

Influence of Internet of Things in Smart Building: An Empirical Study

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Abstract -Internet of Things has gained a ton of hype in a very short period and is being embraced by changed areas to achieve its potential by getting progressed level of mechanization the individual business-based exercises to receive the rewards. The business land is one such area that numerous nations are zeroing in on changing their structures and foundation to have the urban areas contributing towards to become as 'smart cities'. The smart building is the place where the schools, workplaces, private buildings coordinate IOT for improving the abilities and effectiveness of the structure foundation. The basic drivers that have empowered for keen structures in the commercial centres are meeting the objectives of corporate social obligation, income development and working on functional productivity. With the interest for sending of keen structures on the ascent, there have been many key patterns that have arisen making it a push to have changed change for digitalizing the business structures, homes, and so on through powerful keen arrangements. The paper basically investigates the job of IOT in smart building, the trends of smart building, and highlights the interests of public in IOT and smart building

Key Words: Internet of Things (IOT), Smart Building, Smart City.

1.INTRODUCTION

Innovative developments have consistently assumed a vital part in driving the time into another advanced upheaval, and are having a wide impact on the existences of individuals irrespective of their instructive status, sex, age, pay level, topographical area, and so on. Internet of Things (IOT) is the next enormous thing occurring in the advanced world which has influenced and changed different parts of our lives including the method of living.

Smart Buildings are one of the numerous ideas that Internet of Things (IOT) effects on and gives a total makeover to the exemplary term "buildings". There are various spaces in which Internet of Things (IOT) is facilitating and working on human life and work productivity as well. With the ascent of metropolitan inhabitants and environment-friendly users, the demand

for a smarter and sustainable lifestyle is mounting. Smart buildings with the assistance of IOT plans to give an individuals a smart, efficient and sustainable solution in different aspects of their lives.

Endeavors to make buildings smarter are focusing on reducing expenses by smoothing out building activities like cooling and lighting. Building automation is basic to these endeavors, fundamentally on the grounds that it could diminish the yearly working expenses of buildings. This investigates the intermesh of IOT and Smart Buildings, the patterns that drive the smart building idea and the difficulties that a smart building faces with respect to its execution.

2. LITERATURE REVIEW

The review of literature pertaining to 'IOT and its applications in smart buildings' are discussed with reference to following empirical study

Zoran Morvaj.B (2011) This paper gives an outline into the components and ideal models of a smart energy city in the structure set for the development of existing urban areas and their change to smart cities. The possibilities of smart building has been investigated and placed into point of view as the essential structure square of urban communities. The results showed the decrease in consumption of energy due to IOT.

Hemant Ghayvat, Subhas Mukhopadhyay, Xiang Gui and Nagender Suryadevara (2015) This exploration approach is to plan and create dependable, effective, adaptable, efficient, constant and practical wellbeing sensor networks for smart home frameworks. The finding of the study reveals that remote sensor networks and internet of things-based savvy home is turning into a significant surrounding helped living climate for people, where essential consideration can be given at the period of scarcity, and wellbeing can be estimated and anticipated.

Eugeny I. Batov (2015) The research paper focused on the distinct features of the "smart buildings". The study shows that other than noticing the climate, a structure likewise ought to have the option to change its state. For this reason, smart buildings are furnished with gadgets and actuators that can handle different designing

frameworks like lighting, warming, cooling, theatre setup and so on.

Faheem Zafari (2017) This paper, talks about different miniature area empowering innovations and administrations. Additionally, it also talks about how these can speed up the fuse of Internet of Things (IOT) in smart buildings. The results are expected to show that micro location empowering advances and administrations in IOT prepared smart buildings have a colossal potential.

Ahmed Talaat Totonchi (2018) The objective of this paper was to deliberately survey IOT empowered administrations in smart buildings. The outcomes showed that in fact the IOT is the key empowering influence and driver of various smart buildings administrations. It empowers both the change of existing buildings administrations into smart building administration, and the production of novel smart building administrations. To do that, it teams up and supplements with other current innovations, for example, big data and cloud computing.

3.RESEARCH GAP

There are some studies which have examined the application of IOT in smart building. Some other studies concentrated on smart building and its smart solutions. They have ignored to analyze the interests of publics in smart building and IOT. Therefore, the present study has been taken to examine whether general public prefers smart building or not. This is a pioneering attempt, which works on applications of IOT in smart building and public's interests on smart building.

4.RESEARCH OBJECTIVES

- To study the influence of IOT in smart building.
- To study the smart building trends and smart solutions.
- To study the socio-economic profile of smart building users.
- To analyze the impact of smart building in users' life.

5.RESEARCH METHODOLOGY

The research is based on both primary and secondary data. The primary data is obtained from general public.

6.RESEARCH DESIGN

The research design is empirical in nature since the study is conducted using both analytical and diagnostic

type of research. The study includes a preliminary pilot study followed by main study.

7.SOURCES OF THE DATA

Primary data has been collected from smart building users. Secondary data is collected from various published and unpublished sources including journals, Magazines, Publications, Reports, Books, Periodicals, Articles, Research Papers, Websites, booklets.

8.INTERNET OF THINGS AND SMART BUILDINGS

IOT has altered the housing market with inventive approaches that plan to give individuals an encounter which would make their day-by-day errands simple as well as furnish individuals with the best living experience. IOT is the third wave of the web improvement. It is normal that by the year 2023, a bigger number of 50 billion gadgets would be associated with one another (through the IOT) and this mechanical upheaval would have a tremendous impact over the smart buildings industry because of moving requests of buyers. Regarding a quarter billion vehicles are relied upon to be associated with the web while giving the potential outcomes of computerized driving experience and in-vehicle administrations. Machine-to-machine associations are relied upon to develop to 27 billion constantly 2025. It is assessed that IOT will add worth to the worldwide GDP which would account \$10 to \$15 trillion by the coming 20 years, will affect the economy by up to \$11 trillion constantly 2026 and can create about 4.5 trillion in the public areas and \$14.4 trillion in the private area during the coming 10 years.

Smart buildings are robotized shrewd structures which incorporate smart commercial buildings and smart homes. At present, smart buildings are one of the quickest developing industry cases which take advantage of IOT and are assessed to keep up with the speed until 2020. A smart building incorporates: Intelligent sensors, smarter heating, ventilation and air conditioning (HVAC), safer and healthier working environment, smarter security systems, optimization of quality services, cost reductions, reduced water and energy consumptions, enhanced allocation of resources, predictive maintenance, building management and automation, equipment control regulation and configuration, room and light control, health monitoring and much more. Smart building innovation and computerization are floating the idea of structures towards a more promising time to come.

8.1.SMART BUILDING TRENDS AND SMART ARRANGEMENTS

a) IOT Energy Efficiency

Pollution and level that have been influenced due to the quick urbanization over the previous years with restricted measures embraced to address them, has left our age to manage different predicaments. The worry for the future that the current age will leave for the group of people yet to come is at a basic stage, which is the reason individuals have begun to move towards supportable and effective arrangements. A smart building expects to fulfil the needs of individuals by giving them with smart arrangements where the buildings would monitor and control the carbon impressions and furthermore monitors the water and energy utilization inside the building. The organized sensors would furnish the clients with the insightful data which would help them in dealing with their water also power utilization effectively. Through green architecture the buildings can help to manage air contamination and the water that would be utilized for the plants would be reused a lot to restrict wastage of water. Solar panels would store energy which can be productively used and furthermore helps in reducing expenses. The put away sun-oriented energy could likewise be utilized to create power to work the advanced digital sign board.

b) Smart Heating, Ventilation and Air Conditioning System (HVAC)

In a building, HVAC assumes a significant part in energy utilization. Since energy proficiency is a rising issue, the smart HVAC frameworks target giving energy proficient answers for keep up with the temperature at buildings and homes.

A smart HVAC framework incorporates provisions, for example, customized temperature control, measured framework, staged engines, ductless framework, reinforcement blowers and better nature of air. These frameworks are not difficult to introduce, work and eliminate when required. They are symbol of eco-friendly buildings and require moderately less investments. A BMS (Business Management System) by controls HVAC framework which assists the client with changing the temperature, mugginess, nature of indoor air, screen the temperature, and so on. Its establishment requires sensors, controls, other related software and actuators.

c) Building Management System

Building management systems are most ordinarily carried out in enormous activities with broad mechanical, HVAC, and electrical frameworks. Frameworks connected to a BMS normally address 40% of a structure's energy utilization; in case lighting is incorporated, this number ways to deal with 70%. BMS frameworks are a basic part to overseeing energy interest. Inappropriately arranged BMS frameworks are accepted to represent 20% of building energy utilization. As well as controlling the structure's inward climate, BMS frameworks are in some cases connected to get to control (entryways and access entryways controlling who is permitted admittance and departure to the structure) or other security frameworks like closed circuit television (CCTV) and movement identifiers. Alarm frameworks and lifts are additionally here and there connected to a BMS for observing. In the event that a fire is identified then just the alarm board could close dampers in the ventilation framework to stop smoke spreading, shut down air overseers, start smoke departure fans, and send every one of the lifts to the ground floor and park them to keep individuals from utilizing them. Building management systems have additionally included debacle reaction components (like base confinement) to save structures from earth quakes.

d) Smart Healthcare Monitoring System

Smart healthcare monitoring systems which would be introduced in houses and buildings will keep a consistent check and record the user's pulse and heart beat which will consequently raise mindfulness and modify medical care suppliers if there should arise an occurrence of a crisis. This idea is thought about very supportive for the older populace and the individuals who experience the ill effects of medical problems that require clinical consideration as and when required. The client needing clinical consideration would be upheld with a video call with a crisis support supplier who will offer directions to the client until help shows up.

e) Smart Security Systems

The security system dependent on the IOT stage has the capability of cooperating with the gadget. The framework comprises of a camera, voice sensor/amplifier, movement/action sensor and an LTE/Wi-Fi module which is interfaced with the core of the framework, processor. This whole monetary framework utilizing IOT continuously will permit cell phones and PCs to distantly follow the exercises

happening at the area where the IOT gadget is set and records every one of the exercises, which will be saved money on one's distributed storage account. The IOT based security framework helps in added assurance of the user/user property. Security frameworks are intended to play out specific assignments when a secured zone is breached. The principal benefit of this system is the capacity to distantly deal with one's property all day, every day. With this IOT based smart storage, one can screen, get cautions, advise if there should arise an occurrence of crisis from anyplace on the planet utilizing portable application by means of cloud availability all day, every day. To be explicit, we plan to design a light-weight, minimal expense, extensible, adaptable remote keen security system utilizing IOT which utilizes the coordination of different most recent advancements. The mix of the different advancements can be utilized synergistically as a smart security to control a framework in a house/association (lock or open a framework with the assistance of SMS/application) from far off areas. The total framework is planned considering a wide range of entryway locks and storage spaces by giving a basic, compelling simplicity of establishment; to give homes/associations outrageous security and our framework will be a method for forestalling, recognizing and counter-estimating theft or robbery.

9.QUESTIONNAIRE SCALING TECHNIQUE

The research has two different scales. Each scale has its own range and options. The variety and number of scales are Likert's five-point scale and bipolar scale. (Eg. Yes/No type)

10.SAMPLING TECHNIQUE

Convenient sampling method is adopted to collect the primary data. The respondents for the purpose of study are selected systematically.

11.DATA ANALYSIS

50 responds obtained from the smart building users are scrutinized and systematically tabulated in SPSS package for the primary data analysis. The following statistical tools have been employed to find out the results from the primary data.

- 1.Percentage Analysis
- 2.Chi-square Analysis

11.1.ANALYSIS AND DISCUSSION

TABLE 1: SOCIO- ECONOMIC PROFILE OF THE RESPONDENTS

The demographic profile of the smart building users includes gender, age and occupation. The demographic profile of the respondents is analyzed using Percentage Analysis.

GROUP	TOTAL	PERCENTAGE
Gender		
Male	27	54%
Female	23	46%
Total	50	100%
Age		
Less than 20	13	26%
20-40	26	52%
40-60	06	12%
More than 60	05	10%
Total	50	100%
Occupation		
Government	07	14%
Private	22	44%
Self employed	4	8%
Retired	4	8%
Students	13	26%
Total	50	100%

From the above table it is clear that male users are more in number when compared to female smart building users. Majority of the smart building users belongs to the age group of 20-40. As per the occupation major portion of the smart building users belongs to private sector.

TABLE 2:CHI-SQUARE TEST FOR GENDER

	Value	df	Asym.Sig.(2 Sided)
Pearson Chi-Square	1.491	3	0.22

From the above table it is found that Pearsons's chi-square = 1.491, $p=0.222$, p value is more than 0.05 so it is statistically insignificant. Therefore, it can be concluded that there is no association between gender and their preference towards smart building.

TABLE 3: CHI-SQUARE TEST FOR AGE

	Value	df	Asym.Sig.(2 Sided)
Pearson Chi-Square	9.5194	3	0.02313

From the above table it is found that Pearsons's chi-square 9.5194, $p=0.022313$. The p value is less than 0.05. Hence there is no evidence to accept null hypothesis. It can be concluded that there is a significant association between the different age groups and their preferences towards smart building.

TABLE 4: CHI-SQUARE TEST FOR OCCUPATION

	Value	df	Asym.Sig.(2 Sided)
Pearson Chi-Square	5.2345	4	0.0264

From the above table it is found that Pearsons's chi-square 5.2345, $p=0.0264$. The p value is less than 0.05. Hence there is no evidence to accept null hypothesis. It can be concluded that there is a significant association between the different occupations and their preferences towards smart building.

FACILITIES IN SMART BUILDING

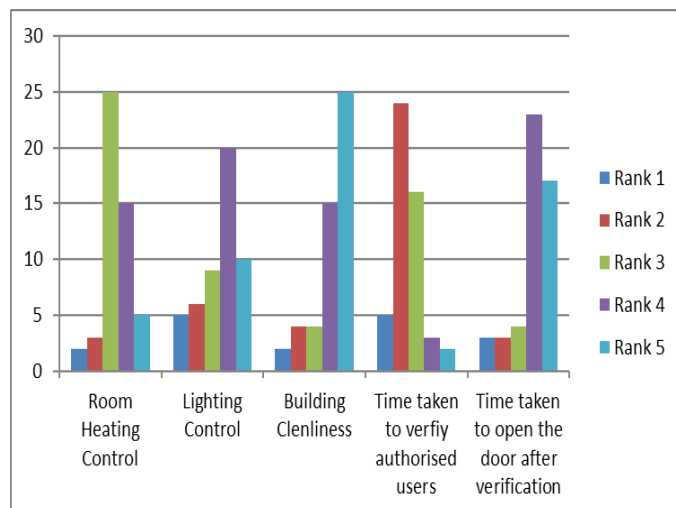
A smart building is defined as the building or a structure that uses automated processes to manage and control its operations (HVAC, lighting, security, and a variety of other systems)

TABLE 5: FACILITIES IN SMART BUILDING

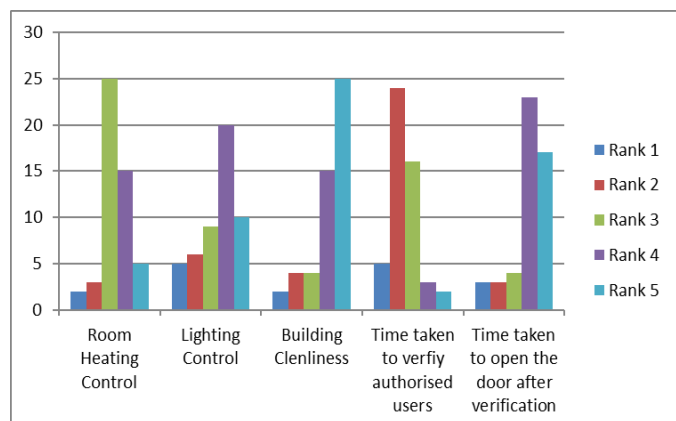
Facilities in Smart Building	No	Percentage	Yes	Percentage	Total
Building Management System(BMS)	18	36%	32	64%	50
Smart Health care monitoring system	15	30%	35	70%	50
Smart HVAC System	10	20%	40	80%	50

Smart security system	12	24%	38	76%	50
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From the above table we come to know that most of the people enjoy all the facilities in the smart building except very few.80% of the user's like's smart HVAC system.

CHART 1: BUILDING OCCUPANTS SATISFACION


From the above bar chart, it is found that most of the users are satisfied by the overall performance of the smart sensors and the smart building.

CHART 2: RESPONDENTS RANKINGS ON SAMRT BUIDLING FEATURES


From the above bar chart, it is found that users enjoy all the salient features of the smart building.

12.FINDINGS OF THE STUDY

By analyzing the applications of IOT in smart building, it is found that most of the smart building users enjoy all the salient features of the smart building. It is clear that most of the users are benefited by smart BMS system, smart HVAC system, smart security system, smart health care monitoring system. And all these sensors availed user's life.

13. CONCLUSIONS

The goal of the paper was to study the influence of IOT in smart building and to highlight the impacts of smart building in user's life. It can be concluded that most of the users are benefited by the facilities in smart building and enjoys the overall performance of smart building and smart sensors.

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