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IoT (Internet of Things) Based Smart City Services for the Creative Economy

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Abstract – With the Internet of Things (IoT), you'll be able to connect almost anything to the rest of the internet. It includes a wide range of hardware and software stacks as well as other technologies. An IoT ecosystem relies on data, people, devices, and communication. Because of India's low level of technology penetration, an effective architecture for IoT must be built on current technological breakthroughs, capabilities that give an inexpensive and long-term solution, as well as entrepreneurial and social value. This is especially important for India. For every nation's future growth, it's critical to have a smart city. In order for the Indian government to provide a wide range of services to its people, IoT plays a critical role. Many heterogeneous and homogeneous systems may connect openly and effortlessly while having selective access to data for the construction of different digital services will be conceivable. The Internet of Things (IoT) is a technology aimed at facilitating the "creative economy." In order to create smart cities, the federal government and several municipal governments are ready to make investments in the IoT sector.

Key Words – Digital India; Internet of Things; Smart Cities; Smart Healthcare; Smart Energy and Smart Infrastructure.

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INTRODUCTION

There is nothing new about the idea of the Internet of Things (also known as IoT in the industry lingo). When British inventor Kevin Ashton originally used the term in 1999 to describe a system in which the Internet is connected to the real world by sensors [2, these sensors have a function in collecting data] and delivering it through networks to servers, he coined the term "Internet of Things." Since he predicted the impact of Internet-connected gadgets on our life back then, which is today a reality rather than science fiction. Automobiles are now ubiquitously connected to the Internet via GPS terminals onboard, as are other pieces of industrial or agricultural equipment that can be controlled remotely via the Internet, such as drones and even refrigerators and washing machines (the fact that smart phones are now in everyone's pocket is the best evidence of the growth of this IT industry segment). It is estimated that by 2025, there will be 75.44 billion pieces of linked devices on the planet.

IoT is already being prepared for use by countries such as the United States, China, and South Korea. India isn't going to let itself fall behind the times. Because it will be an officially funded programme, the Internet of Things (IoT) is primed to take off in India, where the federal government wants to provide INR 48,000 crores in funding over the next five years and to build up 100 smart cities throughout the country. Because the Internet of Things (IoT) and smart cities are relatively new concepts, there isn't a lot of literature on the issue currently. Companies like CISCO, IBM and others have given solutions to make IoT a feasible choice for contemporary cities with the goal of increasing quality of life, Boulos and Al Shobraji note.

Smart City Implementation Models based on IoT

Many local governments have recently aimed to establish an IoT-based smart city via the creation of a test bed for IoT verification and an integrated infrastructure based on IoTs. Additionally, this trend is in line with the Korean government's push for a more innovative economy. IoT-based smart city implementation methods that local governments might use are discussed in detail in this chapter.

Figure 1: Smart City Implementation

LITERATURE REVIEW

A. Manimuthu, V. Dharshini, I. Zografopoulos, and others (2017), Using intelligent technology, cities are becoming more beautiful and efficient in every way. Existing agile city ecosystems are revolutionized while efficiently meeting consumers and residents' expectations by innovations in information and communication technologies (ICTs) and the spread of big data, internet of things (IoT), and cloud (BIC) infrastructures. Using contactless technologies, we examine the technology-driven applications that may have an impact on municipal infrastructures already in place throughout the city's transition to smart cities. Using BIC as a platform for contactless applications, we show applications, design concepts, technical standards, and cost-effective methodologies. We also cover user interfaces for smart city settings. Furthermore, we talk about cutting-edge sensing techniques and smart city characteristics that enable smart contactless cities. An example of how BIC might help in an emergency circumstance like the COVID-19 pandemic is shown in a case study.

Liu Q. et al. (2017), Wireless and sensor networks, information science, and human–computer interactions are all advancing at a fast pace, and smart cities are following suit. With urban computing, such technologies may be integrated to enhance urban people' quality of life, including health care, urban planning, and energy. The urban heat island in the greater Washington, DC region is used as an illustration of how cloud computing, mobile computing, and edge computing can assist smart cities. Using cloud, mobile, and edge computing to solve the issues posed by urban heat island spatiotemporal dynamics, such as increased emissions of air pollutants and greenhouse gases, reduced human health and comfort, and poor water quality, is discussed in this paper. The integration of the three computing technologies is explored in order to develop a better computer infrastructure supporting smart cities overall. Network access optimization, service quality and convergence, and data integrity and security are all explored as part of the integration.

Ismagilova et. al. (2018) Researchers from the universities of Eastern Europe and the United States have collaborated to produce an article, Designers, integrators, and organisations tasked with managing these new entities face substantial political, technological, and economical hurdles as a result of smart cities' complexity and interdependence. Study after study emphasizes how important it is for smart cities to protect its residents' data privacy and security, as well as how difficult it is to store and handle all of that data. Many of these issues are examined in this paper, which provides a helpful synthesis of pertinent important works and establishes a framework for smart city interaction. Several key themes in smart cities research are addressed in the study: privacy and security of mobile devices and services; smart city infrastructure, power systems and healthcare; frameworks and algorithms to improve security and privacy; operational threats to smart cities; use and adoption of smart services by citizens; blockchain; and social media. For academics and practitioners alike, the study's results may serve as a useful framework and point of departure for future research.

C. Perera, ch. Liu, and s. jaywardena in 2015 found that Devices that are linked to the Internet, such as radio frequency identifications, sensors, actuators, and other instruments and smart appliances, are part of the Internet of Things (IoT), which is an ever-changing global information network. Large firms, academic research institutions (such as universities), and private and public research groups have all made significant progress in developing and commercializing IoT solutions during the previous decade. More than a hundred IoT smart solutions are surveyed and examined in depth in this study in order to determine the technologies employed capabilities and applications that are available in the marketplace today. We categories and discuss these solutions into five groups based on the application domains they are used in: (from top to bottom) Smart wearable, (home), (city), (city environment), (environment), and (business) These results will be used to inform future IoT research and development, as well as to stimulate and inspire more efforts. A comprehensive review of previous research is also provided, as as suggestions for new paths for future study.

D. Minoli, K. Sohraby & B. Occhiogrosso, (2017) Smart cities, smart grids, smart homes, physical security, e-health, asset management, and logistics are among the numerous areas where the Internet of Things (IoT) is making an impact. To give an example, the concept of smart cities is gaining traction across the globe, with cities implementing smart city technologies such as integrated street lighting controls, infrastructure monitoring, public safety/surveillance systems, physical security, and gunshot detection/detection/meter reading. Support for IoT-enabled smart buildings is a closely linked and cost-effective IoT application at the user level. Comfy, usable, secure, and energy-efficient commercial space are all top priorities. These criteria may be organically supported by IoT-based solutions. IoT-based solutions like power over Ethernet have the potential to revolutionise how a wide range of devices are connected inside a building. IoT use is being hampered by many deployment-restraining difficulties, including the absence of complete end-to-end standards, fragmented cybersecurity solutions, and a paucity of fully-developed vertical applications. Using IoT in smart buildings presents a number of technological possibilities and obstacles. This article examines some of them.

RESEARCH METHODOLOGY

Methods of Data Collection

84 Indian executives on the job completed a questionnaire. Companies are going forward with IoT implementation, and workers are extensively engaged in such transformation efforts, thus this is the favoured category of respondents for this kind of inquiry. More than one major research study has consistently shown the Internet of Things to be the next major technological breakthrough after the Internet age.

Primary and Secondary Data

In order to acquire relevant data for the study paper's main goals, the questionnaire was carefully created and conducted. The main data was gathered using the convenience sampling technique. Secondary data was gathered from a variety of sources, including journal articles, books, and conference proceedings.

Data Analysis and Interpretation:

Tools The main research data was analysed using IBM SPSS and Microsoft Excel 2013. The following details were gathered for the investigation: –

- **Dependent Variable:**

IoT based Smart City Solution Adoption Likelihood

- **Independent Variables:**

IoT Drivers: Government IoT Policy, Information Security and Device and Sensor Interoperability, IoT Revenue Model and Hardware Cost and Reliability IoT Advantages: Parking and Traffic Management, Energy Management, Air Quality and Noise Management, Health Care and Citizen Safety Management and Information Accessibility

- **Demographic Variables:**

Age, Qualification, Gender and Income

- **Alpha Value:**

5% [0.05] Confidence Level: 95% [0.95]

KEY RESEARCH OBJECTIVES

- In-depth research on the IoT development in India's smart cities
- Examine the influence of Indian government IoT policy on the possibility of IoT based smart cities' adoption
- Determine whether or not the benefits of IoT-based smart cities will be adopted in India.
- Find out whether IoT-based smart cities are valuable to Indian corporations and how easy they are to utilise.
- Find more about the demographics of Indians that favour smart cities built on IoT.

Hypothesis # 1: In India, government IoT policy plays an important role in the adoption of IoT based smart city solution

Hypothesis # 2: In India, strong revenue model affects adoption of IoT based smart city solution significantly

Hypothesis # 3: In India, information security affects adoption of IoT based smart city solution significantly

Hypothesis # 4: In India, hardware cost and reliability affects adoption of IoT based smart city solution significantly

Hypothesis # 5: In India, device and sensor interoperability affects adoption of IoT based smart city solution significantly

Hypothesis # 6: In India, strong relationship exists between key independent variables listed above and dependent variable.

		IoT_SmartCity_Adoption	Govt_IoT_Policy
IoT_SmartCity_Adoption	Pearson Correlation	1	.571**
	Sig. [2-tailed]		.000
	N	84	84
Govt_IoT_Policy	Pearson Correlation	.571**	1
	Sig. [2-tailed]	.000	
	N	84	84

		IoT_SmartCity_Adoption	IoT_Revenue_Model
IoT_SmartCity_Adoption	Pearson Correlation	1	.824**
	Sig. [2-tailed]		.000
	N	84	84
IoT_Revenue_Model	Pearson Correlation	.824**	1
	Sig. [2-tailed]	.000	
	N	84	84

		IoT_Smart City_Adoption	Information_Security
IoT_SmartCity_Adoption	Pearson Correlation	1	.761**
	Sig. [2-tailed]		.000
	N	84	84
Information_Security	Pearson Correlation	.761**	1
	Sig. [2-tailed]	.000	
	N	84	84

		IoT_Smart_City_Adoption	Hardware_Cost_Reliabilit y
IoT_SmartCity_Adopti on	Pearson Correlation	1	.666**
	Sig. (2-tailed)		.000
	N	84	84
Hardware_Cost_Reliability	Pearson Correlation	.666**	1
	Sig. (2-tailed)	.000	
	N	84	84

		IoT_SmartCity_Adoption	Device_Sensor_Interoperability
IoT_Smart City_Adop tion	Pearson Correlation	1	.565**
	Sig. (2-tailed)		.000
	N	84	84
Device_Sensor_Interoperability	Pearson Correlation	.565**	1
	Sig. (2-tailed)	.000	
	N	84	84

Dependent Variable: IoT_SmartCity_Adoption					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9.949a	4	2.487	17.798	.000
Intercept	1497.178	1	1497.178	10713.986	.000
Parking_Traffic_Management	9.949	4	2.487	17.798	.000
Error	11.039	79	.140		
Total	1713.000	84			
Corrected Total	20.988	83			
a. R Squared = .474 (Adjusted R Squared = .447)					

Dependent Variable: IoT_SmartCity_Adoption					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.480a	4	2.870	23.845	.000
Intercept	1552.832	1	1552.832	12901.593	.000
Energy_Management	11.480	4	2.870	23.845	.000
Error	9.508	79	.120		
Total	1713.000	84			
Corrected Total	20.988	83			
a. R Squared = .547 [Adjusted R Squared = .524]					

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8.094a	4	2.024	12.398	.000
Intercept	1191.722	1	1191.722	7301.572	.000
AirQuality_Noise_Management	8.094	4	2.024	12.398	.000
Error	12.894	79	.163		
Total	1713.000	84			
Corrected Total	20.988	83			
a. R Squared = .386 [Adjusted R Squared = .355]					

Dependent Variable: IoT_SmartCity_Adoption					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13.534a	4	3.383	35.856	.000
Intercept	1438.410	1	1438.410	15243.633	.000
HealthCare_Safety_Management	13.534	4	3.383	35.856	.000
Error	7.455	79	.094		
Total	1713.000	84			
Corrected Total	20.988	83			
a. R Squared = .645 [Adjusted R Squared = .627]					

Dependent Variable: IoT_SmartCity_Adoption					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.530a	4	2.882	24.076	.000
Intercept	899.215	1	899.215	7510.737	.000
Information_Accessibility	11.530	4	2.882	24.076	.000
Error	9.458	79	.120		
Total	1713.000	84			
Corrected Total	20.988	83			
a. R Squared = .549 [Adjusted R Squared = .527]					

DISCUSSION

Several independent variables, including the "IoT Revenue Model [Pearson Correlation = 0.824]," "Information Security [Pearson Correlation = 0.761]," and "Hardware Cost and Reliability [Pearson Correlation = 0.666]," have strong positive relationships with the dependent variable Adoption likelihood of an IoT-based smart city solution. A substantial positive association exists between the independent variable Adoption Likelihood of IoT-based Smart City Solution and variables Indian Government IOT Policy (Pearson Correlation = 0.571) and Device and Sensor Interoperability (Pearson Correlation = 0.565). The sig fields in the correlation tables show p values that are smaller than the alpha value of 5% with a 95% confidence level. There is a rejection of zero and acceptance of another hypothesis.

Using ANOVA analysis, we find that the independent variables "Health Care Safety Management" (R square = 0.627), "Information Accessibility" (R square = 0.527), "Energy Management" (R square = 0.524), "Parking and Traffic Management" (R square = 0.447), and "Air Quality and Noise Management" (R square = 0.355) account for 62.7% of the variability in the dependent variable "Adoption Likelihood" (R square = In order to see the impact on the dependent variable "Adoption Likelihood of IoT based Smart City Solution," we combine the five independent variables: health care safety management, information accessibility, energy management, parking and traffic management, and air quality and noise management. We get R square = 0.865, which means that 86.5 percent of the variability in the dependent variable is explained by these five independent variables.

Fig. 2 shows the growing scholarly interest in smart city security and privacy over the last several years, as seen by the chronological perspective by volume of the publications.

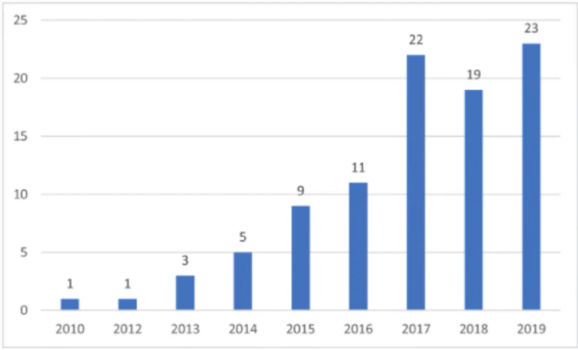

Fig. 2: Publications on privacy, security, and risks in smart cities: 2010–2019

CONCLUSION

If Indian inhabitants are to benefit from the Internet of Things-based smart city solution, they need to have a positive outlook and comprehend the implications of this new technology Perceived ease of use and perceived utility are important choice criteria for technology adoption, according to the Technology Adoption Model [TAM]. IoT revenue model, high information security, good government attitude and reasonable hardware and acceptable dependability are what India requires. It also needs up-to-date infrastructure as well as greater device and sensor interoperability is also needed. For Indian corporations, improved health care safety management, greater information accessibility for Indian residents and better energy management are the most important benefits. Several million dollars are being invested by large corporations to build up IoT infrastructure and create various apps. IoT deployments outside India should be studied in depth by the Indian government and corporations, and then tailored to meet the specific demands of the people living in India IoT will benefit from the Digital India initiative, which seeks to build e-infrastructure throughout India. As we enter the new and exciting age of the Internet of Things, India, with its strong concentration on technological development, is ideally positioned to thrive economically.

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