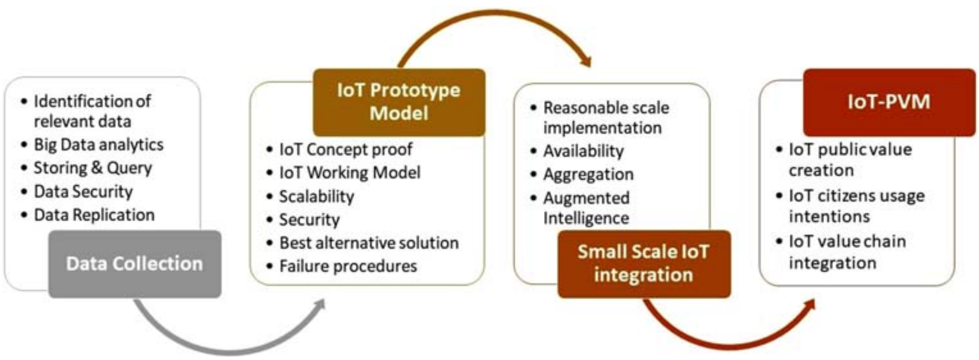

Figure 6. The IoT-PVM value loop.

success factors of IoT service perceived value towards citizens' intention to use. Under the existing literature, we have derived a conceptual model IoT-PVM for examining the IoT service orchestration in public sector services and to investigate the mediation of perceived value in the relationship between public trust and digital social affinity on citizens' intention to use. The data of 380 citizens have gathered from users of IoT and e-government public services in Pakistan and was analysed by PLS-SEM. The results revealed and predicted significant factors which influence the IoT service orchestration success in smart government. IoT orchestration in the private sector has already proven sustainable sensing and connectivity interface and this can also become an efficient tool in public services to address the citizens' demand. Our conceptual model (IoT-PVM) sustain to identify the factors perceived to interpret the citizens' intention to use the IoT technology in public services. The results also determine that perceived value act as a significant mediator in IoT service intention to use while public trust and digital society affinity work as a moderator in citizens' intention to use public services. The model has explained 56.7% variance in public trust, 51.2% in digital society affinity, 59.7% in perceived value, and 61.2% in intention to use IoT service orchestration. Citizens' should be made aware of the potential benefits of using IoT service orchestration which helps to implement smart government. To conclude, the results of this empirical work highlight the significant positive influence on the citizens' intention to use. Successful implementation of IoT in the public sector is innovative, user-oriented, and well-founded, contributing to societal benefit and public value creation.

This study's limitations specify possible routes for future research. First, our study considered perceived value as a single construct due to value-based adoption model for IoT service orchestration (Kim et al., 2017b), however, it can be further divided into intrinsic and extrinsic value creation. Therefore, in future research, we will examine the multi-dimensional aspects of perceived value. Second, the survey respondents were from Pakistan only, this may limit the rationalisation of the results. Therefore, in future studies survey will be conducted from other countries to perform cross nations comparisons. Third, this empirical analysis is dependent on the limited number of survey respondents, although, we have tried to minimise the potential bias by expert opinions and field experience. Four, the explained variance in perceived value is 59%, which shows that other factors should be included in future studies to make more generalised findings. Five, this study does not provide details on the effects of intermediary factors such as age, education, gender, and internet knowledge on the overall model. Therefore in the future study, it can be further elongated to study the role of intermediary variables. Six, the IoT initiative in public services is deeply related to a huge amount of data generation, therefore it is not free from security vulnerabilities, but in this study, we have not discussed this area and left for future research. It is expected that future research will further improve the model by performing various operations such as addition, elimination, or modifications in the constructs with the context of throwing light on the literature of citizens' perceived value and intention to use.

8. Research contributions

Our research study makes numerous contributions to the research both in theoretical and managerial perspectives. The IoT service orchestration in public services is still in its infancy, therefore requires further research both in qualitative and quantitative scenarios. However, this study built some conceptual and managerial spadework as described in the subsequent section.

8.1. Theoretical contributions

This research study has responded to the call for literature enhancement in the field of smart government initiatives (Gil-Garcia & Flores-Zúñiga, 2020; Janssen et al., 2009; Ndou, 2004; Ng et al., 2019) and the citizens' usage intentions to adopt IoT service orchestration (Bhattacharya et al., 2017; Čolaković & adžialić, 2018; Kankanhalli et al., 2019). To ensure the success of IoT in the public sector along with framing the constructs we have taken help from UTAT and TPB by adding another construct as digital society affinity (Aldás-Manzano et al., 2009). The provided conceptual model (IoT-PVM) has behaved as expected as it has enriched the literature for IoT service orchestration in the public sector. The IoT-PVM model is shaped implicitly by combining the meta-analysis and SEM as suggested in a study by (Dwivedi et al., 2019). The study contributed theoretically and stressed the value of citizens understanding the benefits of how IoT would make a meaningful contribution to enhance their behaviour and social perceptions. To enrich the adequacy, acceptability, and theoretical aspect of this study we have used the perceived value of IoT as a construct in the proposed IoT-PVM because in Pakistan IoT service orchestration has yet not been comprehensively used in public services. Another theoretical strength of the IoT-PVM conceptual model is to treat the perceived value as a mediator between digital society affinity and intention to use which examines the perception of IoT service orchestration in citizens' intention to use public services in the digital society. The results also provide impressive support for the development of the IoT-PVM value loop based on the idea of a quality value loyalty chain (Parasuraman & Grewal, 2000). In terms of the digital society concept, our work strengthens the previous findings of (Dufva & Dufva, 2019; Kim et al., 2017a) that the significance of IoT in public services explores a more dynamic viewpoint to empower citizens' to engage in a digital society. Ensuring privacy for building public trust (Wirtz et al., 2019) is closely connected with creating public value and therefore essential requirement for adopting IoT services in the public sector. Finally, the IoT-PVM serves as a guideline for a qualitative research approach to gain a more precise vision and that is essential for the emerging field of IoT service orchestration in the public sector.

8.2. Managerial contributions

Our study also provides insights to the smart government practitioners on guidelines to facilitate the citizens with IoT service. The administration of digital societies in Pakistan can be achieved by making significant efforts at all levels from the national government to local government. First, IoT service orchestration in Pakistan should meet the citizens' needs and enrich the relative advantage of public services by providing G-Cloud to integrate different databases and to provide a resilient and secure IoT environment to the citizens. Second, governments in the emergent economies such as Pakistan usually engage in creating collaborative and regulatory policies for digital government, therefore the government in Pakistan should accelerate the adoption of IoT by including open standards efforts, targeted federal funding, and impactful public-private partnerships. Therefore, this research study will help them to understand the factors which support the creation of IoT services intention among citizens. Third, the incorporation of public values in digital societies like Pakistan, the technical and socio-economic design is an immediate challenge that cannot be left to private business alone rather can be incorporated through a public-private partnership. Fourth, in the context of the digital Pakistan initiative (GOP, 2018) our study will act as a thought-provoking factor for the IoT services policy-makers to develop inclusive policies comprising the citizens' centric perspectives to ensure success and to increase citizens' perceived value towards intention to use.

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Appendix. Survey questionnaire

Respondents general information

XXXXXXXXXXXXX-XXXXXXXXXXXXXXXXX-XXXXXXXXXXXX

Measurement scale

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Please tick (✓) your answer as per your degree of acceptance in front of each question.

General Themes	Descriptive Statements	1	2	3	4	5
Facilitating conditions	I have the resources necessary to use IoT system					
	It would be helpful to use IoT services if support services is available (In case of difficulty)					
	I have enough skills and knowledge to use IoT services					

(*Continued*)

Continued.

General Themes	Descriptive Statements	1	2	3	4	5
Social influence	Citizens who can influence my behaviour think that I should use the IoT system					
	People who have influence on my behaviour, their adoption of IoT services will compel me to use these services					
	Use of IoT services would make me feel accepted by the society in order to increase my self-esteem					
	People whose opinion are important to me would like the influence the IoT services usage					
Behavioural intention	I intend to use the IoT system immediately as deployed by the government					
	I intend to continue using IoT services to interacting with public sector services rather than discontinue their usage practices.					
	I would be willing to continue IoT public services to improve digital society integrations					
	I predict that I would use IoT public services given that I have access to it.					
Performance expectancy	Using IoT system enables me to accomplish tasks more quickly					
	IoT public services save time to access e-government services					
	Using IoT services increases the quality of my service level at minimal efforts					
Information privacy	IoT service providers should take vigilant steps to ensure my personal information on their systems					
	IoT service providers should not use my personal information not specifically authorised by me					
	I think sharing my personal information with other services facilitators would lead to many uncertainties					
	IoT service providers should not sell my personal information to other companies for marketing, publicity, etc.					
Trust in Government	IoT services offered by government is reliable and dependable					
	I think government has the capacity to respond and solve the crisis in IoT systems (if generated)					
	I can trust services offered by government in context to my previous experience with digital/smart/e-government services					
Citizens Empowerment	I feel motivated to actively use IoT services when interacting with public sector services					
	The government should empower public participation process by using various motivational techniques					
	Using IoT services gives me a feeling of accomplishment					
Digital Society Affinity	IoT would gain me social recognition and acceptance in digital society					
	I cannot go for several days without using IoT service, if IoT is integrated with public services					
	IoT would help me leave citizens with a positive impression in a society					
Perceived value	The real time usage of IoT devices will help to reduce my efforts and will be valuable to me					
	Using IoT is an effective way of interact with the e-services offered by government					
	This IoT system will increases my benefits related to public services					
	I find following the IoT helpful for obtaining solution for specific e-gov related problems					
Public Trust	I think trust is a significant factor in IoT system success which influence the relationships between me and government					
	IoT services will protect my privacy concerns					
	The reputation of the agency managing the IoT services will enhance/ develop my trust on IoT services					
	I think government is responsive/sincere in term of IoT services policy making process					

It is requested to just answer the questions according to your understanding, we just want to understand your thinking in this regards. Nothing will be treated as wrong in this idea sharing concepts.

1. What are your understanding of IoT in public services?
2. What are your concerns or fears (if any), about the use of IoT devices in public services?
3. What is your general idea about the use of e-government services in Pakistan? (Positive or Negative)