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Digital Transformation at Workplace: ICT as a Key Enabler of Smarter Buildings

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Abstract

The topic of smart buildings is often discussed interchangeably with sustainable buildings which have been in focus for quite some time. The key selling point for such buildings is addressing the green environment agenda as well as reducing operational costs via efficient energy usage. A significant aspect however often left out while discussing smart buildings is related to the potential benefits that businesses can accrue by leveraging the power of ICT. These benefits mainly encompass enhanced employee productivity, employee engagement and improved space utilization of building premises.

The objective of this paper is to highlight the advances in ICT which can be utilized to create smarter buildings. Although there are several benefits of smarter buildings, the paper focuses on employing ICT to create better working environment for the occupants while enhancing the space utilization. This paper explores how smart workspaces can benefit organizations and identifies the ICT architecture for smart buildings. This paper also discusses stakeholders in the context of smart building and their perspective on benefits and opportunities in this space. The paper concludes with highlighting a few case studies of smart buildings across the world. The methodology includes analyzing and proposing advanced use cases possible by integrating the enterprise IT systems with IoT/M2M sensors and building management systems.

Keywords: Smart Building, Smart Workspace, Employee Productivity, Space Utilization, Digital Transformation

1. Introduction

1.1 Need for Smart Buildings

"We shape our buildings, and afterwards our buildings shape us" - Winston Churchill

We have seen how digitization has disrupted the way businesses operate today. A thorough understanding & application of this trend has become a critical part of strategy process for any forward looking organization. While digitization brings a major shift in how business is conducted, these technologies also bring an opportunity to transform our workplace. This transformation is strategic for several reasons including enhancing employee engagement & productivity while improving the office space utilization for the building. In this paper we will study these potential benefits and relevant use cases which are possible with the advancements in ICT.

To understand why we need smart buildings, first we need to understand how the workforce has transformed over the years. Today, most employees utilize digital technology quite frequently in their daily life and expect nothing less from their workspace. For example, employees expect office meeting room reservations to be accessible and adjustable over smartphones. An increasing percentage of employees want personal control over the temperature & lighting in their seat location. Thus employees have become active participants and consumers of their workspace. Providing such flexibility not only engages the employees but also improves their productivity levels as we shall observe in next few sections.

Another significant aspect enabled in smart buildings is the improved space utilization of the office building. With precise insights on how the building spaces are being used, office managers can allocate resources efficiently and also do long term planning for the real estate leasing decisions. As we will discuss in the paper, space utilization can also be improved by automating seat allocations & hot desking solutions enabled by the data and insights gathered via an array of sensors deployed in a smart building.

1.2 Smart Buildings are More than Just Green Buildings

For a long time, buildings have been considered to be static assets which once built needed minimal

maintenance and interaction. Thus lot of focus was on the initial investments and implementation with a secondary view to how buildings will be run. This view has changed as operational costs of running buildings have increased over the long lifetime of a building (Fuller, 2016). Many governments are introducing regulation for building maintenance to ensure resident safety and efficient use of energy resources (NYC.gov, 2017). Also, a lot of environmental initiatives have increased the consciousness of green agenda, due to which real estate companies have been focusing on constructing Green buildings. The improved energy efficiency in such buildings is achieved by several steps such as: utilizing newer building materials for utilizing sunlight for heating, using screens/glass for enabling natural lighting, deploying water management systems for recycling water within the building etc. These initiatives towards Green buildings indicate a good start, however such buildings still do not fully leverage the power of ICT and have a scope of improvement in several aspects. First, as green buildings utilize basic sensor technologies, the systems are either mechanical or have a pre-defined behavior for a limited set of conditions. Thus building systems have restricted intelligence to control Heating, Ventilation, Lighting, Access and Security. Secondly, most green building systems act independently and locally. A lot more is possible in case the green building systems are integrated with a smart building management system (BMS) which enables use of data from several systems to take synchronized decisions for the building as a whole.

Thus smart buildings are not just green buildings and enable much more that energy savings. Another key reason for using smart connected buildings is surveillance & security. However, as the topics of Energy savings and Security surveillance have been widely discussed and their ROI understood and accepted, these are not discussed further in the paper and we focus on the broader set of use cases which enhance space utilization and occupant experience in an enterprise setting.

2. ICT Enablers for Smart Buildings

In recent years sensor technology has evolved significantly while device costs have plummeted. Thus sensors can be deployed to monitor everything in a building including lighting, temperature, air condition, motion, presence & number of people etc. Also, cloud computing has enabled huge amounts of sensor data to be stored and powerful analytics to be run to drive strategic insights. Further, the intelligence need not be coded, and can be learnt and enhanced with use of machine learning algorithms. This capability, when coupled with edge computing, provides very low latency on automated and intelligent decision making. It includes several scenarios such as automated light control when a meeting room is empty, managing thermostat based on occupancy level and external weather conditions etc. This enables facility managers to manage, monitor & optimize real-time building operations.

Going a step further, ICT can be used to integrate the enterprise IT systems with the BMS built on API based design and information exchange. Thus BMS would integrate all relevant information (e.g., employee data, visitor schedule, email, calendar etc.) enabling accurate decisions based on contextual information as well as personalized preferences of occupants.

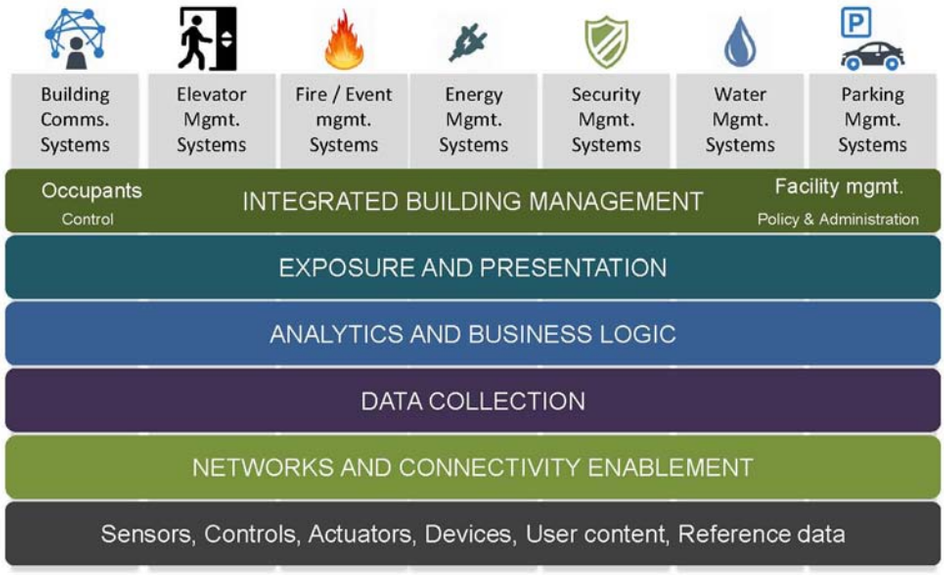

Fig. 1: ICT Framework for Smart Buildings

We can refer to the smart building ICT architecture stack presented in figure 1. As indicated, the sensors form the lowest layer in the stack and collect data, implement actions based on logic from above layers. This is followed by the Network layer which enables connectivity between different building systems as well as with enterprise systems, analytics engine and databases. Next is the data collection layer which includes databases/data centers for the smart building information that is collected over time. This is followed by analytics where business logic resides and drives the automated actions and generates insights for users. Above analytics, we have exposure and presentation layer which is used to structure information for the consumption by building occupants and facility managers. The whole stack is presented to users in the form of an integrated smart BMS, which can be used for controlling systems behavior as well as for administering any policies related to space management. Finally the BMS supports different vertical segments (such as communications, elevator, fire, water etc.) within the smart building.

3. Key Benifits

3.1 Employee Productivity

"Productivity isn't everything but in the long run it is almost everything" - Paul Krugman

Productivity in an office context signifies quantity and quality of work delivered by the employees. In most knowledge based work, a good way to understand productivity would be to measure the time, attention or amount of focus an employee can dedicate to a task. Unfortunately, these parameters are not immediately and directly measurable. Hence, we have used some indirect measures to understand the impact of smart buildings on employee productivity:

- Employee health & well-being: US labor force data indicates 3% of productivity is lost due to health reasons (US Department of Labor, 2016). A smart workspace provides a comfortable and stress free work environment to the employee. This is enabled by adequate ventilation, customized lighting and seating based on noise preferences etc. This has direct impact on employee well-being and health, leading to increased productivity.
- Employee control on workspace: A team at CMU identified eight case studies confirming the impact of providing individual temperature control on productivity gains of up to 3% (Loftness, Hartkopf, & Gurtekin, 2003). This is re-affirmed by a study from ASHRAE which indicates productivity improvements of up to 5% with configurable work environment (Fisk, 2002). In a smart building, employee productivity is enhanced by providing a configurable workspace and giving the control to employee so they can configure the workspace as per individual preferences. Thus, lesser amount of time is wasted in making and tracking helpdesk requests and employees can work at their optimal productivity levels due to improved comfort levels.
- Availability of resources to the employees: With smart BMS, employee productivity goes up as the meeting rooms are easily manageable over smart systems without need of an intermediator. Also, dynamic & intelligent seating allocation becomes highly relevant in agile and activity based projects. Employees working in same projects can be seated in proximity to facilitate collaboration and information exchange. This can evolve based on project requirements and can be updated once employees finish a project and move to separate teams on other projects.

We have discussed the positive impact a smart workplace can have on employee productivity. Considering employee costs are one of the highest components of OPEX for most organizations, productivity gains of as little as 1% via smarter workplace can translate into huge savings for the organization.

3.2 Employee Engagement

In the context of knowledge work, the cost of replacing an employee is quite considerable. It includes not only the hiring costs like job posts, interviews, negotiations etc., but also lost productivity due to inefficiency during notice periods and time & effort spent on training new employee. In many cases these costs add up to as much as two years of payroll cost for the position (Fitz-Enz, 1997). Thus it becomes paramount for an enterprise to focus on employee engagement. In the context of digitization, highly connected office environment and smart workspace have a major role in attracting and engaging employees. As we will discuss in section 4 (use cases), smart buildings provide employees with a comfortable, responsive and personalized workspace, thus enabling significant improvements in employee satisfaction and engagement. With smarter workspace, an organization can not only retain existing talent, but also promote its corporate brand value to double the likelihood of attracting new talent from market (Barklund, 2015).

3.3 Space Utilization

Smart buildings provide an array of data points which can be utilized by facility management to derive strategic insights. These can help in understanding how the space is being utilized, when is it not utilized, and ways to predict the space requirements into the future based on past trends and evolving enterprise data. Also, this analysis can be carried out dynamically with the real-time information from the smart building sensors and management system. Some of the examples where smart buildings enable higher space utilization are as follows:

- With constant monitoring of use of meeting rooms, facility managers can understand whether the meeting room is left un-booked frequently because it's not preferred by employees. The preference may be because of size, lighting etc. parameters which can be addressed to enhance utilization of the meeting room in future.
- In case the use of workspaces fluctuates heavily from low to high depending on days of week or season etc, the smart building data can be used to create forecast models so that facility managers can take informed decisions to either sub-let or sub-lease additional capacity as forecasted into the future.
- It's possible that for a particular organizational unit, the space utilization is observed to be constantly low (reasons may be due to high percentage of travelling, onsite or work-from-home employees etc.). In such cases long term decisions can be taken to reduce the footprint and lease smaller amount of space in future.

A study conducted by CBRE indicates that at least 30% of the space lies underutilized for different enterprises in APAC. For companies in the Consulting/Business services sector, the number is as high as 65% (CBRE, 2015). Smart buildings can enable facility managers to develop a better workplace strategy & planning so that a lot of this unutilized space can be released to save operational costs.

3.4 Benefits Illustration in Indian Context

Assumptions	***#***	***Units***
Employees	500	Headcount
Avg salary	700000	INR
Space requirement (Dhanalakshmi & Selvabaskar, 2014)	150	sqft / employee
Leasing cost (Construction World, 2017)	65	INR / sqft / month
Electricity usage (CDP. 2015)	2686	kwh / yr / emp
Electricity charges (Govt of India, 2017)	5	INR / unit(kwh)

Expense Calculation	***"Annual Expense (Cr. INR)"***	***Smart Building Impact***	***"Annual Savings (Cr. INR)"***
Salary	35	Productivity Enhancement	0.70
Office Leasing	5.85	Better Space Utilization	0.29
Energy	0.67	Energy Savings	0.17

An illustration is provided for an assumed office space of Technology company in the city of Pune. The efficiency is assumed based on references from previous sections. It indicates the possible benefits of converting the office into a smart building and also establishes that savings due to productivity & space utilization is significantly higher than just energy savings.

3.5 Benefits Summary

Below table summarizes the key benefits discussed in this section and maps them to performance metrics and corresponding operational savings for the enterprise.

Table 1: Key Metrics to Measure the Benefits of Smart Buildings

Benefit Category	*Impact of Smart building*	*Key Metrics*	*Operational Savings*
Employee productivity	Positively impacting employee health & well-being	# days (or hours) of absence due to health issues	Reduce operational costs in terms of employee time as well as medical/ insurance costs
	Enhance employee control on workspace	# Helpdesk Complaints related to temperature, lighting etc	Higher efficiency, meeting of timelines/deadlines
	Efficient resource availability to the employees	Reduced occupant requests via 'Help Desk' and other similar feedback systems	Reduced costs due to lesser overheads on intermediaries
Employee Engagement	Enhance employee loyalty	Attrition rates	Lower re-training costs
	Attract new employees	Percentage of employees joining who were made joining offer	Lower hiring costs
Space Utilization	Better utilize the space available with enterprise	# Complaints of non-availability of space / meeting rooms	Reduce costs spent in managing space
	Reduce space footprint in long run based on average utilization	Reduction in amount of space required per employee	Reduce real estate costs in long term

4. ICT Enabled use Cases in a Smart Building

Fig 2. Smart building use cases

The figure shows several use cases which can be implemented within a smart connected building. These use cases are explained and mapped to the benefits for the organization as follows:

Table 2: Smart Building Use Cases Description and Benefits Mapping

#	*Use Case Description*	*Benefits*
1	Automated building Entry / Exit for authorized users (car plate recognition) and automated space access by detecting identity badge proximity	Employee productivity
2	Automated car parking allotment & parking space management (lease additional parking slots or release slots to other organizations within the building)	Employee productivity Space utilization
3	Preventive maintenance of building resources: lift / common areas etc., to minimize down time. Also anticipate traffic and position the lifts accordingly.	Employee productivity
4	Hot desking: Dynamic seat allocation for collaborative work environment	Employee productivity Space utilization
5	Local environment settings as per employee preference, recommended guidelines and external weather (heating, lighting, ventilation etc.)	Employee productivity Employee engagement
6	Integrate email, calendar with meeting room booking system to enable automated booking management - suggest options based on number of attendees, location and earlier preferences of the meeting organizer. Thus employees do not book oversized rooms and also avoid the hassle of going through room choice manually. Booking is also released automatically in case meeting is cancelled / re-scheduled.	Employee productivity Employee engagement Space utilization
7	Digital signage - Use for stand up Agile meetings / discussion rather than booking out a room.	Employee productivity Space utilization
8	Pre-enrolled visitors for ease of access without wasting employee time.	Employee productivity
9	Connected facilities for replenishing consumables to avoid "out of service" and downtime for machines such as – Coffee machines, Printers, Tissue dispensers, Soap dispensers, Bins.	Employee productivity Employee engagement
10	Users can request workplace services via their smartphones, report faults via use of QR codes in different parts of the building via smartphone app	Employee productivity
11	Monitor movement, posture etc., and make recommendations - If employee is sitting for long hours, recommend a walk / break.	Employee productivity Employee engagement
12	Tracking space usage on weekly and monthly basis to forecast the requirements and decide the amount of space to be leased in future.	Space utilization

5. Key Stakeholders

5.1 Enterprises

As discussed in section-3, smart buildings not only accrue commercial benefits, but also enable higher employee satisfaction and corporate image. Stakeholders from different units within an organization can view the benefits in their perspective as highlighted in the figure below.

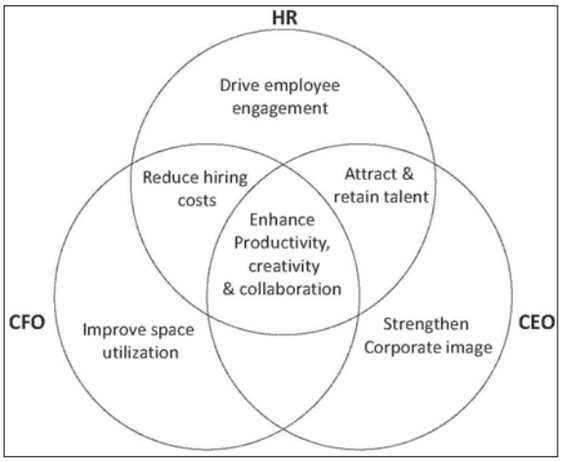

Fig. 3: Enterprise Stakeholder Perspectives on Smart Building Benefits

Enterprise IT department led by the CIO is another key stakeholder which enables these benefits for the rest of the organization. It must be understood that the true potential of smart buildings can only be realized when the enterprise IT systems are integrated with the BMS. For this, all smart building related decisions have to be either led by or developed in close collaboration with IT.

5.2 ICT Companies

ICT companies play the most important role in the smart building value chain as they are involved from the inception phase (Consulting) to delivery of smart building systems (ICT planning & design, Sensors & network deployments, Data center, Analytics and Customized application development) and continue into the operational support phase throughout the life of the building (by setting up and managing operations center for remote monitoring).

As the field of smart buildings is nascent, there are several consulting opportunities where organizations want to understand the applications of ICT to transform their offices into smarter workplace. While the subject of smart buildings falls underneath the umbrella of IOT, it needs

dedicated experts who can guide enterprises and facility managers through this transformation. A survey done by CABA indicates that most decision makers do not yet understand how to leverage the power of ICT, big data & analytics for their buildings (CABA, 2015). Thus role of Entrepreneurs & Consultants becomes critical in this space.

6. Case Studies

There are many cases of upcoming buildings with integrated, advanced and smarter ICT systems. Many of these initiatives have observed positive ROI within a short span of time. We have listed below a few case studies indicating some of the smartest buildings across the world:

THE EDGE, AMSTERDAM

The Edge is located in Amsterdam and occupied by Deloitte (Randall, 2015). It hosts a total of 2500 occupants. This building is considered one of the smartest workspaces in the world. It is specifically designed to with a consideration for agile work culture to promote employee collaboration. The building is packed with around 28,000 sensors and offers wide array of smart services ranging from automatic parking access, electric-vehicle docks, to user preference analytics. Lights are powered via Ethernet LAN transforming each lighting point into a internet connected data hub. Numerous employee friendly features make this building the model for future workplaces.

COLLIERS R&D, FRANCE

Colliers is an international real estate company and uses its R&D center in France to implement and experiment with new smart building concepts (Abdelnour-Nocera, Oussena, & Burns, 2015). With smart technologies, it has been able to achieve significant space utilization with 180 employees using just 140 workstations. It also integrated the employee IDs with building sensor network and enterprise systems to derive insights on space usage, and future workspace enhancements.

LE HIVE, PARIS

Le Hive is located in Paris and is occupied by Schneider Electric hosting 1800 employees (BREEAM, 2014). Considered one of the greenest and smartest buildings, Le hive offers a wide array of smart features to its occupants. Employees have full control over their workspace conditions like light, temperature etc., and can make changes via a smartphone app. The app has several smart features because of its integration with building management and enterprise IT systems. Employees are able to view room availability, book meeting rooms and find way through the building very conveniently. The building is also fitted with smart lighting and blinds controls. These smart features have complemented the green features to enable huge energy savings of 47% for the company.

7. Conclusion

As highlighted in the paper, it's pertinent that organizations understand that smart buildings have a lot more to offer than just energy efficiency. Also, to achieve maximum potential of its resources, an organization need to ensure that workspace is people centered, activity based and designed for flexibility with use of appropriate technology. With these aspects covered, enterprises can seek to attain higher employee productivity & engagement while ensuring better space utilization of their real estate.

Organizations which have not yet planned for this trend must understand that smart features will soon be must-have requirements for the building occupants (more so with increasing number of millennials in the workforce). It's no longer a question whether to embrace and invest in smart buildings or not. The question is whether your organization would be ready when smart buildings become essential for long term corporate success.

Glossary

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers

BMS – Building management system(s)

BREEAM - Building Research Establishment Environmental Assessment Method

CABA - Continental Automated Buildings Association

CBRE - CB Richard Ellis, an American commercial real estate company

CMU - Carnegie Mellon University

IOT – Internet of Things

M2M – Machine to Machine

QR - Quick Response Code

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