Analyzing the applications of internet of things in hotel industry

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Abstract. Tourism is one of the fastest growing business domains. Self-assisted services and Internet of things-based devices have become the current age cash. Internet of Things is a network for devices to connect and communicate information using physical devices embedded with sensor, software, cloud computing and other technologies. Therefore, self-assistance options enhance customer experience when it comes to hotel accommodation. The Internet of Things plays major role in improving the stay experience by providing customized services to customers. Self-services like pre-booking, registration and user preferred payment mode, automated check in & check out are also few aspects that are contributing for improved guest experience. In this paper, role of Internet of Things in hotel industry is taken into consideration for improving the guest experience and providing the customized services and the application of IoT in hotel industry has been analyzed.

1. Introduction
IoT is a unique global network architecture which can configure itself as per interoperable communication protocol. This network is effortlessly integrated with physical and virtual system that uses smart interface, known by their unique address and have physical traits and virtual identity. IoT plays an important role in the internet era. Since the rise of the idea of the Internet of Things (IoT), more gadgets are being associated to the internet. These gadgets can detect condition (health, location, hazards), share data and perform required operation. IoT is opening up in individuals' day to day life and is making their life convenient. Technology has embedded information and communication system in the environment with the help of network of sensor and Radio Frequency Identification (RFID). This has resulted in the generation of large scale of information which must be stored, prepared furthermore, introduced in a consistent, productive, and effectively interpretable structure. The Cloud computing in IoT act as a virtual infrastructure. It integrates monitoring devices, storage devices, analytics tools, visualization platforms and client delivery [1].

The IoT requires a common understanding of the circumstance of its clients and their devices, software architecture and systems to process and pass on the logical data to the significant destination, and the analytical tools that focus on self-governing smart behavior of the system. With these three basic grounds set up, the user-friendly smart and strong IoT system can be build [1,2]. The development and advancement in electronics has resulted in micro-electronic systems, which have the ability to sense, communicate and compute fast and wirelessly. Wireless sensor network of miniature devices called nodes finds number of applications in monitoring of temperature, traffic, and retail activity. Cloud computing platform plays multiple roles in internet of things that are: its act as receiver.
of information from sensor network, a processing system that analyze and interpret the information, and visualizing the information [3].

1.1 Elements of IoT
The elements of IoT can be categorized into three levels as shown in Fig. 1- Level 0: Sensor, controller, things & gateways, Level 1: Data storage & data analytics, Level 2: Data Visualization & interpretation.

Level 0: To get physical parameters in the outside world or inside the thing itself, system need sensors. These can be either inserted in the gadgets themselves or implemented as independent thing to measure and gather information. Another key component of this layer is the actuator. Actuators being in close coordinated effort with the sensors, they can change the information produced by smart objects into physical activity. The connected things should be capable of communicating in both directions with their analogous gateways or data acquisition devices and in addition having the option to perceive and converse with one another to accumulate and share data and collaborate in real time. This type of functioning requires large amount of bandwidth and computing power. Gateways provide a spot for local processing of data gathered by sensor which is relevant and compact form of information for further processing. The one more important functioning provided by gateways is security [1].

The technology used in Level 0 is Wireless Sensor Network (WSN). The integrated circuits with wireless communication and low power have made possible a device for use in remote sensing application that have high efficiency, low power consumption and the cost is also low. The sensor network that is made of large number of sensors are suitable for collecting, processing and then analyzing large amount of data. The stored sensor data are sent to centralized or distributed system and shared among sensor nodes. It is important to uniquely identify the object in IoT network and therefore, unique addressing of object is required. This will permit to recognize billions of gadgets and control the gadgets that are at remote places using internet. Each component associated with network must be identified by its location, identification and the functions it is performing [4].

Figure 1: Elements of IoT

Level 1: The data gathered from sensor network is required for actuation and keep a track of system. The centralized or distributed machine intelligent algorithms are required to make sense of data gathered. System equipped with machine learning algorithm, neural network, and AI algorithms are required to make machine driven decision. These frameworks have qualities, for example, interoperability, coordination and flexible correspondences. These systems have software and hardware modular architecture which is useful for IoT applications. The centralized infrastructure is
required for storage and data analytics. Cloud is considered as brain of the IoT systems. Cloud-based framework is intended to store, process and analyze gigantic volumes of information for more profound bits of knowledge using artificial intelligence algorithm and data analytics engine [3].

Level 2: Visualization is basic element of an IoT application. This helps in providing the easy access of framework to user and more data can be given in significant manners to users. Extraction of significant data from unprocessed information is important. The visualization tool help in finding how user can perceive the given information in a given situation. This whole process is required for representation of information for end use [4].

The three elements of the IoT plays major role in working of the IoT systems. The data is gathered from the environment using sensor is stored and then processed. The data is analyzed, visualized and then interpreted into useful information. This information is then used to make actuators work. The unique identification of IoT devices in the network is important. These unique IDs are used to identify, locate and operate IoT devices seamlessly.

1.2 Scope of IoT

IoT market is expected to keep on growing rapidly in 2020 and according to International Data Corporation (IDC) there will be 41.6 billion associated IoT gadgets, or "things," creating 79.4 zetta bytes of data in 2025 [2]. IoT is being used for monitoring and control application, data collection and predictions. The data collected by active devices can be sold in data market by small and medium size firm. Data can be offered to organizations that will utilize it to take care of their Business Intelligence and to users who can use it in their app. The analyzed and visualized data which is obtained from IoT devices can be used for prediction and can create a new product chain [3].

IoT can be used for tracking human, vehicles, machinery, ships, cargo and processing it to analyze the information according to the requirement. IoT is also being used for monitoring and control application like keeping the check on the device performance, health condition, environmental condition, energy usage and can send the alert in abnormal conditions. IoT technology is helpful in providing real time solution to the people in need. The IoT can also be used to predict the work patterns, areas for improvement to increase the efficiency and future outcomes based on data collected and analyzed by IoT devices [4].

1.3 Applications of IoT

The IoT technology is being used globally. Condition-based maintenance alerts, production flow monitoring, remote supply chain, building management, security frameworks, healthcare, equipment management and retail are major areas covered in the IoT business domain. The customer IoT are home security, smart home, personalized healthcare, Wearable innovation, remote apparatuses, and remote gadgets [5]. The various sectors in which IoT is being implemented are home, cities, tourism, health and transportation as shown in Fig. 2.

Smart home is one of the most popular applications of internet of things. The smart home is equipped with sensor and the information gathered by these sensors is used to control the smart home. Thermostat is used to control the temperature of home, smart fridge that provide the user with the availability and unavailability of items in fridge, smart security system for security of the house. Smart City provides technical solution to improve and ease the life of people. The IoT can be used for waste management, automated car parking and automated street lighting in a city [5]. The main aim of implementing the IoT in city is to provide the fast and automated solution of routine life services. The IoT can be implemented in different aspect of health care medical system, medication, diagnosis and cure [2]. With the use of IoT the patients can be monitored by doctors remotely and in case of emergency medical help can be provided. The IoT is very useful for making elderly people take medicine on time. The car and other transportation facilities when connected with the sensor can be constantly tracked and can avoid any bad circumstance.

The sensors are also useful for navigation of road, reduction of pollution (as sensor monitor the condition of vehicle). The quality and quantity of the crops are being improved with use of IoT. In
field of agriculture IoT helps farmer to plan the crop to be cultivated, as IoT system analyses the climate condition, check the soil quality and recommend the crop to be cultivated [3].

The tourism industry is collaboration of multiple businesses and impacts the GDP of the country. The industry is getting high-tech with new development in the technology. The tourism deals with services like transportation, hospitality, museum and cruises. The main areas in tourism where IoT can contribute are personalization and improve the traveler’s experience. The IoT is also helpful to automate the shared services (Uber, Ola) business where billing and tracking are major issues [2].

![Figure 2: Application of IoT](image)

1.4 IoT in Hotel Industry
Technology is playing a crucial role in enhancing, co-creating and personalizing guest stay experience in the hotel property. The day-to-day itinerary planning, data search and to find the activities and places nearby property are few things expected by guest that can improve experience. The few application of IoT within a hotel property are smart room service, automated check in & check out, hotel room automation and smart upkeep as shown in Fig. 3.

The electronic key card that is sent by hotel in guest’s phone to unlock the room is also one key application being implemented in hotels. The previous health record can be used with sensors to monitor current health status of guest and in case of emergency, alert can be sent to hospital. The Security of any hotel is significant element and requires lots of attention and investment for the security of guest. The IoT with the smart video can screen the suspicious conduct in the recording of surveillance camera of observation and can tell and hold onto the chance of burglary or intrusion [6].

Hotel can introduce detecting devices to execute smart tasks and the operations, for example, track visitor location, and convey personalized message. Numerous hotel property, for example, Hotel Icon
in Hong Kong give a mobile "Handy" to visitors to use during their stay offering an add on feature for visitors. Hilton and Marriott hotel branches have begun testing their smart guestroom which provide customized room feel, and voice-initiated gadgets that modify and work according to guest. Virtual help interfaces help visitor by interacting with them and enhance their stay experience. Sensors introduced inside kitchens can screen the expiry date of cooking essentials and beverages and help the kitchen staff to plan the utilization of the available thing accordingly. Incorporated sensor with artificial intelligence can recommend recipes with available items to kitchen staff [7,8].

**Figure 3:** Application of IoT in hotel industry

Smart hotels can use the data gathered from the previous stay of guest to customize environment in guest’s room. The smart hotel can also utilize IoT for eco-friendly management practices within property, including recycle and reuse of waste, power saving, and nourishing and maintaining plants. IoT introduced in the hotel and within the town gather significant volume of internal as well as external information, for example, location of guest, availability of facility required for guest, climate condition, street conditions and air terminal traffic situation. This data may not straightforwardly impact guest's stay experience however will influence the traveler overall impression. Tab. 1 provides the data about sensor that can be incorporated for upgrading hotel operations [4,8].
Table 1. Sensor & it’s Operation in Hotel Industry

| Position of Sensor | Type of Sensor         | Operation                                                                 |
|--------------------|------------------------|---------------------------------------------------------------------------|
| Within Hotel Property | Location Sensor        | Provide food facility or other facility to guest anywhere within hotel property |
|                     |                        | Check expiry date and par-stock level. Detect item profile and location.    |
| Store house         | Inventory tag          | Track outdoor temperature and manage power consumption                     |
| Outdoor of Hotel    | Thermal sensor         | Provide guest preferred experience within the room                         |
| Hotel Guest room    | Temperature Sensor,    |                                                                             |
|                     | Light sensor, voice    |                                                                             |
|                     | sensor, door sensor    |                                                                             |
| Hotel Garden        | Moisture Sensor        | Check the moisture of soil and automate the plant watering system           |

Marriott International in collaboration with Samsung and Legrand is working on smart hotel room. The future smart hotel room of Marriot will be equipped with high-tech services. The mirror can go about as a screen and play the activities at the planned hour and room can alter its lights and temperature, according to the guest preference. The shower can change the temperature of the water according to the necessities of visitors and simultaneously can monitor leakage, status of Tank and send the alert to the staff for further action. Automated parking, smart swimming pool and temperature control of hotel are few applications that are already being implemented in the industry [7].

The IoT is transforming hotels drastically and reshaping the hotel industry. The IoT is not only improving the guest experience but also helping the hotel staff. The hotel staff can now understand the customer requirement better and have higher customer satisfaction rate. The IoT has automated the hotel kitchen, hotel lobby and hotel rooms.

2. Analysis of the Literature

Gubbi et al. have presented the study of cloud centric implementation of IoT. The internet of things has actually working in the real world, this technology is working seamlessly in the background and extracting the data from the physical and working on it. The authors have proposed a framework enabled by a scalable cloud to provide the capacity to utilize the IoT. The framework allows networking, computation, storage and visualization themes separate thereby allowing independent growth in every sector but complementing each other in a shared environment [1]. Balandina et al. have discussed about the implementation of IoT in various sectors of business. Health services and the travel industry are among the quickest developing business sector in the world. The new age of computerized administrations reshapes scene of these two enterprises. A few players consider it to be a danger, as computerized administrations affect their customary plans of action. IoT will play a significant role in advancement of internet ecosystem regarding e-tourism, travelling and smart healthcare in near future. In this paper researchers summarize finding and innovation in field of IoT and provides an idea of how to implement these finding in business domain. The modern tourism is about sharing and lending devices to tourist but issue faced by such business is billing and tracking.
These issues are being addressed by use of IoT technology. IoT has provided the personalization touch to tourism and increased the satisfaction level of the vacationers. Incorporating IoT in tourism has led to new possibilities in e-tourism [2]. Lee presents the study about the architecture, ecosystem and business model required for implementing Internet of things in business sector. The author has also explained in detail the use of IoT in hotel rooms. This paper presents three categories of IoT applications: operational enterprise IoT, analytical enterprise IoT, and collaborative enterprise IoT [3].

Tripathy et al. have provided a framework using Internet of Things known as iTour. This framework will provide self-reliant tourist mobility. The authors have explored the difficulties in implementing the framework, and the IoT based roles in the framework [6]. Kansakar et al. have discussed about implementation of Internet of thing in hospitality. The authors have also emphasized on challenges of IoT that are security, data handling and real time response [7]. Verma & Shukla have proposed a system to streamline the business with traveler’s requirement analyze tourist experience and also researched about Impact of IoT in tourism industry. The travel industry business spins around the user necessities and to take into account the same, the most recent patterns in technology and innovations go about as a viable measure. The IoT is impacting both travel industry and travelers in many ways. The basic requirement of traveler is mobility and flexibility throughout the experience of travel and accommodation. The business has begun taking big moves and it will soon be reforming the general pattern of operations [8]. Buhalis et al. have described about the advancement in internet with distributed system and how it has changed the working style of industries. The connectivity of applications, sensor and gadgets helps in gathering the information of traveler which can be further use to facilitate or eradicate the problem faced by traveler in future. Further it can also be used to send personalized advertisement to the customer that will be beneficial for the business and customer. The model in consideration empowers completely coordinated software, utilizing huge information to upgrade accommodation dynamics and strengthen competitive edge. The main motive of proposed framework is to improve the effectiveness of interoperability among applications which will provide more reliable and easier to operate infrastructure with minimal costing on customized interface [9].

The IoT is thriving with new research and development; this is the rapid growing field. Smart cities, smart agriculture, smart homes and smart planet are becoming a reality with increasing services and gadgets. The hoteliers have understood that the IoT will help increase their business; therefore, numerous hoteliers are investing in researches to make IoT as a solution for the increasing the quality of services. This paper portrays new IoT system that utilizes smart agents and fuzzy principles to personalize the IoT system without uncovering the private data of the visitor. This exploration is a case of improving quality of services by combining Artificial intelligence and IoT. Therefore, increasing the customer experience [10]. Torres provides the detail of design and development, working and draw-back of digital key app for hotel rooms. The author has also discussed about check-in, check-out, food orders using smart devices [11].

2.1 Survey of Existing Study

IoT used in hotel provides a flawless, flexible and transparent solutions to hotel owners. The customer enjoys the personalized, highly optimized, automated and interactive hotel services. The environment polluting factors in hotels can be controlled by IoT enabled management systems for building, power and lighting control [8]. The major obstacle to the adoption of IoT services in hotel industry is security of data as the data will be stored in cloud. Incorporation of sensor and cameras in working & living environment can lead to cybercrimes. The potential risk on security can be reduced by setting up security protocols. Data encryption, firewalls and security analytics are the few mechanism can be used for making secure systems. Blockchain gives decentralized security and protection, but include delay, high computation and significant energy that is not suitable for most resource constrained IoT gadgets. The IoT services needs strict and confined security rules and regulation. Therefore, government can play important roles in formulating these norms [10].

In this study analysis of 29 documents is presented and the Fig. 4 shows the chart of these papers which are published in timespan of 2014 to 2020. From this figure, it is analyzed that IoT is most
trending topic in research sector and lots of research work is being carried in this field nowadays. In the field of Internet of Things, 55.2% of the total papers are published in conferences, 27.6% are articles, 10.3% are book chapters and 6.9% are conference review papers. So, IoT is being used everywhere from home appliances to high tech machinery control. The IoT is an integral part of tourism sector and hotel industry are using IoT to automate every possible service for improving guest experience.

![Figure 4: Paper Published in timespan of 2014-2020](image)

The Fig. 5 shows graph of the documents published in IoT from various countries in timespan of 2014 to 2020. It can be seen from the graph that India is publishing maximum number of papers in comparison with other countries. China is on second position in publishing articles on Internet of Things. IoT will be definitely a game changer in technology world and the research in IoT will transform the business sector drastically.

![Figure 5: Country-wise growth of IoT](image)
3. Conclusion
The IoT has changed the hotel industry drastically. With new inventions and advancement in technology, hotel industry is changing its way of working. The guest is now interested in personalized services, the brand name of the hotel is not just enough for the guest to select the property for their stay. The self-assistance is new trend as the guests wants to enjoy their personal space while on vacation and IoT has resolved this problem to large extend. The hotel industry has automated the system to provide guest preferred smart services from check in till check out, thereby enhancing the experience of the property. The impacts are both positive and negative with a few difficulties as well. The IoT solutions for hotel industry are not only beneficial for the hotel owner, customer and society but also should fulfil business’s social responsibility.

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