October 4, 2021

World Habitat Day
Accelerating urban action for a carbon-free world

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4th October, 2021

Accelerating Urban Action for a Carbon-Free World

निर्माण सामग्री एवं प्रौद्योगिकी संवर्द्धन परिषद्
आवासन और शहरी कार्य मंत्रालय, भारत सरकार
BUILDING MATERIALS & TECHNOLOGY PROMOTION COUNCIL
Ministry of Housing & Urban Affairs, Government of India

"Creating Enabling Environment for Affordable Housing for All"

Smart Home Automation Technologies to enhance Energy Efficiency

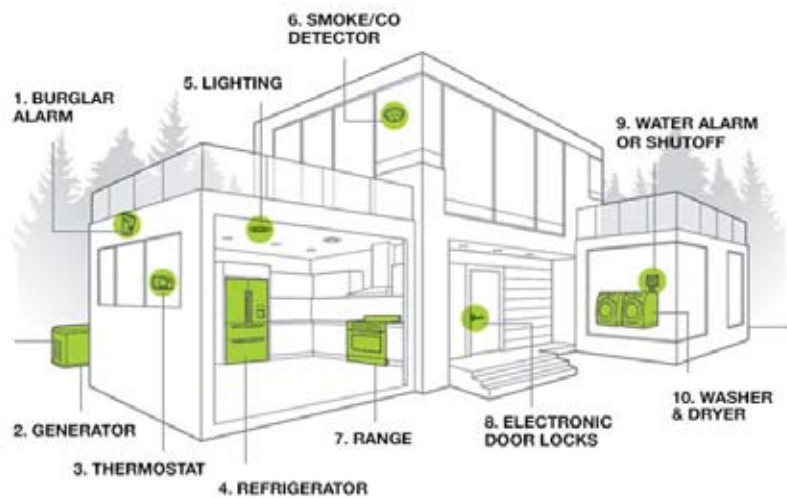**S Vikash Ranjan[1]**   **Abdullah Nisar Siddiqui[2]**   **Chawan Vijay Kumar[3]**

With recent technological advancements in the world, the concept of smart home automation has seen quite a surge in its market. The technology that brought a revolution in the field of automation is the Internet of Things (IoT). [1] A Smart Home also referred to as an automated home, intelligent home consists of numerous technologies which are embedded in a single frame. A home furnished with all the common devices but with the feature to interact with each other as well as with humans is a Smart Home.

It uses internet-connected devices to enable remote monitoring and control of appliances and systems, such as lighting and heating. In the residential sector, energy consumption includes all energy consumed by households, excluding transport uses. This requires electricity for heating, refrigeration, lighting, water heating and consumer goods. Residential sector accounts for over 25% of India's electrical consumption which is primarily used for lighting,

Source: homeautomation.jpg (598×418) (seabreezeelectric.com)

Figure 1: Smart Home Integration

heating and cooling[2].

Between 2000 and 2013, electricity demand in the buildings sector increased at a rate of 8 % per annum. The Smart-Cities government's mission to develop smart cities/ homes has given rise to the concept of home automation systems in India.

Growing technology/ IoT adoption in every area of daily life, aspirations for improved living conditions, and growing dispos-

able income reinforce the home automation sector, which looks very promising. Global analysis indicates that, with the help of progressive legal, regulatory and policy structures in the electricity sector, the idea of smart homes provides a significant opportunity to minimize energy consumption in the building sector, save on energy costs and eliminate excessive capital expenditure to enhance electricity production, transmission and distribution efficiency. In India, the concept of smart homes is in developing phase which offers huge potential of achieving energy efficiency

1 Vyas, Chinmaya & Patil, Shashikant. (2016). Smart Home Analysis in India:An IOT Perspective. International Journal of Computer Applications. 144. 29-33. 10.5120/ijca2016910384.

2 Bureau of Energy Efficiency, Ministry of Power, Govt. of India. (2019). "Unlocking National Energy Efficiency Potential – UNNATEE, Strategy plan towards developing an energy efficient nation (2017-2031)".

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in residential sector. Therefore, improving energy efficiency, dynamic optimization of energy consumption, and integration with the overall smartness of the electrical distribution network becomes the need of the hour.

"WORKING OF A SMART HOME"

There is a simple approach for the functioning of a Smart Home. Firstly, the system is set up where all the devices used in the home are provided with sensors to sense the internal and external environment, home occupancy, etc. These devices include electricity and energy meter - controls and monitors units consumed on a daily basis and calculates the energy consumed, energy consuming appliances like lighting, HVAC system, refrigerator, electric vehicle, washing machine, television, water heaters etc., components of house that have bearing of energy consumption such as curtains, windows, doors, thermostats etc., user interface devices like smart phones and monitors, information devices like AV (audio visual) systems, Chatbots etc., home security system and other devices like home and health management systems. All the connected devices mentioned above have the ability to sense the physical conditions, understand user's commands, have capability to act on the data sensed, user instructions and store the data regarding event, incidents/preference and use analytics to understand information from gathered data.

Different data is collected by these devices depending on the desirability of the user and these data are sent to the main node (central controller/hub). Hub stores all the data coming from different nodes and sends the data to the server through internet where the data is stored and processed. When the processed data is analysed if the actual value is beyond the required value, the data is again sent to the primary node and if the data is correct and within the required value then it is monitored if there exists any issue which could be alerted via SMS, alarm, etc. The flowchart is given in figure 2.

With the smart home concept, energy consumption parameters are to be taken into consideration. Energy efficiency can be achieved by various strategies like preventing idle running of energy consuming system, optimization of adjustable building envelope elements and operating parameters to minimize energy demand and synchronize with the user's preferences, shifting the operation of non-essential energy consuming systems to off peak time, making use of renewable energy generation source, storing the surplus renewable energy to offset peak demand etc[3].

Smart Home should be incorporated with low power and low-cost computing devices for its efficient utilization which can produce low energy making or homes smart and energy efficient. This leads to many technologies[4] that can contribute our homes to be intelligent

3 H. Singh, V. Pallagani, V. Khandelwal, and U. Venkanna, "Iot based smart home automation system using sensor node," in 2018 4th International Conference on Recent Advances in Information Technology (RAIT), pp. 1–5, IEEE, 2018.
4 R. J. Robles and T.-h. Kim, "Context aware systems, methods and trends in smart home technology," in International Conference on Security-Enriched Urban Computing and Smart Grid, pp. 149–158, Springer, 2010
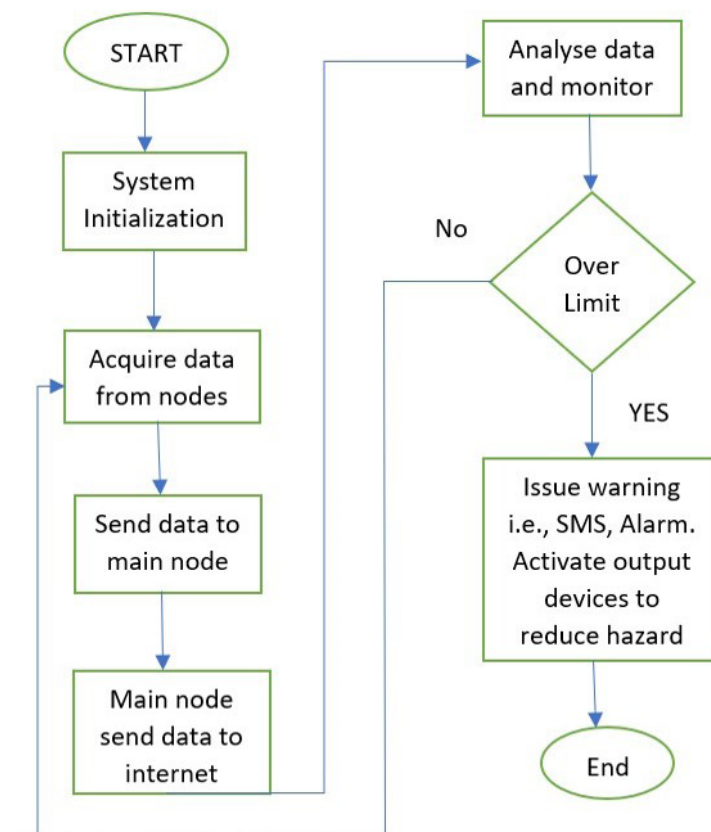
Figure 2: Working flowchart of Smart Home

enough. Some technologies are: Internet of Things as a technology (IoT), Machine Learning (ML), Artificial Intelligence (AI), Z wave, ZigBee Technology, Cloud Computing, Edge Computing etc. User interface for Smart Home can be of three kinds 1) App/dashboard based, 2) Voice based, 3) Gesture based.

The smart home market in India is influenced by factors such as a significant increase in the IoT market, cost-reduction measures made possible by home automation systems, manufacturers expanding their product portfolios and increasing the importance of remote home monitoring. In addition to safety and security concerns factors such as increased disposable income, smartphone penetration, availability of affordable Internet access, and increased knowledge of smart systems have also boosted adoption, driving the growth of the Indian home automation industry. According to the report of the Ministry of Communication, the demand for smart homes in India is estimated at US $355.4 million in 2016 and projected to rise at 43.75 % (CAGR) from 2016 to 2020. The present global market size for smart homes is estimated at US $1 billion[5].

Under "Indo-German Energy Programme" (IGEN) – Energy Efficiency Residential Buildings (EERB) - a study has been conducted on baseline assessment of smart home automation technologies market and technology mapping in India by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in collaboration with Bureau of Energy Efficiency

(BEE), and Deloitte Touche Tohmatsu India LLP. Surveys have been conducted to understand the consumer needs, preference, awareness and barriers regarding smart home technology and policies. The respondents of the survey included consumers from 13 cities of age group 30-60 years. The respondents are households of 1 BHK to 4 BHK and individual bungalow with annual income from less than 10 lakhs to above 50 lakhs. During the survey, the consumers are requested to indicate their preference from options 1 to 9 about the products which are currently in use or planning to buy in the coming five years.

36% of the respondents preferred security and access as their first preference and smart lighting as second preference with 36%. Smart AV system is considered as third preference with 55% of survey responses. During the course of survey responses have been collected to identify the key drivers for adoption of smart home appliances. It is observed that 91% of respondent opted for convenience and life style, followed by 82% for interior enhancement. It is also observed that energy savings wasn't the primary concern as only 45% of the respondents opted smart

home appliances for saving energy at home.

Also, the consumer responses demonstrated that the major barriers for smart home automation technologies are data security and cyber risk (67%), cost of technology resources (53%). Some of the other factors which affect are the complexity of installation and lack of clarity of energy savings. The following figure indicates the percentage of these barriers as per the survey responses.

On the basis of surveys and interviews with manufacturers and service providers, it was learned that the building codes and the green rating system, i.e. In the current scenario, ECO Niwas Samhita (ECBC for residential sector) has little to no impact on demand on smart home products. Approximately 55% of respondents indicated that there is no impact of the policies mentioned on the demand for their products and services. In this context, 36 % of respondents do not have an opinion, and about 9% of respondents agree that this policy has an impact on the demand for their products and services.

Based on the data on average expenditure on smart home au-

5 Technical report on Smart Homes (March, 2017) by Telecommunication Engineering Centre, Ministry of communication, GoI
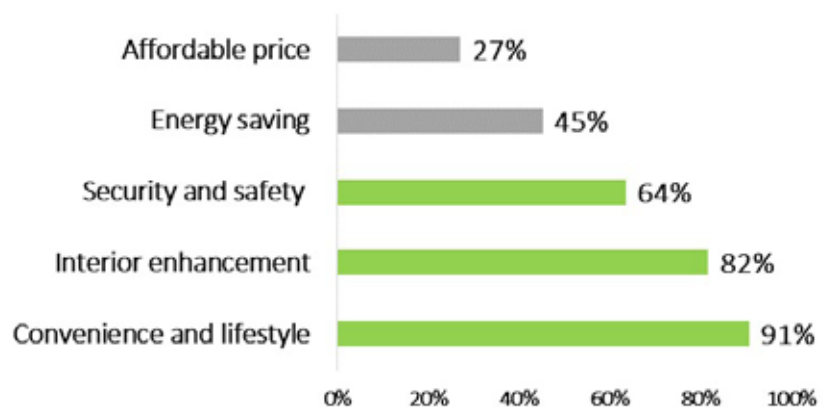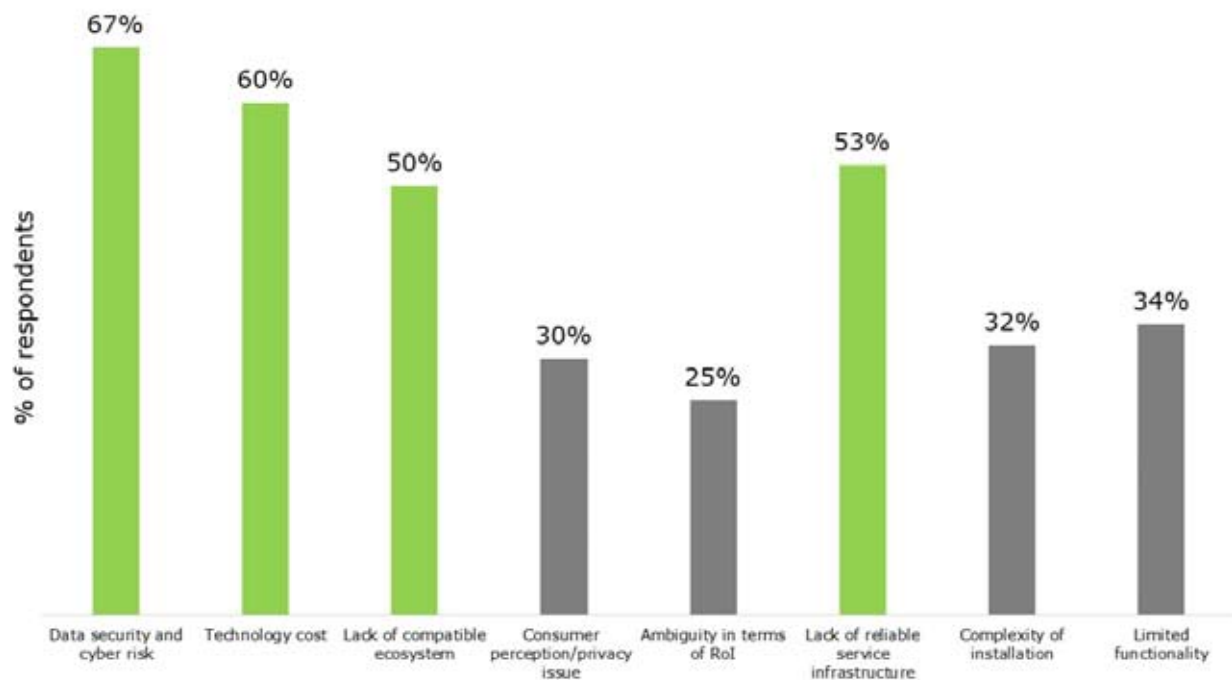

Figure 3: Key Drivers for adoption

Figure 4: Major barriers for Smart Home Automation

tomation products and services collected during the consumer survey, the penetration of smart home automation products is estimated to be 0.07% in 2016 and is expected to increase to 0.20% by the end of 2020. With business-as-usual scenario, the penetration is expected to reach about 2.8% by the end of 2030.Some of the key policy required to disrupt Indian smart home market, identified based on the discussion with industry leaders and subject matter experts, includes: 1) Policy for data safety and cyber security to protect consumer privacy and to mitigate risk of data theft. 2) Policy to standardize products for seamless integration of products of different make 3) Policy to promote use of smart home in new and existing homes by voluntary or mandatory compliance. Indian market may follow the trends similar to other developed nations, where the smart home market is expected to grow by ten folds due to implementation of some of the above-

mentioned policies[6]. Considering this factor and reduction in cost of technology with economies of scale, Indian smart home market size is expected to grow to about US $62.8 billion by the end of 2030 (with regular policy interventions by concerned departments) and the penetration level (with reference to total number of households in 2030) is exacted to reach 28%.Inclusion of smart home policies in the country and creating awareness about the different existing technologies and policies would foster the growth of smart home market. In India, therefore, the promotion of smart homes should be encouraged to make it digitalised, safe and efficient.

GIZ on behalf of The Federal Ministry of Economic Cooperation and Development (BMZ), Germany, and Ministry of Housing and Urban Affairs (MoHUA), India under the

Indo-German Technical Cooperation, agreed to jointly promote the "Indo-German Energy Programme" (IGEN) with the aim to foster sustainability in built environment. IGEN's programme, Climate Smart Buildings (CSB) proposes to extend technical assistance and cooperation to improve thermal comfort conditions in the affordable housing sector, and implementation of Global Housing Technology Challenge-India (GHTC-India).

The CSB programme is aligned with the commitments made by the Indian Government to meet its objectives submitted under NDC. Under this programme, GIZ is exploring opportunities to include smart home applications in affordable housing sector to make houses energy efficient and thermally comfortable.

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6   International Energy Agency (IEA)-4E.MARCH 2018 - INTELLIGENT EFFICIENCY - A CASE STUDY OF BARRIERS & SOLUTIONS - SMART HOMES. https://cda.iea-4e.org/publications-library