International Journal of Research in Engineering, Science and Management
Volume 5, Issue 5, May 2022
https://www.ijresm.com | ISSN (Online): 2581-5792

Intelligent Building Planning and Designing

Umesh Vazurkar[1], Sarkare Omeir[2*], Pullanvalapil Siddharth[3], Pujari Rutwik[4], Shinde Rohit[5]
[1]Assistant Professor, Department of Civil Engineering, A. P. Shah Institute of Technology, Thane, India
[2,3,4,5]Bachelor of Engineering, Department of Civil Engineering, A. P. Shah Institute of Technology, Thane, India

***Abstract*: The word 'intelligent' was first used to describe buildings in the United States at the beginning of the 1980. Intelligent buildings are a reality increasingly present in cities around the world. The concept of intelligent buildings is not new, but it has evolved mainly due to the development of new technologies, which, when incorporated, enable more intelligent resources and processes, which expand the building's capacity to operate in a more efficient, flexible, interactive and sustainable way. It is a building that uses both technology and process to create an environment that is safe, healthy and comfortable to everyone. An intelligent design needs to start with a complete model. The model will be a 6 Bhk bungalow comprising of area of 108,046,235.52 sq mm and G+2. This modeling begins early on with CAD designs that evolve into Revit project renderings. The intelligent building will comprise of Elevator system, Lighting system, Smoke control system, Water management, video monitoring and Security Access control. All the bylaws will be considered while designing and planning of the structure including architectural and structural component. The structure will be planned with the objective of decreasing expenses by reducing energy consumption. Lastly, we will understand what an Intelligent Building is and will also understand intelligent planning and design of a structure with considering structural components (Water management, Electricity distribution, Lighting system, Elevator system) & architectural components (Video monitoring, Security access control, Smoke control system, Fire detection alarm) and to provide knowledge on underlying concepts and potential of an intelligent building, infrastructure and connected communities.**

***Keywords*: Intelligent building, Project rendering.**

1. Introduction

Intelligent buildings may seem like a very modern concept, their origins actually go pretty far back in history. The first signs of an automated HVAC system came in the 17th century with Cornelis Drebbel. Drebbel created a mercury thermostat that could automatically keep a space at a constant temperature. His invention was one of the first feedback-controlled devices known to history. He also developed the first known system of air conditioning, using salt as a cooling agent. In the 18th century, René Antoine Ferchault de Réaumur, a French scientist created a temperature-controlled incubator based on Drebbel's ideas and the thermometer that Réaumur invented. The rise of digital computers in the 20th century were also integral to the advancements made in building automation technology, resulting in the modern building automation that we see today. Intelligent building (IB) was advocated by UTBS (United Technology Building Systems) Corporation in the U.S.A. in 1981 and became a reality in July, 1983 with the inauguration of the City Place Building in Hartford, Connecticut, U.S.A. (So & Chan, 1999). Although communication and automated facilities might have been used to certain degree in other buildings prior to the City Place Building, the term of "intelligent building" was not used.

The United Technologies Buildings System (UTBS) which was an affiliate of United Technologies (UT) played a key role in integrating the building facilities with computer network for the City Place building. UTBS was not only a client of the City Place, it also took part in installing the air conditioning, elevators, and fire prevention facilities for the building. By connecting the local area networks to digital private branch exchange (DPBX) device, communication equipments, and information equipments of the building, UTBS improved the energy efficiency of the building and also the overall safety of the building. To understand the social background and technological developments that led to the emergence of intelligent buildings and to identify the prospects of future developments, this section will identify the reasons for the emergence of intelligent buildings by looking into the development of building technology:

Rapid development of communications and computer technologies:

After the 1970's, competitions in aerospace industry and demands for advanced technology by the Moon Landing project facilitated many technology breakthroughs on the hi-tech products. The first and second energy crises also led to evoke the environmental awareness and the concept of sustainable development. As a result, products which previously were limited in kind but huge in volume became more diversified and lesser in volumes to meet the requirements of energy efficiency, increased safety, and improved compatibility. As the technology became more popular and commercialized, hi-tech products were no longer elusive.

Implementation of the telecommunications law and policies:

Unrestricted transmission of information is the primary requirement of the information community. The policy of telecommunications liberalization is the key factor for communications automation and networking. The United States and Japan revised their telecommunications laws and policies in 1982 and 1985, respectively. For its part, Taiwan allowed private operations of fixed network systems in 2000. The

*Corresponding author: sarkareomeirfaisal30@gmail.com

telecommunications liberalization policy of Taiwan includes: Consumers will be able to benefit from inexpensive access to communication services. Data and information can be transmitted more swiftly and conveniently. It made the living more diverse and many new concepts of office space were generated, such as the paperless office and home office.

Competition of high-end office buildings:

Typically, office buildings are concentrated in city center for the convenience of business operations. This has resulted in inflated real estate prices and office leasing rates. The use of elevators as means of vertical transportation in buildings has given rise to taller and more massive buildings. As building facilities become more complicated, operation and management of such facilities require some intelligent systems that are highly automated and integrated. At the same time, builders add more facilities to their high-end buildings to gain better return on investment. By using the high performance, low cost, and well-developed technologies, the intelligent building systems are extensively used in buildings. These advanced features increase the profits of the buildings as well as the reliability and life supportability of building.

A. Need for Current Study

Intelligent building is a topic which should be taken in consideration while construction as it is not only eco-friendly but also provides improved lighting, enhanced air flow quality, augmented thermal comfort, increased personnel security, and quality sanitation facilities for achieving the greater comfort for the owner or occupant. The most important aspects of an intelligent building is that it offers greater efficiency as energy gets optimized to the fullest. These buildings combine technology and the IoT (internet of things) to provide solutions to the age-old issues of overspend and inefficiency in building construction and use. In these building all the systems are connected, from air conditioning to security and lighting. This building provides low maintenance and preserves energy. There are many types of systems used such as lighting, HVAC, safety, power management, security (access control, video surveillance, and visitor management), smoke control, elevator, etc. These systems not only make things comfortable and secured but also help in different scenarios such as fire outburst. These buildings also help in protecting the nature. These systems maximize building performance and efficiency. These buildings successfully merge building management and IT systems to optimize system performance and simplify facility operations. Hence it is important to understand and study the concept of intelligent building and implement while constructing or planning any building related projects.

B. Problem Statement

An Intelligent building is a building that, with minimal human control, optimizes defined qualities. For a building to be intelligent, we expect it to manage itself, at least to a high degree. With a high level of complexity (due to extensive use of digital solutions) it will be practically impossible for a human operator to manage the building's various systems manually. Intelligent buildings are expected to do things better than traditional buildings. In practice, optimization involves the use of advanced digital systems. Keeping things generic and avoiding technicalities, we have (so far) identified eight generic components needed to make a building intelligent, i.e. to make a building capable of optimizing relevant qualities with limited need for human control. While you will find many of these in regular buildings today, a smart building according to our definition requires all eight.

C. Scope

Nowadays intelligent buildings are becoming a kind of necessity as they help us to conserve energy. Intelligent building is the use of different types of systems such as Elevator system, Lighting system, Smoke control, Electricity distribution, Water management, etc. These systems not only make things comfortable and secured but also help in different scenarios such as fire outburst. These buildings also help in protecting the nature. In short looking at today's condition where there is daily some or the other incident occurring in the buildings surrounding us and kind of harm, they are doing to environment it is necessary to implement the use of intelligent buildings.

D. Objective

1. To expand the building's capacity to operate in a more efficient, flexible, interactive and sustainable way.
2. To study how to deliver a more comfortable experience for their residents/occupants.
3. To Reduce energy consumption and Improve building efficiency.
4. To model an intelligent building while considering architectural and structural component.
5. To provide knowledge on underlying concepts and potential of an intelligent building, infrastructure and connected communities.

2. Methodology

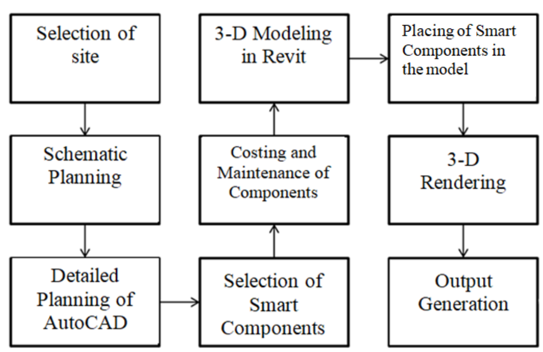

Fig. 1. Methodology flowchart

A. Selection of Site

The site we have selected for our project is located at Dargah Rd, Sector 18, Sector 34, Sea woods, Navi Mumbai, Maharashtra 400706. The purpose of selecting this area is, as it has various facilities around the area; Such as hospitals, schools, malls, bus stops, and train stations. This site has PALM BEACH Lake on the opposite side and a great wide beach behind the side located at almost 1 km. from the site the closest railway station available is Seawoods Dave. The mall is located just above the railway station. For using public transport, the bus stop is a 5minutes walk. There are 3 hospitals in the vicinity. Podar international school is 15 min walk from the site. Terna Engineering College is also 15 min away by bike. It also has a park called Wonders Park 30mins away by a vehicle. This is an amusement park. In short, this site satisfies the need for almost all the required things, which should be present in the vicinity of a house.

Fig. 2. Prospective site

B. Schematic Planning

After the selection of the site, a rough plan for the G+2 structure was prepared. Planning was done per all structural and aesthetical components. The number of bedrooms and bathrooms on each floor were decided and also the proper positioning of the staircase for the structure was done. The plan area was discussed for the building in this phase & the total area for each floor was also calculated.

C. Detailed Planning on AutoCAD

After the schematic plan, a more detailed plan was prepared on the AutoCAD software for drawing 2D. Over here the rooms, terrace, and toilet areas were named in the plan. A total of 6 bedrooms were given in the plan, and 4 bathrooms with 2 attached to bedrooms were given. The kitchen area was given and the other areas other than the main house where planned. All the 3 floors were thoroughly detailed in this phase.

D. Selection of Smart Components

In this, the smart/intelligent components to be placed in the building were selected by our group. These components namely are the Elevator system, Lighting system, Smoke control, Electricity distribution, Water management, Fire detection system, Security Access Control, and Video monitoring because of these components the various tasks of our smart building are expected to be better than any traditional building.

1) Solar system

- Solar PV panels
- On grid inverter
- Module mounting structure
- AC/DC cables
- ACDB/DCDB (Switches)
- Earthling Lighting arrestor

2) Security access control

- 4 Biometric sensors
- 14 windows sensors
- Alarm Panel
- Video Door Phone

3) Video monitoring

- 11 CCTV
- Led screen
- Hard disk (storage)

4) Water management

- Tank and sanitation
- Plumbing pipes

E. Cost and maintenance of Smart Components

1) Smoke control system

- 10m 80mm pipe - 23,000/-
- 12 sprinkler - 7,000/-
- 20m 40mm pipe - 22,000/-
- 40m 32mm pipe - 37,000/-
- 40m 25mm pipe - 30,000/-
- 3nos hose reel drum - 9,000/-
- Booster pump - 40,000/-

2) Fire detection system

- 12 detectors - 25,000/-
- 3 MCP (manual call point) - 12,500/-
- 20m 4core armored cable - 4,000/-
- 100m 2core armored cable - 15,000/-
- 2 zone panel - 10,000/-
- 12v Batteries (backup power for alarm panel) - 4000/-

Table 1
Total cost and maintenance of each Smart Components

System	Total cost (in Rs.)	Maintenance (Annually) (in Rs.)
Elevator system	20,00,000	23,600
Lighting system	2,70,000	7,080
Smoke control	56,000	14,160
Water management	3,50,000	4000
Video monitoring	61,800	6,000
Security Access control	1,20,000	-
Fire detection alarm	50,000	7,080
Solar panel	6,00,000	6,000
Fire extinguisher	6,000	-
Fire Hydrant System	1.68,000	4,000

F. 3-D Modeling in Revit

After the analysis of the building and smart components costs, now the time to build the model had come. The model was made with all standards of structure and aesthetics in check. After the extrusion of the CAD plan and fixing of doors and windows, the traditional components in a house like Television, fridge, sofa-set, fan, LED lights, shower set, WC, Washbasin, beds dining table, etc. are placed. The outer plan of the surroundings of the buildings was done after the building of the model. The amenities added were a Watchman's cabin, swimming pool with lounge, children's play area, park benches, car and motorcycle parking, streetlights, etc.

G. Placing of Smart Components in Building

After the modeling of the building in Revit, the next step was to place the smart components in the model, and by their uses, the components should be placed. Here are some images of the components that were placed.

Fig. 3. Elevator system

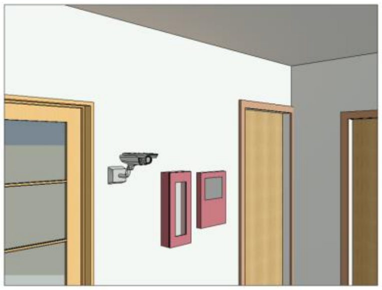

Fig. 4. Security access control system and fire detection system

H. 3-D Rendering

After the model is built and the components are placed, the 3-D renders are taken of the model here are some renders.

Fig. 5. 3-D rendering of the model

3. Outcome and Result

A. Expected Outcome

Intelligent buildings are a key contributor to a future low-carbon economy, where information systems and intelligent building applications will combine and merge perfectly. One of the most important aspects of an intelligent building is that it offers greater efficiency. an intelligent building can use both technology and process to create a facility towards safe, healthy and comfortable and enables productivity and well-being of its occupants. And it can also exhibit key attributes of environmental sustainability to benefit present and future generations. Intelligent Buildings are User Comfort, Safety, Security, Environmental techniques, and energy consumption techniques. Intelligent has become more sustainable. The energy efficiency in these intelligent buildings can be gauged from the fact that some of them have their sources of power generation and at times generate more power than they consume. Intelligent buildings give us the necessary data pertaining to electricity, water consumption, hourly space utilization, etc. This data further helps the residents to take corrective action pertaining to their constructive utilization. Greater the efficiency, lower the consumption. That's the principal these intelligent buildings tag themselves with. Intelligent buildings tend to provide a healthier, productive and comfortable space for the people staying in intelligent buildings.

B. Output Generation

After the complete detailed planning, modeling of building and placing of smart components, and taking off the 3-D renders. The output is generated. The output is a model with all the basic and intelligent amenities an intelligent home requires. Another output we gain is that of all estimations of our building and the components we placed and how economic they were and will be in the near future.

Fig. 6. 3-D model of the project

C. AutoCAD Plan

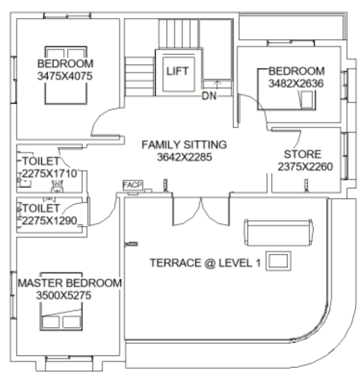

Fig. 7. Ground floor plan
(Carpet area: 108,046,235.52 sq mm)

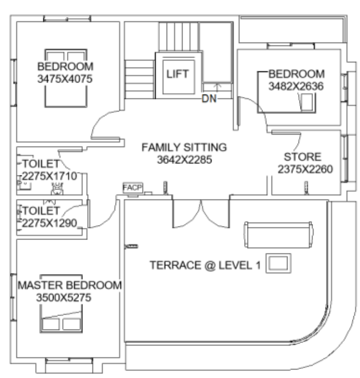

Fig. 8. First floor plan
(Carpet area: 74,972,753.28 sq mm)

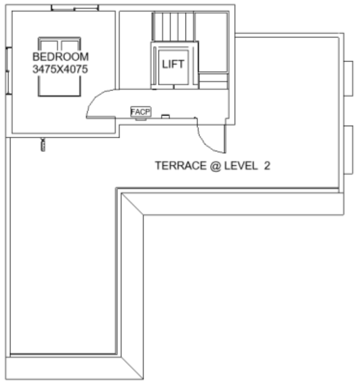

Fig. 9. Second floor plan
(Carpet area: 26,941,881.6 sq mm)

4. Conclusion

This paper presented an overview on intelligent building planning and designing.

References

[1] M. Udin Harun Al Rasyid, et al, "Surveillance Monitoring System based on Internet of Things."
[2] Sourav Kumar Bhoi, et al, "A Fire Detection System for Smart Home Based on IoT Data Analytics."
[3] Faisal Saeed, et al, "IoT-Based Intelligent Modelling of Smart Home Environment for Fire Prevention and Safety."
[4] Y. Andaloussi, et al, "Access control in IoT environments: Feasible scenarios."
[5] Samer Abdo Al-Rabeei, et al, "Security Fundamentals: Access Control Models."
[6] S. Gusmeroli, et al, "A capability-based security approach to manage access control in the Internet of Things."
[7] Ying Chen, et al, "Network Simulation on the Smoke-proof Effect of the Staircase in High-rise Building under the Effect of Wind Pressure."
[8] Cong Zhang, "Numerical simulation study on smoke stratification under the effect of mechanical smoke exhaustion."
[9] M. Udin Harun Al Rasyid, et al, "Smart Home System for Fire Detection Monitoring Based on Wireless Sensor Network."
[10] Anshu Prakash Murdan, et al, "An autonomous solar powered wireless monitoring and surveillance system."
[11] Sruthy S, et al, "Wi-Fi Enabled Home Security Surveillance System using Raspberry Pi and IoT Module."
[12] M Abbas M. Al-ghaili, et al, "Buildings Energy Savings – Lighting Systems Performance.
[13] Ivan Chew, et al, "A Spectrally-Tunable Smart LED Lighting System with Closed-Loop Control."
[14] M. Magno, et al, "A low cost, highly scalable Wireless Sensor Network Solution to achieve smart LED light control for Green Buildings."
[15] Lian Guey Ler, et al, "Framework Implementation for Smart Water Management."
[16] Zuzana Vranayova, et al, "Water management of "smart" buildings and cities."
[17] Helena M. Ramos, et al, "Smart Water Management towards Future Water Sustainable Networks."
[18] Songkran Kantawong, et al, "Multipath tall Building Elevator Module for flexible Transport System with PLC based on Cloud Control."
[19] Chen Mingxia, et al, "Design of Elevator Control System Based on PLC and Frequency Conversion Technology."
[20] Shuo-Yan Chou, et al, "Improving Elevator Dynamic Control Policies Based on Energy and Demand Visibility."
[21] Darsh Belani, et al, "Intelligent Building.
[22] Derek Clements-Croome, "Intelligent buildings."
[23] Osama Omar, "Intelligent building, definitions, factors and evaluation criteria of selection," New Era of Today's World.