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Introduction

Background to Digital Transformation

Digital transformation, a new topic warming up since 2017, has many definitions, like a more specific one: digital transformation is using latest, faster and frequently changing digital technologies to solve those questions which rely on cloud computing. However, digital transformation should not only be capable of solving problems by cloud computing, it's more like a method, according to the definition from IDC: digital transformation is using digital technologies and skills to drive innovation of business pattern and way and re-construct the business eco-system [1]. By these definitions, digital transformation seems do not have enough effect to small or mid-size company, however, for those companies who have long history and solid foundation, digital transformation is an important level of enterprise strategy, according to a research from AppDirect, about 70% executives agree that only those industries have digitally transformed can survive in next five years. [2] Information above throw out few questions: what does digital transformation mean? And what we can do to about this? After reading this article, you may find some tips for these questions.

This Article first introduced IoT and intelligent buildings, and show some examples of those company which already start digital transformation process, and explained where can we change by applying digital transformation, what information can we get by applying digital transformation, what can we do after gathering these information, and finally, what actual benefits can we get from digital transformation. This article will help companies rethink the importance of digital transformation and help them respond to future challenges.

IoT and Intelligent Buildings

Before talking about digital transformation, first I want to talk about the IoT, abbreviation of internet of things, and more specifically, intelligent buildings. From the words of internet of things, it's not too hard to guess what included: smart system, big data etc. smart devices and systems connect together, collecting data, analysis, and making more personal, better experience for users, it not only provide efficiency and better user experience, cut down the cost, but also using gathered data to help user's decision, because of these features of IoT, it becomes the centre of digital transformation. As you know, there are many usages of IoT, but intelligent building is one of the usages which can fast deployed, and also easy to see the benefits, In order to work out intelligent building solutions, I did many background researches which you can see below, my background research include examples, plans, method and benefits, by referencing these solutions, business, government and people can get profit.

Background Research

Review

At first, I read through the background reading provided, the IoT one is quite general, talking about the IoT deployment situation for different industries, what reasons stop IoT deployment

and where is IoT usually uses on, it provides an overview of IoT. Then I start to look through intelligent buildings, market drive analysis explains four main reasons to drive investment of intelligent buildings: cost savings, occupant satisfaction, improvement of operational efficiency and sustain of economic growth. Smart cities start with smart buildings shows an opinion: if we want to build a smart city, we should start from smart building, this fine grain opinions told us an obvious fact: city is constructed by buildings, smart building doesn't need huge investment to get started, one building can become smart at a time. Smart buildings automation describes guidance to transform old buildings to be smart, it will start with thinking about the outcome and experience you want to get, then start to outline the goal and expectations after each time period, referencing exist examples and mature transform technologies, and keep updating exist solutions to prepare for future. These Background readings provide readers base understand of IoT and intelligent buildings and give me a clear guide to do advanced research.

According to previous background reading, I continuously doing these further researches, start from existing example of companies which have long experience in smart building area, understand those sources where data come from, what can these data been used, and what benefit can we get by collecting data and smart buildings, brief descriptions are showing below:

Table 1: Some of background research

How organizations are implementing IoT [3]	Overview of IoT
Market driver analysis [4]	Main reason of incoming investment of intelligent building
Smart cities start with smart buildings [5]	Example based intelligent building explanation
Smart building Automation [6]	Standardized approach make building "smart"
What is smart? A real estate introduction to cities and buildings in the digital era [7]	Explain impact of smart buildings from smart grids and digital skins
A review of smart building sensing system for better indoor environment control [8]	Provided a systemic view of how sensors managing indoor environment
Worldwide smart building market opportunities, 2019-2024-Emergence of 5G technology & rising smart city trends [9]	Worldwide smart building solution providers
Smart buildings: A monitoring and data analysis methodological framework [10]	Describe data collection from sensors and data analytics
Assessing the impact of smart building techniques: a prospective study for France [11]	Smart building help energy saving
Smart technology in the home [12]	Smart home is constructed by smart homes
The feasibility of highly granular lighting control in open-plan offices: Exploring the comfort and energy saving potential [13]	Exploring different dimming levels affect to participants and energy saving

Tables above just explain some of background researches I did, in order to finish this article, more background research are done and will be mentioned later.

Opportunities

As the improvement of IoT marketing, the achievement of IoT become easier, and more facilities which originally only exist in imagination came true, advanced sensor and communication technologies allow us to build smart building in a way with less influence of normal user experience and perform instant data analysis, this also provide chances for concepts of IoT spread widely. By referencing examples recently, there are many opportunities for IoT to meet:

1. Smart workplace improves experience of customers and occupants.
2. Smart home gives new imagination to more personalized home experience.
3. Smart traffic, public safety, emergency services and transport help people waste less time on traffic jams, give citizens more confidence of their city, improve survival rate of urgent patients, save more times on commuting.
4. Smart school gives students more chance to achieve academic access.
5. Smart hospital helps doctors take care their patients better.
6. Smart farming raises plants production.
7. Smart parcel companies provide faster parcel delivery experience for customers.
8. Smart energy management and waste management respond the call of sustainable development.
9. Auto driving, drones and robot free people from repeating works, replace people from dangerous scenarios.
10. Smarter aerospace makes people explore deeper space.
11. Smart military equipment management provide longer lifespan to high-value equipment.

The market of IoT is extremely large and the potential usage still not be fully untapped, IoT aims to make internet even more immersive and pervasive [14], but overall, IoT is provide service for people and markets of IoT are main surrounded by people's living quality.

Data sources

From beginning, this article has mentioned that IoT can't work independently, if IoT wants to be smart must build on large amount of data, but the problem is where can we get different data for analysis, the main method to collect data nowadays is from sensors, but actually, there are two methods to collect data: physically and automatically.

Physically: Survey or questionnaire, a low-resolution data collection method, however, we cannot deny survey is an very important way to collect data until other data collection methods have not been introduced, see this from now, there are many disadvantages of using survey to collect data: usually, observers might spend days to finish his data collection, which also

increase the humanity cost, but finally got less information than expected, this method is now start to be discard by many companies.

Automatically: the reason sensor market increasing can be found in different ways, the cost for sensors has dropped more than 60% in the past 10 years, and because of the improvement of communication technologies, more modern sensors can connect to WIFI and become more accessible, the increase of sensor's performance is also a reason to make data collection automatically. Different sensor can collect different data:

1. From security and access control systems.
2. Environment supervising data: temperature, humidity, carbon etc.
3. Family intelligent gateway.
4. Location information devices
5. Manufacturing and production devices
6. Consumer durable goods (television).
7. Utilities infrastructure
8. Connected fleet vehicles
9. Surveillance
10. Medical devices
11. Aerospace data centre
12. Cloud computing centre
13. Wearable devices

Data collect are now become easier, high-resolution and on an ongoing, real-time basis, and with the help of machine learning, data can be used in a more accurate and efficient way to help people innovate more new features.

Possible features

This section works out those features can be used of IoT according to opportunities and source above:

1. Help monitor occupants, achieve unmanned attendance recording, also help energy management and improve the security of the building.
2. Integrate body temperate detect sensor on monitor systems to avoid spreading illness.
3. Environmental data track and adjust like air temperature, carbon and lighting.
4. Location data-collect ingoing basis throughout the day to help plan various space design.
5. Office assets meta-data collection.
6. Office personalization.
7. Automatic, remote family smart device control and monitoring.
8. Retrieve and collate geolocation information from supply chain distribution vehicles and optimize delivery and inventory between distribution centres.
9. Integrating geographical information system features.
10. 3D urban models.

11. Building information models.
12. Autonomous vehicles.
13. Monitor and manage utility grid elements for improved generation and distribution efficiencies.
14. Face recognition help catch criminals.
15. River network redesign, better water resources allocation.
16. Social media support city governance and service.
17. Intelligent traffic management.
18. Intelligent public transport dispatch.
19. Sensor and cloud computing based ETWS (earthquake & tsunami warning system).
20. Submarine resources exploration.
21. Unmanned supermarket-goods automatic recognition, payment by face recognition.
22. Personalized discount for different customers.
23. Dynamic storage management from collected data.
24. Real-time and personalized anomalies ICU patient treatment.
25. Wearable based non-urgent disease diagnoses (according to blood pressure, body temperature, heart rate etc.).
26. Wearable based action and sleep monitoring give advice about health to users.
27. Patient traffic shifting between crowded hospitals and vacant hospitals.
28. Dynamic solidier and equipment dispatch.
29. Battlefield monitoring and investigation.
30. Plants' nutrients, water monitoring.
31. Soil monitoring-yield based soil quality dynamic adjustment.

As we can see, IoT can help people across industry, business, environment, traffic, delivery, security and medial aspects, IoT builds a large network connected between people, device and sensors.

Benefits

From beginning, things being invented are used to help people's daily life, IoT are the same, by deploying different sensors and smart devices, people can get lots of benefits, after considering difference scenarios, because of the page limit, only part of benefits list below:

For workplace:

1. Smart office help companies cut down estate costs and per-employee cost, create more space for workers and reduce energy cost, then achieve revenue growth.
2. Better environment can increase customers' satisfaction and occupants' efficiency, occupants will have more passion on their works.
3. Connected working devices makes virtual environments come true, and allow employees to stay connected anywhere they want.
4. Increase density of offices can free up more space encourage collaboration and increase productivity.
5. Flexible working place will help companies retain talent.

6. Smart workplace can help companies manage assets better.
7. By deploying smart building, automatic HVAC control, estate can provide more comfortable environment for different offices, can realize the increase in rents and get more long-term tenants.
8. Sensors can give tips for estate to arrange difference services and maintenance.

For home:

1. Smart meters can send energy usage regularly to help users drive reduction in consumption.
2. Centralized control can give more convenience while managing difference devices, provide better in-home experience.
3. Automatic environment control can provide more comfortable and convenience experience at home.
4. Connected smart devices allows users realize the working situation of different devices and arrange maintenance earlier to avoid inconvenience.

For difference industry:

1. Integrating geographical information systems will help parcel companies track their supply chain to let more package deliveries per employee and provide more accurate delivery times for customers to make their arrange times and avoid re-delivery.
2. Automatic customer preference analysis system will provide personalized advertisements and discount information to different customers to make revenue growth.
3. Different sensors can work together to track assembly line to improve product quality then improve customer satisfaction.

For city:

1. Face recognition in some aspects can deter criminals, and can also help catch criminals, increase the safety of city.
2. Smart grids, dynamic resources management can help save energy, respond sustainable development of earth.
3. Cloud computing can help people predict disaster like extreme weather, earthquake etc. earlier, can help people protect themselves and their properties.
4. Intelligent traffic management, public transport dispatch, auto drive provide citizens better experience on road.
5. Wearable devices provide non-invasive health monitoring and real-time health data collection.
6. Smart hospital can allocate medial resources reasonably, reduce time wait of patients.
7. Smart farming can provide good quality, larger quantity to avoid hungry.

Benefits given by IoT are far more than this list, and as the development of IoT, there will be more new features been worked out, and people will get more benefits.

References

1. IDC: The premier global market intelligence company. (2019). *IDC - IT EXECUTIVE - Digital Transformation (DX)*. [online] Available at: <https://www.idc.com/itexecutive/research/dx> [Accessed 11 Oct. 2019].
2. AppDirect. (2019). *AppDirect Study Finds that 86 Percent of Executives Believe Platforms....* [online] Available at: <https://www.appdirect.com/about/press/releases/appdirect-study-finds-that-86-percent-of-executives-believe-platforms-are-the-key-differentiator-for-successful-digital-transformation> [Accessed 11 Oct. 2019].
3. Canvas.qub.ac.uk. (2019). *How organizations are implementing IoT*. [online] Available at: <https://canvas.qub.ac.uk/courses/8445/files/301945/download?wrap=1> [Accessed 11 Oct. 2019].
4. Canvas.qub.ac.uk. (2019). *Market driver analysis*. [online] Available at: <https://canvas.qub.ac.uk/courses/8445/files/301946/download?wrap=1> [Accessed 11 Oct. 2019].
5. Canvas.qub.ac.uk. (2019). *Smart cities start with smart buildings*. [online] Available at: <https://canvas.qub.ac.uk/courses/8445/files/301947/download?wrap=1> [Accessed 11 Oct. 2019].
6. Canvas.qub.ac.uk. (2019). *Smart building automation*. [online] Available at: <https://canvas.qub.ac.uk/courses/8445/files/301944/download?wrap=1> [Accessed 11 Oct. 2019].
7. Lecomte, P. (2019) 'What is smart? A real estate introduction to cities and buildings in the digital era', *Journal of General Management*, 44(3), pp. 128–137. doi: 10.1177/0306307018823108.
8. Dong B, Prakash V, Feng F, et al. A review of smart building sensing system for better indoor environment control[J]. *Energy and Buildings*, 2019.
9. PR Newswire (2019) 'Worldwide Smart Building Market Opportunities, 2019-2024 - Emergence of 5G Technology & Rising Smart City Trends', PR Newswire US, 9 October. Available at: <http://search.ebscohost.com/queens.ezp1.qub.ac.uk/login.aspx?direct=true&db=bwh&AN=201910091500PR.NEWS.USPR.IO98060&site=eds-live&scope=site> (Accessed: 11 October 2019).
10. Bolchini C, Geronazzo A, Quintarelli E. Smart buildings: A monitoring and data analysis methodological framework[J]. *Building and Environment*, 2017, 121: 93-105.
11. Ieeexplore.ieee.org. (2019). *Assessing the Impact of Smart Building Techniques: a Prospective Study for France - IEEE Conference Publication*. [online] Available at: <https://ieeexplore.ieee.org/abstract/document/4781017/citations#citations> [Accessed 11 Oct. 2019].
12. Darby, S. J. (2018) 'Smart technology in the home: time for more clarity', *Building Research & Information*, 46(1), pp. 140–147. doi: 10.1080/09613218.2017.1301707.
13. de Bakker, C. et al. (2018) 'The feasibility of highly granular lighting control in open-plan offices: Exploring the comfort and energy saving potential', *Building & Environment*, 142, pp. 427–438. doi: 10.1016/j.buildenv.2018.06.043.
14. Ieeexplore.ieee.org. (2019). *Internet of Things for Smart Cities - IEEE Journals & Magazine*. [online] Available at: <https://ieeexplore.ieee.org/abstract/document/6740844> [Accessed 12 Oct. 2019].
15. Plageras, A.P., Psannis, K.E., Stergiou, C., Wang, H. and Gupta, B.B., 2018. Efficient IoT-based sensor BIG Data collection–processing and analysis in smart buildings. *Future Generation Computer Systems*, 82, pp.349-357.