CSC4008: Assignment 1

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Introduction (20%)

Digital transformation is the integration of digital technology into all areas of business, reimagining a business for the digital age. This fundamentally changes how a business will operate, whether that be internally or delivering value to customers.

Digital transformation isn’t only limited to larger, established corporations but also to small businesses starting out and everything in between. Utilizing digital transformation can be the most effective way in future-proofing an organisation.

Digitalisation allows a business to simplify and streamline established practices of the everyday work. The way business is carried out does not change but operational efficiency increases.

On the customer side, digital transformation increases satisfaction and will most likely result in repeated business. It also allows customers to take a more independent approach to doing business. We see examples of this in everyday life such as self-checkout tills at M&S and Tesco.

On the employee side, digital transformation allows for more efficient processes to occur; allows access to entirely new levels of collaboration and connectivity, data and analytics and vastly superior systems. All this combined empowers the employee to be their best individual self.

Thanks to the introduction of digital transformation, the building in which employees work not only offers all resources they need but does this whilst also making the building as efficient as possible. This in turn minimizes costs and increases energy savings throughout the lifetime of buildings.



Figure Secretary of State Karen Bradley is pictured with, from left, John Healy and Suren Gupta of Allstate and Invest NI chief executive Alastair Hamilton at the new Allstate building at Mays Meadow, Belfast [1]

Smart buildings use technology to enable businesses, school and various other establishments to make better and more effective decisions with data obtained through IoT sensors, artificial intelligence (AI), systems and augmented reality. Smart buildings can use a wide variety of technology and are designed be retrofitted with future technological developments.

All core systems within a smart building are interlinked can also create a smarter environment for employees. This is a fundamental feature of a smart building. For example, IoT occupancy sensors and building management systems working together can allow a building to automate various processes including security, ventilation, heating and maintenance.

47% of businesses view IoT as essential or important to their business. [2] In the coming years this figure will only increase as costs for IoT sensors decrease and other businesses begin to see the benefits provided by digital transformation and IoT.

Analysing data retrieved from smart buildings gives a business an insight into trends and usage patterns, allowing for informed decisions to be made in how to optimize a building. This can lead to increased productivity, reduce energy consumption and operating costs. A balance is key for a business moving forward. Smart Buildings and the Internet of Things (IoT) is now here.

Background Research (30%)

Various drivers exist as to why a business may want to shift towards digital transformation. A survey carried out by Navigant Research shows that the most important driver for investment into smart building technology is cost savings, with 44% stating this is the most important factor, followed by occupant satisfaction (22%) then operational improvement. (19%) [3]

As net-zero targets need to be met, climate change becoming an even greater focus and the cost of the living soaring, smart buildings are becoming even more relevant in 2022 than they ever were before.

Chart, line chart

Description automatically generatedIn order to enable the use of smart buildings, data collection has moved from low-resolution to high-resolution. With IoT sensors, it is now possible to collect high resolution data streams on an ongoing and real-time basis (data collected every few minutes rather than every few months or years) [4]

Hardware prices of IoT sensors has dropped significantly from $1.30 in 2004 to $0.60 in 2014. Prices were projected to drop to a further $0.38 in 2020. [4]

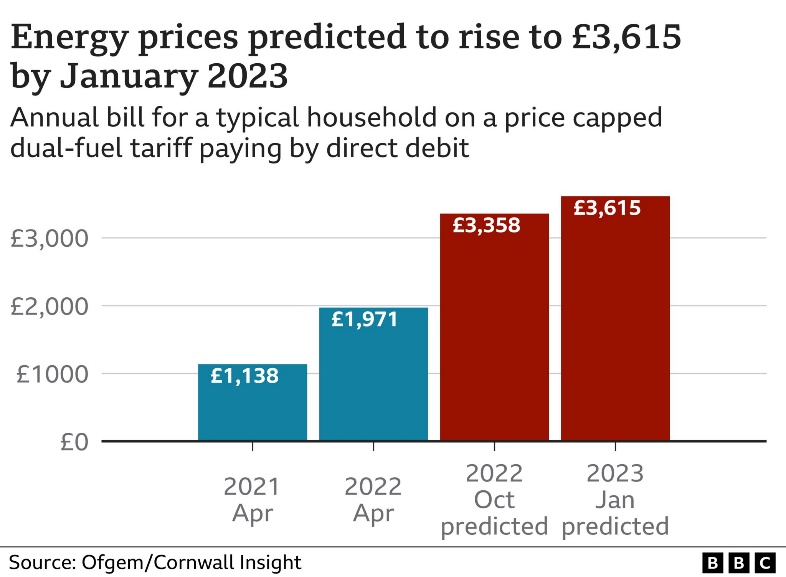
Most modern sensors now can connect to Wi-Fi and networks and the data collected can be accessed via an API in common formats.

Deloitte estimates that sensors in real estate will grow at a 78% annual growth rate between 2015 and 2020, with a total of 1.3 billion sensors deployed by 2020 [4]

Figure Cost of IoT Devices [4]

With this predicted rise in IoT sensors, real estate professionals can collect new streams of data on a more consistent basis, and able to do so in future for less expense. The United States of America is home to over 5 million large commercial buildings such as warehouses, offices and schools. It is estimated that these buildings are responsible for over two-thirds of the U.S. energy consumption, while over an estimated 30% of the country’s electrical use is wasted. [5] With IoT sensors able to automate processes like heating and power usage, these figures will see a gradual decrease as more and more is invested in digital transformation.

In 2022, gas and electricity prices have soared in the UK, with the annual bill for a typical household to be £3,615 in January 2023 [6] The soaring cost of living can be seen as a major factor into investing in smart buildings and IoT.

This exponential increase doesn’t just affect households, but businesses also. With the decrease in cost of IoT sensors, there has never been a better time for businesses, and even households to invest.

Electricity bills have potential to be lowered, with smart thermostats and lighting systems able to monitor energy consumption. Facility managers can change the schedule and reduce the energy use of several electronics during peak hours if it is found that they are not in use.

Figure Energy Bills Prediction [6]

Many homes today already utilise some form of IoT sensors including a service called Hive that can help to save up to £311 on energy bills [7]. This allows a user to monitor everything from a heating to lights and sensors all from one app. This can also be controlled through voice assistants like Amazon Alexa and Google Home. These IoT sensors allows a family to make savings whenever possible all from their own voice and phone application.

Along with the savings that come with smart buildings and homes, they can also digitise the workplace. This is the evolution of the typical workplace. All technologies used encompass the digital workplace, including the ones currently in use and ones that have yet to be implemented. These can range all the way from email all the way to virtual meeting tools.

While costs of implementing a more digital workplace may deter businesses, there are several benefits that should ease those worries. This includes:

* 64% of employees would opt for a lower paying job if they could work away from the office. [8]
* Organizations with strong online social networks are 7% more productive than those without. [8]
* Organizations that installed social media tools internally found a median 20% increase in employee satisfaction. [8]
* When employee engagement increases, there is a corresponding increase in employee retention by up to 87%. [8]
* Information workers prefer newer communication tools, particularly instant messaging, over more traditional ones like e-mail or team workspaces. [8]

Allstate in Belfast, Northern Ireland have recently opened their new building at Mays Meadow in 2018. Managing director of Allstate Northern Ireland, John Healy, stated: “The building delivers a stimulating, collaborative working environment for employees. The impressive design fits the requirements of our world-class organisation and supports our outstanding employees in defining, delivering and maintaining technology now and for the future.” [1]

This combination of digitalisation workplace and Allstate, Northern Ireland’s Largest IT Company, creating new smart buildings that maintains technology now and for the future gives employees options on how and where to work, ensuring they are as efficient as possible no matter where they are.

Opportunities (10%)

While IoT is mostly focused on businesses and how they can become more efficient through smart buildings and homes, the benefits that IoT can bring to the 21st century cannot be overstated.

Modern global challenges that negatively impact our environment can be tackled using bespoke IoT solutions. This includes:

* **Climate Change –** Even if we stopped using greenhouse gases, earth’s surface would still take thousands of years to cool back to pre-industrial conditions [9] for us to stay net zero, buildings can be equipped with IoT sensors that track energy consumption, heating, lighting, and elimination of waste sustainably. The Computer Science Building at Queens University Belfast utilises several sensors in the labs, detecting whether students are inside and turning specific lights, saving energy.
* **Water –** IoT could be used to improve the efficiency of water systems, predicting when maintenance needs to occur, avoiding equipment downtime. Water quality could also be monitored through IoT to prevent pollution and in some cases even improve water quality.
* **Agriculture –** Fields could be monitored in real time with IoT. With the help of these sensors, farmers’ time can be saved as well as reducing the extravagant use of resources such as water and electricity. A real time observation of various factors such as temperature, soil quality and humidity can be kept under check too.
* **Waste** – Control of the waste through smart cities can help keep them clean. Sensors can be added to bins to track the amount of rubbish is in it. Once full, a waste gathering can be setup, optimising the best route drivers, strengthening the environment.
* **Wildlife** – Many animals today are endangered and run the risk of becoming extinct. With the use of IoT sensors such as drones and collars can help monitor endangered species, providing immense help in conservation of these animals.

Many other business ideas can implement IoT into their products that provide an exciting experience for the customer.

* **Healthcare and Fitness –** While fitness wearable have existed for some time, IoT can go further. Heartrate readings can be easily monitored and passed onto to a medical professional quickly. If a user has a smart fridge, data collected from a workout can be synced with this and tell a user the proper nutrition they need.
* **Retail** – Various stores in the U.S. have already utilised IoT to provide several features for their customers. An example of this is a customer’s bank balance is already debited when they leave a store, eliminating the need for cashiers.
* **Toys** – Toys can include IoT sensors inside them such as a walkie talkie. Parents can use an app to send the walkie talkie messages when they are away from their child at work.
* **Cars** – While driverless cars are becoming more and more of a reality, security can be improved using IoT technology. Various sensors in a car could be implemented to help track a driver’s weight, height and arm length etc. If for any reason these do not match, the car can lock itself from driving immediately. Other IoT sensors can be implemented to ensure a driver is at a safe distance from a car ahead of them etc.

Data Sources (10%)

For IoT to work effectively, data must be collected. Where this data is collected depends on what the data is needed for. Data doesn’t tell a story by itself but by combining it from disparate sources, software engineers can computer scientists are given a completely new view on how to solve a problem.

Data can be obtained from various sources, allowing the creation of a wide range of IoT solutions.

**Industrial Control Systems**

Control systems are used to control industrial processes such as product handling, manufacturing and distribution. This can include several over types of control systems including Supervisory Control and Data Acquisition (SCADA).

Data has been obtained by these systems for decades and thanks to machine learning, this data can be utilised and for IoT-based predictive maintenance, scalability, remote management and monitoring.

By applying machine learning to SCADA data, a business can predict a fault failure or can determine the remaining life of a specific hardware, potentially savings millions in operational costs

**Business Data**

Customer Relationship Management (CRM) are utilising IoT technology to improve front-end processes. Engineers having access to all customer data through CRM can give them a detailed history. Customers won’t have to call the business to get an issue sorted.

Predictive maintenance can also be utilised with IoT. If an asset is still under warranty, IoT and machine learning can connect a device to Enterprise Asset Management (EAM) system and check if it is still under warranty. If is shown that it is still under warranty, a maintenance crew doesn’t need to be sent. Instead, a message can be sent to the asset to call the manufacturer to fix it, helping to reduce maintenance costs and prevent warranties from being compromised.

**Wearables**

Data collected from smart watches and wearables can help to encourage healthier habits and optimize physical health. Sleep data can also be obtained, telling a user how long they slept and give tips on how to improve their sleeping habits.

In a more industrial setting, wearables can help make dangerous jobs safer, easier and more secure. Gas detection sensors could potentially track an employee’s exposure level. When displayed alongside their work schedule, optimal times can be established to lessen health risks that might arise from gas exposure.

Helmets can also use IoT to detect fatigue in drivers by analysing brain activity. Once detected, the driver can be told to stop driving and let their manager know, helping to prevent an accident.

***Sensors***

In the context of smart buildings, occupancy IoT sensors can be utilised to obtain a real-time visualisation on the utilisation of rooms, common areas and desks. These sensors could be placed under desks to determine whether it is in use, sensors placed on ceilings to determine if heating needs to be activated. These sensors can even be introduced to the outside of smart buildings to adjust ventilation and temperature inside based on outside conditions.

These sensors help to provide a complete picture of the usage of a multiple offices and buildings through just one entry point and enables optimizations for all rooms in a smart building.

Possible features (10%)

Digital transformation alongside IoT provides many structures to preserve data, helping to alleviate many tasks that employees would have had to do themselves. Once firms IoT foundations have been established, these foundations can maintain the daily tasks of a business meaning information cannot be lost due to human error.

IoT devices such as semiconductors are becoming smaller, allowing them to be produced at scale and be used in areas that may not have seemed possible 10 years ago. These smaller IoT devices make it possible to analyse air quality to protect people from the effects of pollution.

An IoT solution can be useful on its own but when combined with AI can become even more useful. With large datasets of raw data collected, machine learning models can be utilised on that data and convert it into something more insightful to better understand changes in an environment.

IoT solutions also provide smart and quick responses for business. Data is unhindered from employee mistakes, with this information being uploaded directly and immediately, a business can respond just as fast to it. With constant updates to data, a business can save energy, resources and time.

IoT solutions can integrate well within existing technologies such as big data, deep learning, machine learning and cloud computing. Entire ecosystems can coexist with IoT, saving a business time and resources should they choose to start implementing an solution. Once implemented, quality of work will be enhanced almost immediately.

Any IoT solution must be dynamic in order to change depending on a business use. In a smart building, heating must know when to turn on when someone enters the room. It must also know the specific weather conditions outside in order to set ideal temperatures inside.

Working with large datasets, security must be one of the major features of any IoT solution. Sensitive data can be carried and stored in an IoT system, so security must be of utmost importance. Security must not be an after thought when designing an IoT system and must be implemented during the development of an IoT system to prevent any possible breach. This may be seen as one of the big deterrents implementing an IoT solution in a business with the resources and time needed to ensure it is secure. Failure to tackle security will lead to a mistrust amongst users and businesses and in turn, demand diminishes.

Benefits (10%)

With all possible features discussed and opportunities that arise from implementing digital transformation and IoT, there are numerous advantages that come with implementing a solution securely and correctly.

Productivity can increase with thanks to IoT solutions. By offloading mundane tasks to automatic processes of IoT, it allows more skilled employees to tackle more complex tasks that require more involved work and thinking. Thanks to IoT and digital transformation, the workforce can be scaled down, reducing cost to a business.

Automated control over various operations of a business thanks to the interconnection of various IoT devices, allowing for more efficient operation management. This can include areas such as inventory management and shipment tracking. For this business, an RFID tag can be connected to a network of sensors. This allows a business to easily track the location of various goods.

This automated control also applies to other areas of a business, such as improving energy management and water usage. IoT sensors that detect motion in rooms can reduce business resource and asset use by disabling use of certain functions of that room. This can be implemented in small and larger businesses and allows them to reach net-zero targets quicker.

With the integration of digital transformation and IoT also comes improved work safety. With a network of IoT including motion sensors, security cameras and monitoring devices, the security of a business can be ensured. This helps to prevent thefts and in some rare cases even espionage.

Smart devices such as voice assistants and smartphones etc, that reside with a customer are an invaluable source of information. With large volumes of user specific data, businesses can target specific adverts that are relevant to a customer and even fine tune their price policy for specific customers. In turn, this helps a business understand a customer better and leads to improved customer service and retention.

A business that employs a bespoke, secure high-tech IoT solution is more likely to make a positive impression for the customer, investors and business partners, providing the business with a trustworthy image that is likely to attract highly experienced staff that can help to improve the vision of digital transformation further.

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