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Internet of Things in Smart City

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Abstract: ***The Internet of Things (IOT) refers to a system that connected object able to collect and transfer data over wireless network without human interference. IOT is considered as key infrastructure in smart city development. The growing development and enhancements in digital technologies, smart cities have been equipped with different electronic devices on the basis of IOT, therefore cities becoming smarter than before and also safe. A device using the internet has evolved over the last few years. According to recent studies, over 50 million IOT devices are added in 2020. These objects make our city smart. The IOT in smart city bettering the Transportation System, Traffic congestion, Smart waste management, smart car parking system and also maintains security.***

Keywords: Internet of Things (IOT), Smart City, Sensors, Solid Waste Management, Smart Parking, Traffic Congestion Reduction.

I. INTRODUCTION

Due to rapid growth of population in urban cities, the services and the smart facilities are required to provide the city residents. Smart Cities is the future of civil habitation, since in future the vast amount of population will move towards urban areas thus forming vast cities and populated cities. For managing the needs and advancing services the cities will incorporate smart infrastructure . To fulfill the requirements of city the use of Internet of Things is a great approach.

In order to understand smart City we will understand it with the help of definition. Since there are many definitions, but we are not present all of them [16] "A Smart City is a city well performing in a forward-looking way in the following fundamental components (i.e., Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance), built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens". This definition contains the idea about Smart Environment which is relevant to environmental pollution. Smart cities have become smarter than before because of the recent developments of digital technologies. Sensors, actuators, and smart phones that speeds up the huge business potentials for the IOT. A smart city has equipped with different electronic things such as street cameras for observation systems, sensors for transportation systems and for other monitoring purposes, etc. Sensor services for collecting and monitoring the particular data of cyclists, vehicles, public parking lots, etc and analyze it.

Over the last century, with the advances in technology, massive migration of individuals from rural areas to the main cities. As a result, these cities becomes highly populated and thus caused many civic problems, including traffic congestions and accidents. Furthermore, declining prices of vehicles and the increase in demand by consumers. The large amount of jams are also occur in cities. In Fact, traffic congestions causes high consumptions of fuel which not only increases expenditure for communication but also pollutes the environment. The smart Garbage collection is also mandatory for the city to disposal the waste of the city. The use of IOT in garbage collection makes it more efficient and reliable. With the use of the various sensors and the use of the servers based technology the fuels of the truck has been saved and dry/wet waste disposals perform more smartly.

To deal with the explosive rate of population, many countries and organizations propose smart cities to optimize energy consumption in cities. Due to the complication of energy management, this includes distribution of networks, households/buildings and so on, numerous types of information need to be transferred in real time. And because enhancement in energy management the cities becomes more efficient.

II. OBJECTIVES

A. To understand the IOT makes Smart cities very efficient.
B. To understand Smart Waste Management is convenient way of disposing the waste.

Following hypothesis are proposed to attain the above objectives using survey analysis:-

1) *H1:* "The implementation of IOT in Smart City helps the city to work efficiently and makes city secure and more advanced."
2) *H2:* "Implementation of Smart Waste Management makes city more reliable and dispose the garbage more precisely."

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III. LITERATURE REVIEW

In [1] Sikder et al. defines that Lamp Unit (LU) were consist of the motion sensors and ambient sensors like LDR, Local control Unit(LCU) were collects all data from LU. Control Centre (CC) were collects all data from LCU and stored in server. And protocols such as Zigbee, 6LowPAN is used for saving the light energy. [2] Ganchev et al. said that the automatic car parking system serves many users but there is fluctuation in time. The author Dongre et al. [3] explained how cities can implement smart traffic management, smart road light and smart waste management and strategies like facial acknowledgment or biometrics must be utilized to approve people and approve information. In article [4] the author Higashino et al. uses mobile phones to track the location of crowd and vehicles and based on this the message about disaster is send to all citizens, according to these crowd map is created among this information. In article [5] Park et al. said that Technological Roadmap (TRM) is used for organization to help the city to adopt more technology with less cast affect. [6] Arasteh et al. said that the combination of the IOT platform with other autonomous and intelligent systems providing smart and efficient applications to the citizens. [7] Srikantha et al. implements Radio Frequency Identification (RFID), weight, temperature, humidity and chemical sensors are embedded in dust-bin also using a Gray Level Aura Matrix (GLAM) approach to extract the image. Dynamic routing is used to planning the management ie. no. of trucks needed and amount of fuel required. Wireless Sensor Network (WSN) for monitoring the level of dust-bins located in recycling spots. [8] Alrashdi et al. said that NIDS methods and also machine learning terms like Decision Tree, K-Nearest Neighbor, and Random Forest are helpful for detecting the cyber-attack in smart cities. [9] Soomro et al. introduces IOT devices that collect traffic related information and that would be passes to other driver's devices to avoid traffic. And the implementation of Artificial Intelligence (AI) manages the traffic very efficiently. [10] Ji, Z., Ganchev et al. said that system developed by using IOT will provide the services like automatic street light, video surveillance, weather report, water pollution. [11] Abdullah et al. introduces the garbage collector that uses technologies like IOT and Cloud Storage to efficient solid waste management in smart cities. And implement sensors in the smart bin to classify the waste into categories like degradable, plastic, metal etc.[12] Anudeep et al. analyzed the live location of the vehicle then this information was passes to the cloud. The passenger can access this information at anytime and anywhere. And the system is validated for location of bus, no. of seats available and estimated arrival time using the mobile app. [13] Zalke et al. implementing smart vehicles which collects information like the speed of the vehicle, the number of persons sitting on/in the vehicle, the location of the vehicle, utilization of safety feature by owner/driver, drunk and drive situation with the help of the various sensors. [14] Araujo et al. analyzed Vision-based solution and compare its results with the sensor-based solution for a same set of spots in order to evaluate effectiveness and also study of how much time the drivers take to entry or leave a parking space these information can schedule better our answers to drivers. In article [15] author explored various specifications and features of IOT systems, along with effective incentives for utilizing them.

IV. METHODOLOGY

An online survey is held using Google Forms. The link of the form was circulated in social media platform. The questionnaires in the forms were designed to test the proposed hypothesis which verified certain parameters.

A. Participants

A total of 57 participants data was collected from different states of India. Among the 57 participants 66.7% were male and remaining 33.3% were female.

B. Measures

Participants were asked to indicate their response in two parameters i.e. YES/NO.

Gender	Yes	No	Total
Male	29	9	38
Female	12	7	19
Total	49	8	57

Table I

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There exists a simple formula to calculate the expected for any value in the above table.
Formula:
Expected Value = (row total) * (column total) / (grand total)
Expected Value:

$E_{11} = \frac{38 \times 49}{57}$ $E_{12} = \frac{38 \times 8}{57}$ $E_{21} = \frac{19 \times 49}{57}$ $E_{22} = \frac{19 \times 8}{57}$

$E_{11} = 32.66666$ $E_{12} = 5.333333$ $E_{21} = 16.33333$ $E_{22} = 2.66666$

Gender	Yes	No	Total
Male	32.66666	5.333333	38
Female	16.33333	2.66666	19
Total	49	8	57

Table II

Degree of freedom = (Rows-1) x (Columns-1)
= (2-1) x (2-1)
Degree of freedom = 1
The formula for Chi-Square is

$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$ Where, O_i = Observed Value, E_i = Expected value

$= [\frac{(29-32.66666)^2}{32.66666} + \frac{(9-5.333333)^2}{5.333333} + \frac{(12-16.33333)^2}{16.33333} + \frac{(7-2.66666)^2}{2.66666}]$

$= [0.101626 + 0.260417 + 0.203252 + 0.520833]$

$X^2 = 1.08613$

Thus, the value for x^2 is 1.0861

Gender	Yes	No	Total
Male	34	4	38
Female	15	4	19
Total	49	8	57

Table III

There exists a simple formula to calculate the expected for any value in the above table.
Formula:
Expected Value = (row total) * (column total) / (grand total)
Expected Value:

$E_{11} = \frac{38 \times 49}{57}$ $E_{12} = \frac{38 \times 8}{57}$ $E_{21} = \frac{19 \times 49}{57}$ $E_{22} = \frac{19 \times 8}{57}$

$E_{11} = 32.666666$ $E_{12} = 5.333333$ $E_{21} = 16.33333$ $E_{22} = 2.66666$

Gender	Yes	No	Total
Male	32.66666	5.333333	38
Female	16.33333	2.66666	19
Total	49	8	57

Table IV

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Degree of freedom = (Rows-1) x (Columns-1)

= (2-1) x (2-1)

Degree of freedom = 1

The formula for Chi-Square is

$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$ Where, O_i = Observed Value, E_i = Expected value

$= [\frac{(34-32.6666)^2}{32.666666} + \frac{(4-5.333333)^2}{5.333333} + \frac{(15-16.33333)^2}{16.33333} + \frac{(4-2.66666)^2}{2.66666}]$

$= [0.0544218 + 0.333333 + 0.108843 + 0.666667]$

$X^2 = 1.16327$

Thus, the value for x^2 is 1.16327

V. EXPERIMENT

The test scores of independent samples were calculated at the confidence level of 95 percent using chi-square test.. The participants presented multiple questions to test the parameters in the test (e.g. Is IOT (Internet Of Things) in Smart cities make city to work efficiently? Smart waste management can provide convenient management of waste in cities?). So, the calculated chi value is 1.0861, and the tabulated chi value is 3.84 at significance level 95 percentage with the degree of freedom 1. From the third table, calculated chi value is 1.1633 and tabulated chi value is 3.84 at significance level 95 percentage with the degree of freedom 1.

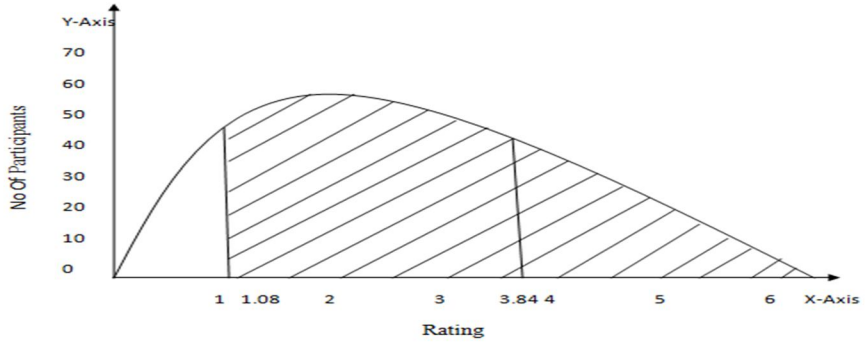

Fig 1. Statistics for chi square for hypothesis 1

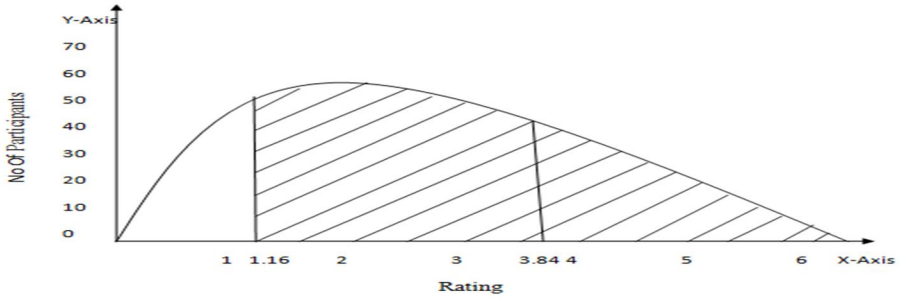

Fig 2. Statistics for chi square for hypothesis 2

VI. RESULT

The test scores of independent samples calculated using chi-square test using survey analysis resulted that the involvement of IOT in smart city makes city efficient to work . Therefore, the hypothesis “H1” is accepted. And the Smart waste management can provide convenient management of waste in smart cities. Thus, the hypothesis “H2” is accepted.

VII. LIMITATION AND FUTURE SCOPE

The limitation is that most of the connection objects uses RFID so the there is risk of hacking also increases. The combination of the IOT platform with other intelligent systems for providing smart and widespread applications is one of the most interesting future trends. Furthermore, providing a mechanism to overcome some of the essential challenges like the privacy right of the citizens is still an area of interest.

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VIII. CONCLUSION

Implementation of IOT in Smart cities not only developing the infrastructures but provides more facilities like smart west management, smart traffic congestion system, Smart parking systems and many more. Involvement of IOT make city reliable, efficient and convenient. It also provides secure and comfort life to citizens.

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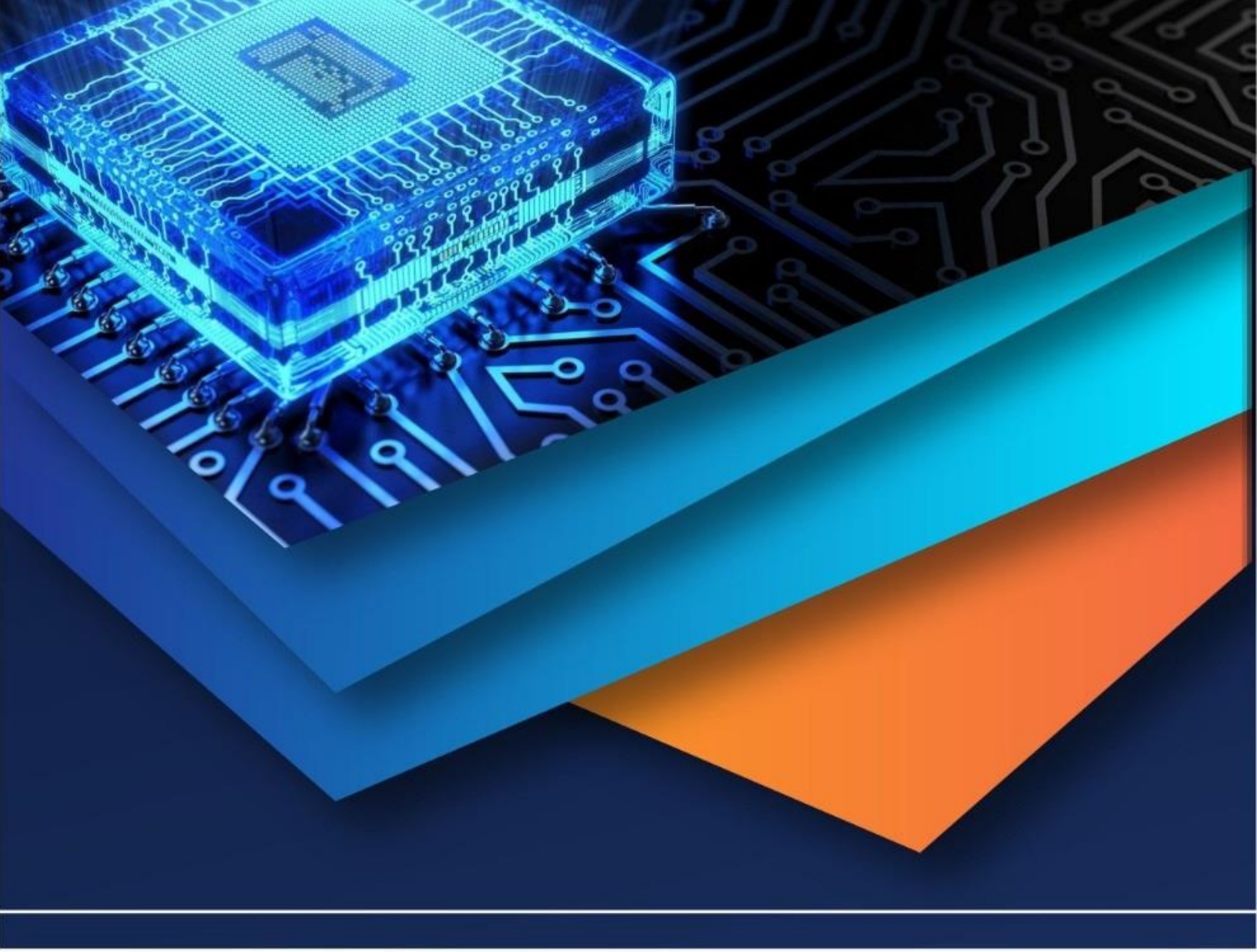

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