UNIT 19 INTERNET OF THINGS

Assignment 1

Learning aim A
Examine systems and services that form part of the Internet of Things

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Contents

Introduction

This report aims to examine the real-world impact of IoT systems, and the various components, applications, and challenges associated with these systems in the modern world. Furthermore, it will highlight specific scenarios where IoT systems play a crucial role

in enhancing quality of life and, in some cases, even saving lives, particularly within the healthcare sector.

What is the IoT?

While the IoT (Internet of Things) is a relatively new concept and idea, coming around only in the 21st century, there remains a lot to be said about this innovative technology. The IoT refers to a network of objects embedded with electronics, software, sensors, and connectivity which enables them to connect and exchange data. This encompasses a wide range of devices, including physical objects, vehicles, household appliances, and other items that meet the aforementioned criteria.

What do we use IoT for?

The IoT (Internet of Things) is widely utilized across the globe, encompassing a diverse range of industries. There are several key sectors, including:

- Home Sector
- Health Sector
- Industrial and Transportation Sector
- Retail and Commerce Sector

The applications of IoT vary greatly based on the specific industry or environment for which it is designed and implemented. For instance, in the Home Sector, IoT may be used to control a remotely operated radiator, while in the Transportation Sector, the focus may be on advanced traffic management systems rather than smaller devices like a radiator or thermostat.

IoT Systems

The Internet of Things systems have a significant impact across various industries, including the Home, Health, Industrial and Transportation, and Retail and Commerce sectors. The role of these systems varies depending on the specific situation, with each sector leveraging IoT systems to improve quality of life and other relevant aspects. The following provides examples of IoT systems utilized in different sectors.

Home Sector

The rise of the Internet of Things has had a profound impact on our daily lives. With an increasing number of devices able to connect to the internet and be controlled remotely, we now have greater control over many aspects of our homes. From smart cameras and thermostats, to speakers, lights, and plugs, these IoT devices are making it easier to manage our homes and enhance our daily experiences. With the use of a mobile app, we can control these devices from anywhere, at any time, making our homes more comfortable, convenient, and efficient places to live.

Health sector

In the health sector, the IoT has had a major impact. It has completely overhauled the way the patients are receiving care alongside aiding the medical professionals that are providing said care. Due to the increasing production and emphasis on IoT systems, there exists a not

insignificant number of devices that help to monitor and manage health conditions, such as wearable fitness trackers, smart scales, and other medical devices. These systems collect data to be analysed and compared to previously available data that helps to identify any potential health hazards or issues the patient might run into. This promotes more personalised care that is catered towards an individual, increasing the quality of care they receive. Additionally, IoT systems have enabled patients to connect to medical professionals remotely for different procedures such as a consultation or follow up, such as seen with AskMyGP in the UK. Finally, this has allowed the healthcare system to be much more accessible for everyone.

Industrial and transportation sector

The impact of IoT systems in the industrial and transportation sector is undeniable. IoT has transformed the way businesses and organizations operate, providing real-time data and insights on various systems. This has led to improved efficiency, reduced downtime, and increased productivity. IoT sensors, for instance, can monitor industrial machinery and vehicles, giving businesses valuable information on their performance and location. This optimizes processes and procedures, making operations more effective.

In transportation, IoT systems are used for tracking and monitoring vehicles, resulting in faster delivery times and increased road safety. Furthermore, integrating IoT can also help reduce fuel consumption and promote eco-friendliness in businesses.

Retail and commerce sector

The retail and commerce sector has benefitted from the use of IoT systems in a variety of ways. However, there any many opportunities for improvement that can be found detailed below.

One example is the implementation of smart shelves, which keep track of inventory levels and let store managers know when stock is running low. Another is smart shopping carts that help customers keep track of their purchases and simplify the checkout process. IoT sensors can also be used in inventory management systems to monitor the movement of goods within a store. Electronic price tags, updated remotely with IoT, can eliminate the need for manual updates. Customer experience can be improved through the use of IoT sensors and cameras that gather data on customer behaviour. Predictive maintenance using IoT sensors can prevent equipment downtime. Contactless payment systems using IoT technology reduce the risk of infection and augmented reality displays provide customers with interactive product information and recommendations.

Home Sector

Smart Doorbell

A smart doorbell is a great example of an IoT system that is commonly used in the home sector. A famous example of the smart doorbell is the ring camera, which works through an application on the phone and an internet connection.

Purpose

The purpose of the smart doorbell in the home sector varies depending on the person, however it follows the general idea of serving as a way for people to view their front door while not answering the door or not being home. Another purpose for this IoT system is to be used as a way to receive a parcel or speak to the delivery driver in order to request that a parcel is left inside or nearby, or any other instructions.

How does it work?

The smart doorbell works similarly to most IoT systems. In this specific example of the Ring doorbell, it works by first being calibrated and connected to a network that is constantly operating nearby. This is most commonly done on a mobile device such as a phone or tablet, however some products may offer a desktop setup. Once the doorbell has been connected to a network, it is setup outside of a door and holds a sensor that works based on motion detection or button activation when someone would press a button on the doorbell to "ring" the doorbell. This then sends a notification through the internet onto a mobile device that also has an internet connection, and also has the specific software for the hardware, which in this situation is the doorbell. Once the notification has been received, the user can access the application and view the live camera feed, choosing whatever action they want, whether that be answering the door or talking to the person through the doorbell.

Smart Lighting

Smart lighting is another great example of an IoT device that has come into the limelight recently. It provides people with a way to control lighting both inside and outside of the house, ensuring that money is not lost on electricity bills from the lighting. Additionally, these lights usually tend to be LEDs with multiple colour options, giving more life to peoples living rooms and many more.
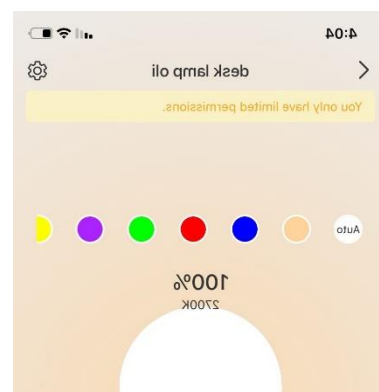
Purpose

As mentioned above, the primary purpose of smart lighting is to provide people with a way to turn lights off and on remotely. This has a host of benefits that greatly improve quality of life, such as being able to control all the lights in the house from a mobile phone, and not having to worry about whether all lights are disabled once someone leaves the house as they can just check through their phone. They also tend to have an added benefit of offering multiple colour options and being LED lights.

How does it work?

Smart lighting works similarly to the Smart Doorbell. Initially, the light is screwed into an empty light. From there, a user will have a specific application that they are required to download, the software, in order to connect to the light and calibrate it. Similarly, the light must be calibrated by being connected to the network so it has constant access to the internet. Once calibrated, the user is then able to send a signal through the internet containing the instructions for the light that they accessed through the application, such as turn on, turn off, change colour, and change brightness.

Health Sector

Remote Patient Monitoring

Remote patient monitoring is one of the most recent inventions from the health sector that allow clinicians and technicians to monitor patient's health from remote locations such as their office. It works as a way for patients to remain out and about while also remaining monitored, giving them more freedom in their life but not sacrificing their safety, security and health.
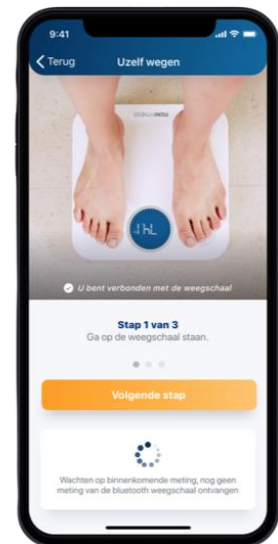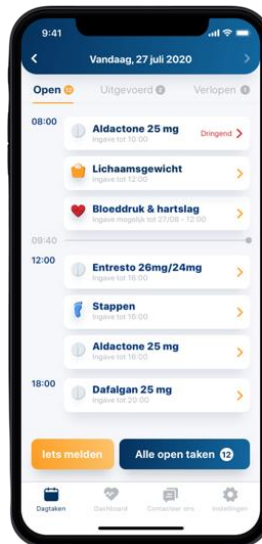
Purpose

The purpose of remote patient monitoring is to communicate important information about patients to clinicians and technicians, and once this information has been communicated then the healthcare professionals are able to make adequate and important decisions while being well informed. Finally, this is a great way for patients to continue to live their life while not jeopardising their health and the quality of any reports they might have to make about it.

How does it work?

Remote patient monitoring works by connecting to a mobile device through a network like Bluetooth or 4G, and then transmits the necessary data to the hospitals and healthcare professionals. One device that tracks information like this is a weight scale, and another example is a blood pressure monitor. This is accomplished by connecting these to the network or mobile device, which sends the information to the hospital without any input from the patient.

Pacemaker
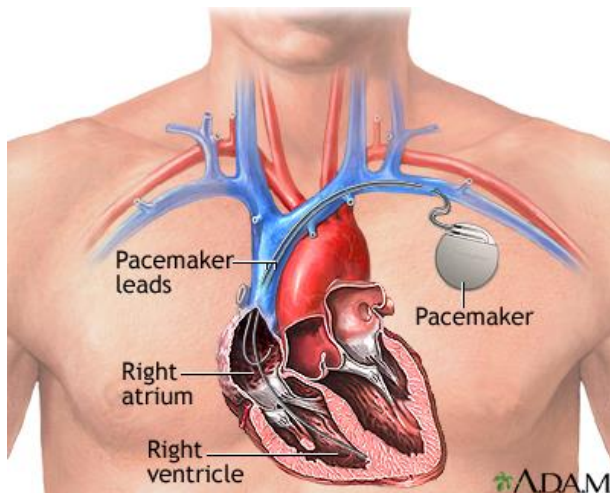
A pacemaker is a vital piece of IoT that works inside of patients to send electronic pulses to your heart to keep it beating at a regular and adequate speed in order to make sure that your heart is functioning properly, and there are no issues with your heartbeat. This is a device that can be crucial in improving people's quality of life if people have issues with slow heartrate and for others, it can be lifesaving.

Purpose

The purpose of a pacemaker is described as above. It works to keep the heart beating at a constant and regular pace to make sure that it is not too slow. This can prevent a number of issues, most notably, a slower heartbeat which can greatly impact someone's ability to live a normal life. It causes issues such as chest pain, confusion, memory problems, and dizziness or light-headedness.

How does it work?

A pacemaker works by being installed just above someone's heart under their collarbone, and senses, using wires, whether or not the heart is beating fast enough. If it is not, or it

misses even a single beat, it sends an electrical pulse to the heart, causing it to beat. Recently, pacemakers have had options to connect to a network, giving information to doctors and healthcare professionals about the patient data and information regarding their heartbeat. This is calibrated before it is installed by the healthcare professional/hospital employee.

M1 Principles underpin the IoT

Home Sector: Smart Light

A smart light bulb and a smart doorbell are both excellent examples of IoT devices that embody the principles of IoT systems and services. They operate through similar principles, yet each device has its own unique features and functionalities.

A smart light bulb is a great example of an IoT device that showcases the principles of IoT systems and services. The smart light bulb connects to a mobile application and operates through the following principles:

Starting with the smart light bulb, it utilizes its connection to a mobile application to showcase IoT principles. This is similar to a smart doorbell which needs a connection to a mobile phone to view the camera feed.

By collecting and analysing data on the light levels in the room, it can respond to user preferences, turning on or off accordingly. This is also in line with the smart doorbell which can collect data on visitors at the door and send mobile notifications.

This device relies on existing internet and telecommunications infrastructure for user connectivity, enabling them to manipulate the lamp. Similarly, without internet access, the smart doorbell would not have access to the mobile device and not operate.

With real-time access, it can dynamically adjust to changes in the environment, adapting to darker or brighter conditions. Similarly to the light, real time data analysis also allows the smart doorbell to make decisions about the collected information, like whether to send a notification.

The smart light bulb accesses analogue data from the physical world, empowering users to automate light levels based on factors like ambient lighting or timing. The smart doorbell also has access to data like the audio and video, which it can transmit to the users applications for viewing.

With always-on connectivity, it can continuously monitor the light and leverage the spectrum of insight in real-time for accurate decision-making. Through always on connectivity, the smart doorbell is similar in that it can monitor, like with surveillance.

While both devices operate on the principles of IoT systems and services, they each have their distinct functionalities.

The smart light bulb emphasizes light level monitoring and automation, whereas the smart doorbell focuses on visitor identification and real-time notifications.

Nevertheless, both devices contribute to the interconnectedness and convenience offered by the Internet of Things, showcasing the potential for seamless integration of everyday objects into a digital ecosystem.

Home Sector: Smart Doorbell

A smart doorbell is another example of an IoT device that demonstrates the principles of IoT systems and services. The smart doorbell operates through the following principles:

The smart doorbell will collect data on who is at the door and send a notification to mobile device. The smart light bulb, on the other hand, focuses on illuminating the room and enhancing the ambiance, by gathering data on light levels.

To further that, the smart doorbell needs access to the internet in order to be able to send the notification or live feed to the mobile device. Similar to the smart doorbell, the smart light bulb relies on internet connectivity to establish a connection with the mobile application, allowing remote access and viewing.

Using access to and analysis of the real time data the smart doorbell might be able to make decisions based on the results of this. While the smart doorbell analyses real-time data to make informed decisions, the smart light bulb utilises real-time data analysis to adjust its brightness and colour temperature.

It has access to audio and video data that it is then able to transmit to the mobile device for the user to view and access. While the smart doorbell has access to audio and video data for user viewing, the smart light allows users to interact with and personalize their lighting experience.

It must have always on connectivity as this allows the device to be constantly on and continuously monitor the camera feed that it can send to the user. Similarly, always on connectivity ensures that the light bulb remains responsive and can adapt to the users' preferences and environmental conditions

The spectrum of insight allows the smart doorbell to follow the five phases to analyse and model data for the user and store it in an archive. Contrary to the doorbell, the smart light bulb employs it to enhance the user's experience by providing various lighting modes, scheduling options, and energy efficiency features.

In summary, while the smart doorbell focuses on security and visitor monitoring, the smart light bulb caters to illuminating and enhancing the ambiance of the space. Both devices leverage connectivity, data analysis, and user interaction, albeit in different ways, to provide convenience and personalized experiences.

Health Sector: Remote Patient Monitoring

Remote Patient Monitoring (RPM) is a healthcare application of IoT technology that demonstrates the principles of IoT systems and services, which is similar to the Pacemaker which also has to demonstrate the different principles of IoT systems. Below the differences between the two can be found. RPM operates through the following principles:

The RPM collects and analyses patient data and uses this to perform functions such as sending an alert to the healthcare provider if the data is outside of normal ranges. As the pacemaker is also a healthcare device, this also operates similarly, sending patient data to the healthcare providers.

RPM relies on the existing internet and telecommunications infrastructure to function properly, otherwise the RPM would not be able to send or transmit any data, as well as not being able to monitor accurately. Additionally, the pacemaker also needs the internet in order to be able to transmit information to the necessary parties.

RPM has access to real time data that it must transfer to medical professionals, and without this access to the data it would be unable to send anything regarding the patient to the medical professional. Furthermore, it must analyse the data to ensure that it only transmits important information or alarming anomalies. This is similar to the pacemaker which needs the real time access in order to send data that could save information.

RPM has access to analogue data from the physical world, perhaps such as time of day and light levels. This could be used to monitor sleep schedules, etc. The pacemaker also has access to such analogue data as this allows it to make better decisions based on the patients current health.

RPM has always on connectivity as without it there may be times when the patient is unmonitored and something dangerous could occur, meaning it is vital to ensure it is active. Similarly, the pacemaker also needs always on connectivity to ensure that the patient is constantly monitored.

RPM uses the five-phase spectrum of insight to continuously monitor the patients data and ensure that nothing out of the ordinary happens to them. The pacemaker also uses the five phase spectrum of insight to ensure that the patients are healthy and make correct decisions regarding the information it has about their health.

Health Sector: Pacemaker

A pacemaker is a medical device that demonstrates the principles of IoT systems and services, not dissimilar to the RPM which also uses these principles to successfully monitor patients and keep them alive. The pacemaker operates through the following principles:

The pacemaker must collect and analyse data on the patient's heart rate and rhythm to make sure that all their needs are being met, such as sending an electric shock when the heartbeat is not functioning properly. Similarly, the RPM analyses data it collects and decides whether or not to report that information to the healthcare provider.

It relies on the internet and infrastructure to transmit any data or information it collects to the medical professionals about the patients. The RPM also relies on this connection to be able to transmit patient data successfully if required.

The pacemaker has access to real-time data to ensure that medical professionals are able to monitor and react to any changes in the patient's heartbeat effectively and efficiently. As mentioned above, this access to the real time data is also needed by the RPM to monitor the patients accurately.

It uses analogue data to track real world variables like time and light levels, to ensure that all the data it is monitoring is accurate, such as when the patient is exercising or going through heartbeat increasing activity. Moreover, this is similar to the RPM which tracks analogue data to ensure nothing anomalous is happening to the patients health.

The pacemaker must have always on connectivity, just like the Remote Patient Monitoring devices, otherwise the patient's life could be at risk due to not sending the information to the healthcare professionals if something occurs and not providing the correct shock to ensure the heart beats properly.

The spectrum of insight allows the patient data to be monitored accurately and analysed, both for the Remote Patient Monitoring and the pacemaker, before being archived for future use and to compare against the patient's current health.

M1 Characteristics of IoT systems and services

Comparison of Home Sector

Smart Lighting risks

There are minimal risks associated with a smart lighting system as the consequences of the device being breached are minimal, which is heavily contrasted to the smart doorbell as shown below.

There are no risks such as payments being compromised, or the data being extracted.

Smart Doorbell risks

The smart lightbulb is completely different to the smart doorbell which monitors camera feed and if the data is compromised then there is a chance of someone being able to monitor the camera feed and viewing the contents of it.

This could provide them information like the camera's address/location, compromising their security, which is contrary when compared to the light bulb, which cannot provide this information.

Smart Lighting legal considerations

Within a smart lighting system there are not many legal considerations that have to be considered when talking about the incidents that might occur, unlike the smart doorbell which has potential for private information to be leaked.

The only data that might be collected without consent could be a login details for the application, and other than this there is nothing that should be of issue.

Smart Doorbell legal considerations

Contrary to smart lighting which has no risks when considering the legal issues and considerations, smart doorbells have many legal considerations that must be observed due to the impact of them.

For example, the same issue of data collection if much larger with a smart doorbell, due to the ability to record footage and information, and this could be illegally or unethically monitored by an outside individual.

This could eventually lead to information/date of the footage being stolen or viewed by others without consent, and this is a legal consideration that has much significance, unlike the smart lightbulb which has minimal considerations.

Smart Lighting sustainability

The smart lighting does have sustainability considerations as it is something that uses power continuously and therefore the sustainability of running a light is important to consider, and this concern also translates to the other IoT devices, such as the smart doorbell in this instance.

However, the smart lighting often provides options to control the light from outside of the home, or set up timed schedules, which provides many options to ensure that the light is very sustainable and therefore is great for this.

Smart Doorbell sustainability

The smart doorbell is similar to the smart lighting, as this as it provides the option to control the device remotely. This means that the smart doorbell is able to be turned on and off when away from home and therefore helps to remain sustainable.

Furthermore, smart doorbells are often motion activated and only turn on when someone or something triggers the motion detection software, saving power and making it more sustainable by only being used when needed. This focus on motion activating is not something that the smart lighting has to worry about, and instead is remotely controlled by a mobile device.

Smart Lighting low mobility

A smart lighting system has little to no mobility, only moving around if the light bulb is to occupy another spot or when being set up, which is likely what will happen with the smart doorbell, only moving when being set up.

Additionally, the only device the smart lighting has a connection to, the application that controls it, will only move around when the user moves with the application, however due to the fact that it is an application and not the physical IoT item, the smart lighting does not move.

Smart Doorbell low mobility

Similarly to a smart lighting system, a smart doorbell system has no mobility as it is installed into one location and will remain that way until it is either moved for a specific reason or

uninstalled. This means that both of these IoT devices are the same in that they have no mobility for majority of their lifespan.

Also similarly, the application is the only thing that will move around connected to the smart doorbell, but this does not count as the actual IoT system and therefore it does not move, which is another similarity to the smart lightbulb.

Smart Lighting time controlled

A smart lighting system does often have the ability to be time controlled and therefore falls under this category, which is dissimilar to the smart doorbell which often only operates on motion detection.

The smart lighting application associated with the IoT system means that it has the option to set up predetermined time system that changes the lights based on what time it is to any setting that was established.

Smart Doorbell time controlled

In comparison to the smart lighting system, which has timing settings and controls, the smart doorbell has no obvious time control settings.

There are no settings or functions that could be created either for the smart doorbell, as it is a system that relies on being constantly activated in order to do its job properly, i.e., monitoring motion.

Comparison of Health Sector

Remote patient monitoring risks

There are some risks associated with remote patient monitoring as this field involves highly sensitive data and information that includes your medical history, and therefore there is a risk of unauthorised access of this data.

For example, some of the sensitive data could include things like: heart rate, body mass index, weight, and any other health conditions like illnesses or mental health disorders.

This puts the patient's medical history and monitored data at risk of exposure. This is a different kind of risk compared to pacemakers, which put patients' lives at risk.

Pacemaker risks

Unlike remote patient monitoring, there are health risks associated with pacemakers.

This is contrary to the remote patient monitoring which is not as life threatening, however as pacemakers start to become IoT enabled, there is a risk of them being hacked and controlled, leading to the hacker potentially putting the patient in life threatening complications by modifying the pacemaker.

Finally, they could also access any data and information that is being transmitted by the pacemaker, leading to patient medical information being stolen, which is similar to the remote patient monitoring.

Remote patient monitoring ethical and privacy considerations
There are many remote patient monitoring (RPM) ethical and privacy considerations that have to be considered when using RPM.

One of these examples is the ethical issue of the wealth gap. Poorer and lower income families might not be able to afford the right medical treatment that is needed, such as RPM, and this promotes the age-old issue that comes with healthcare and whether or not we should be hiding life saving treatments behind a paywall. This issue also translates to IoT pacemakers where people who are able to afford the IoT versions will be able to have better healthcare.

This is a big ethical issue and is one that should be debated and discussed heavily before we decide to proceed with expensive treatments options.

Pacemaker ethical and privacy considerations
Similarly as mentioned above in the risks of pacemakers, there is a big risk of the pacemakers being hacked.

If the pacemakers are hacked then this could lead to the data that the pacemakers collect about the patients being breached and accessed by unauthorised users, which is a huge privacy consideration. This is also an issue for the RPM devices which collect data around the patients.

Also like the RPM, there are ethical issues regarding the cost and prices of the healthcare technology that might not be available to the lower income families.

Additionally, there is also the question of how IoT pacemakers will impact the role of other healthcare professionals.

For example, while there is little to no chance of the pacemakers replacing high level jobs within healthcare, there is a possibility that the lower skilled healthcare jobs could be replaced and lost.

Remote patient monitoring legal consideration
One legal consideration of remote patient monitoring is the fact that the patient data collected through RPM must be collected through legal and proper means.

This means that when establishing RPM, all the correct legal routes must be taken in order to ensure that the patients consent is documented and can be referred to in the future if an issues should arise with the RPM.

Additionally, there are also the legal considerations for any liabilities that occur related to RPM technology. Due to this, it is essential that the technologies are developed in a way that minuses risks and injuries to the patients and ensures the safe use of them.

Similarly, as the pacemaker is a healthcare device there will likely be many legal considerations that have to be considered before they can be used.

Pacemaker legal considerations

The pacemaker has similar legal considerations as RPM technology. This means that pacemakers have to ensure that there are a number of factors that continue to operate smoothly for there to be minimal legal issues.

For example, just like above, there must be patient consent, and compliance with any regulations that apply to medical devices, also similarly to RPM technology.

Finally, there is also liability for the pacemaker technology if it fails or something goes wrong, just like the remote patient monitoring technology. This means that these factors must be considered and included when deciding to move forward with IoT pacemakers.

This means that all IoT healthcare devices have legal considerations regarding how they are used and how they will be implemented for people.

Remote patient monitoring sustainability

RPM technology is similar to most technology in that it is not self-sustainable and requires a constant source of power.

This means that in order for RPM to work efficiently it has to have access to power and be able to connect to the internet in order to transmit any data.

To conclude, remote patient monitoring is not very sustainable as it cannot function without an external power source.

Pacemaker sustainability

Pacemakers are slightly different from remote patient monitoring in that they operate independently for years before they need to be changed or have their batteries replaced.

This is different from the aforementioned remote patient monitoring, as pacemakers have batteries implanted within them that last for years before they need to be replaced or modified.

Additionally, pacemakers are designed to consume as little power as possible to make these batteries last as long as possible, which is different to the RPM which needs a constant power source.

Remote patient monitoring benefits

RPM offers a number of patient and general benefits, and this ranges from things as small as reducing the number of greenhouse gas emissions because patients do not need to travel to the hospital as often, to contributing to productivity gains by optimising how patients are cared for and looked after.

Additionally, RPM can help prevent the spread of disease by allowing medical professionals to monitor patients remotely and determine disease through this.

Finally, RPM also improves the quality of life for patients through their day to day life, reducing the need for hospital visits for check-ups and ensuring that any issues that arise are swiftly identified and dealt with.

This is similar to the pacemaker which offers many numerous health benefits, like day to day life improvements, similar to the RPM, and these can be found detailed below.

Pacemaker benefits

Pacemakers also have many benefits that enhance the patients lives a number of means.

For example, pacemakers are extremely energy efficient as they only need to be replaced once every several years and are designed to operate independently like this for extensive periods of time.

Additionally, pacemakers can contribute to productivity gains by improving the health and wellbeing of patient, enabling them to stay active and healthy, including maintaining a normal lifestyle that might otherwise be limited because of their health conditions.

Finally, this shows how both of these IoT devices work to improve the quality of peoples lives through the introduction of their technology and various features.

Evaluation

Home Sector

The smart doorbell plays an important role in the home sector and when it comes to being able to complete its purpose of allowing users to view their camera feed of their front door and be able to respond to people knocking, it completes this role effectively. It is essential in completing this and I evaluate it to have a high purpose.

The smart doorbell completes its role in the home sector effectively, providing many benefits to the user as it allows them to control their lighting through their phone, meaning that not only can they save on their bills, but they can also improve their quality of life by performing actions like turning their light off from the bed, etc. Because of this, I evaluate the smart lighting as highly effective.

Furthermore, smart light does not have as many complex factors that the principles consider, however the principles that the smart lighting does have an impact on are completed effectively and efficiently to ensure that all of the factors are met.

Similarly, the smart doorbell system does not have many factors that that impact the principles.

However, the principles that are involved require constant upkeep, such as being connected to the internet or providing a constant data flow of the camera feed, and therefore I believe that compared to the smart light, the smart doorbell has more to keep track of and requires more maintenance, meaning the principles have more of an impact compared to previously mentioned smart light.

Principles
Benefits

There are 6 principles that provide many benefits through their combined usage and emphasis within the Home sector for the smart lightbulb and the smart doorbell.

For example, the first principle, collection and analysis of data to trigger actions, provides the benefits of automated systems, like lighting levels for a smart lightbulb, or allowing for recording when detecting motion on a doorbell.

Next, the reliance on existing internet and infrastructure provides the benefits of internet connectivity and therefore connections to IoT Home sector devices over the internet, meaning they can be accessed away from home, such as turning the light off from work or viewing the camera feed in a similar situation.

Continuing on, the principle that talks about access to real-time data allows for the IoT devices to make accurate and informed decisions, providing benefits like turning on the light when sunset occurs, or sending a notification to the associated mobile device for the smart doorbell.

Similarly, the principle basing around access to analogue data from the physical world, like light levels, sound, and more, adds the benefits of adjusting things like the lighting conditions for a smart light, or providing advanced security and convenience features for a smart doorbell.

The principle of always-on connectivity ensures the benefit of continuous monitoring of data from the physical world for smart lightbulbs and smart doorbells, enhancing their functionality and responsiveness.

The principle of the spectrum of insight, encompassing real-time data flow across different phases and processing data at the point of collection to archived data utilisation, offers substantial benefits to smart lightbulbs and smart doorbells, enabling real-time adjustments, improved performance, and informed decision-making.

Risks

These 6 principles also present some risks that can be found through their combined usage and emphasis within the Home sector for the smart lightbulb and the smart doorbell.

The principle of collection and analysis of data to trigger actions poses risks for smart lightbulbs and smart doorbells, such as potential data breaches or unauthorised access to sensitive information, as well as the risk of incorrect or misinterpreted data leading to inappropriate actions being triggered, compromising security, or causing inconvenience or harm.

The principle of reliance on existing internet and infrastructure presents risks for smart lightbulbs and smart doorbells, including the vulnerability to cyber-attacks, such as unauthorized access or control over the devices, potential disruptions in internet connectivity affecting their functionality, and privacy concerns regarding the transmission and storage of data over the internet.

The principle of access to real-time data entails risks for smart lightbulbs and smart doorbells, such as potential exposure of sensitive information during data transmission, and the risk of unauthorized access to real-time data leading to privacy breaches or misuse.

The principle of access to analogue data from the physical world presents risks for smart lightbulbs and smart doorbells, including potential vulnerabilities in data acquisition and processing, the risk of inaccurate or unreliable data leading to incorrect actions or decisions, and the possibility of unauthorised access to analogue data compromising privacy or security.

The principle of always-on connectivity entails risks for smart lightbulbs and smart doorbells, such as increased exposure to cybersecurity threats, including hacking or unauthorized access to devices, potential privacy breaches through continuous data transmission, and the reliance on stable and uninterrupted connectivity, which can be disrupted by network outages or technical issues, affecting the devices' functionality and responsiveness.

The principle of the spectrum of insight introduces risks for smart lightbulbs and smart doorbells, including potential security vulnerabilities during the different phases of data flow, such as in-motion, early life, in rest, and archive, the risk of data integrity issues when processing and utilizing archived data for modelling and analysis, and the need for robust data management practices to prevent unauthorised access or misuse of valuable insights derived from the spectrum of data.

Characteristics
Benefits

We will be covering 4 characteristics that provide many benefits through their combined usage and emphasis within the Home sector for the smart lightbulb and the smart doorbell.

The benefits of the legal considerations of the IoT devices, like the smart lightbulb and the smart doorbell, ensures that the users will remain safe while using these devices, both with the privacy of their information and the safety from cyber-attacks. The data associated with these devices must be used safely and responsibly to ensure that nothing happens that could compromise the user's information and security.

The sustainability considerations of IoT devices, such as the smart lightbulb and smart doorbell, bring several benefits. By incorporating power-efficient designs and promoting recycling and reuse of components, these devices contribute to energy conservation, reduce electronic waste, and support a more environmentally friendly approach to technology.

The low mobility characteristic of IoT devices, including the smart lightbulb and smart doorbell, offers distinct benefits. These devices are designed for fixed or specific regions, ensuring enhanced stability, reliability, and consistent performance in their designated locations. Users can rely on their functionality without concerns about mobility constraints

The final characteristic, time-controlled characteristic, of IoT devices, like the smart lightbulb and smart doorbell, offers valuable benefits. Through exchanging data at pre-defined time periods, these devices enable efficient scheduling and automation. This allows for timely and synchronised operations, such as scheduled lighting adjustments or automated notifications, enhancing convenience and optimising user experience.

Risks

We will be covering 4 characteristics that have potential for risks through their combined usage and emphasis within the Home sector for the smart lightbulb and the smart doorbell.

The legal considerations of IoT devices, such as the smart lightbulb and smart doorbell, pose risks including potential breaches of privacy, unauthorised use of collected data, threats from cybercrime, and the need for robust data protection measures to ensure user safety and data security.

Sustainability considerations in IoT devices, including the smart lightbulb and smart doorbell, come with risks related to power requirements, as inefficient energy usage may impact overall sustainability goals. Additionally, challenges in recycling and reusing components could add to electronic waste if proper disposal methods are not followed.

The low mobility characteristic of IoT devices, such as the smart lightbulb and smart doorbell, may introduce risks associated with limited flexibility and adaptability. Users may face limitations when relocating these devices or expanding their usage to different areas, potentially leading to reduced functionality or the need for additional setup or reconfiguration.

The time-controlled characteristic of IoT devices, like the smart lightbulb and smart doorbell, carries risks of potential synchronisation issues or inaccuracies in data exchange at predefined time periods. Dependence on accurate timing may lead to disruptions in scheduled operations, affecting the reliability and effectiveness of time-based functionalities.

Generalisation

I believe that the most important factor of the home sector when discussing the characteristics and the impact they have on the development, design, and production of the products, has to be the sustainability of the products, alongside the quality of life improvements that they offer.

This is because of the fact that the most common usage of IoT technology in the home sector is based around convenience and improving the home lifestyle, which means that the technology must be sustainable and last long enough to make the purchase worth it, otherwise the entire point of the technology is blown over.

Eventually, this would lead to more bother and work than convenience, defeating the purpose of IoT systems in the home.

On the other hand, I believe that the low mobility characteristic of certain IoT systems is the least important factor as it does not play as much of a role in IoT systems.

Most technology will not be developed around the idea of it remaining in one place, and will simply be an innate characteristic depending on the product, therefore meaning that it is not necessarily an essential characteristic, leading me to evaluate it as the lowest compared to the above mentioned characteristics.

Finally, it is important to also consider the context of the situation rather than blindly assuming whether one characteristic is more important than the others.

For example, with my chosen technologies I have only mentioned the characteristics that apply, however if I was to use a different technology then I would have to re-evaluate the characteristics that apply to that technology, and which is the most important compared to the least important.

Health Sector

Remote patient monitoring enables patients to receive support and assistance through the technology provided, meaning that it saves the patients time and potentially saves their lives through the assistance they are receiving. It is due to the fact that it can play a lifesaving role in patients' lives that I believe it should be evaluated highly against its supposed purpose.

Furthermore, when considering the benefits and the risks of the pacemaker, it is clear that the benefits of being able to live a normal life without the risk of heart issues causing pain, and possibly death, every day and being able to perform everyday functions, pacemakers are clearly worth it. Furthermore, I would also evaluate a pacemaker highly as I believe that the work it does in the healthcare sector is phenomenal and helps to save many lives.

RPM is more complex in its nature, given that it is used to aid in treating patients and ensuring that they remain healthy.

This means that the principles behind remote patient monitoring have more detail and complexity involved, which helps to ensure that patients are healthy and nothing happens to them.

Due to the added complexity of the health sector, combined with the lifesaving nature of RPM, I believe that there are more benefits compared to the aforementioned IoT technologies and is therefore evaluated higher compared to those.

Similarly, to the RPM technology, the pacemaker is much more complex, which inherently adds more detail and information regarding it.

In addition to the extra information, the pacemaker also provides many more benefits for the users as it enables them to continue living a relatively normal life and reduces many of the health complications that they might have run into in the past.

Finally, when considering the principles of the pacemaker and the impact they have on the data and information, it is clear that they play an important role in ensuring that it proceeds normally and are therefore crucial to the pacemaker.

Principles

Benefits

There are 6 principles that provide many benefits through their combined usage and emphasis within the Health sector for the pacemaker and remote patient monitoring.

The principle of collection and analysis of data to trigger actions provides significant benefits for healthcare devices such as pacemakers and remote patient monitoring technology, allowing for real-time monitoring of patient data and the ability to automatically trigger appropriate actions or interventions, such as adjusting pacemaker settings or sending alerts to healthcare providers.

The reliance on existing internet and infrastructure offers significant benefits for healthcare devices like pacemakers and remote patient monitoring technology, as it enables seamless connectivity, facilitating remote monitoring, timely transmission of critical patient data to healthcare professionals, and facilitating remote consultations.

Following on, the benefit of the principle of access to real-time data provides many benefits for the patients, through enhancing the IoT healthcare devices like the pacemaker, and the remote patient monitoring. This allows healthcare professionals to have immediate access to any necessary patient information, allowing them to make swift and informed decisions regarding the patient, encouraging personalised healthcare management.

The access to analogue data offers significant benefits for healthcare devices like pacemakers and remote patient monitoring technology, as it allows for the collection and analysis of a wide range of physiological signals and measurements, enabling healthcare professionals to gain valuable insights into patients' health status and detect early warning signs, leading to more accurate diagnoses.

The principle of always-on connectivity provides significant benefits for healthcare devices like pacemakers and remote patient monitoring technology. It ensures continuous and reliable data transmission between the devices and healthcare systems, allowing healthcare professionals to remotely monitor patients in real-time. This therefore improves patient safety, reducing hospitalisations, and enhancing overall healthcare management.

The principle of the spectrum of insight offers significant benefits for healthcare devices such as pacemakers and remote patient monitoring technology, as it enables comprehensive data collection and analysis across different phases. It allows healthcare professionals to gain an understanding of patients' health conditions. This leads to personalised treatment plans and improved patient outcomes.

Risks

These 6 principles also present some risks that can be found through their combined usage and emphasis within the Health sector for the pacemaker and remote patient monitoring.

The principle of collection and analysis of data to trigger actions poses risks in the healthcare sector, including potential data breaches or unauthorised access to sensitive patient information, as well as the risk of incorrect or misinterpreted data triggering inappropriate actions or interventions, compromising patient safety or causing harm.

The reliance on existing internet and infrastructure in the healthcare sector presents risks such as cybersecurity vulnerabilities, including the potential for unauthorised access to

patient data and privacy concerns regarding the storage and transmission of sensitive medical information.

The principle of access to real-time data introduces risks in the healthcare sector, including potential breaches of patient privacy during data transmission and unauthorised access to real-time medical data. Furthermore the possibility of delays or inaccuracies in receiving and processing real-time data could impact timely decision-making and patient care.

The principle of access to analogue data from the physical world carries risks in the healthcare sector, including vulnerabilities the computer systems, the potential for inaccurate or unreliable analogue data leading to incorrect diagnoses or treatments, and the risk of unauthorised access to analogue data compromising patient security.

The principle of always-on connectivity in the healthcare sector presents risks such as increased exposure to cyber threats, including the potential for hacking or privacy breaches through continuous data transmission. The dependence on uninterrupted connectivity, which may be disrupted by network issues or technical failures, can impact patient monitoring and care.

The principle of the spectrum of insight poses risks in the healthcare sector, including data security concerns throughout the different phases of data flow, potential issues with data integrity during processing and utilisation of archived data for analysis, and the need for robust data management practices to prevent unauthorised access or misuse of valuable healthcare insights derived from the spectrum of data.

Characteristics
Benefits

We will be covering 4 characteristics that provide many benefits through their combined usage and emphasis within the Health sector for the pacemaker and remote patient monitoring.

Addressing the risks associated with IoT devices in the healthcare sector, such as pacemakers and remote patient monitoring technology, brings significant benefits. Robust cybersecurity measures protect patient data, ensuring privacy. Rigorous testing and monitoring enhance device reliability, minimizing safety concerns. Enhanced privacy measures safeguard sensitive medical information, fostering trust. By proactively mitigating risks, IoT devices offer elevated care, security, and privacy for patients.

Incorporating ethical and privacy considerations in IoT devices within the healthcare sector, such as pacemakers and remote patient monitoring technology, brings several benefits. Adhering to ethical principles ensures the responsible and transparent use of patient data, enhancing patient confidence. By prioritising ethical and privacy considerations, IoT devices promote patient-centric care and uphold ethical standards in healthcare.

Next, the legal considerations in IoT devices within the healthcare sector, such as pacemakers and remote patient monitoring technology, offers several benefits. Adhering to legality safeguards patient data privacy and confidentiality. By considering legal

requirements, IoT devices promote a secure and legally compliant healthcare environment, benefiting both patients and healthcare providers.

Focusing on sustainability considerations in IoT devices within the healthcare sector, such as pacemakers and remote patient monitoring technology, offers several benefits. Embracing sustainable practices, such as energy efficiency and responsible management, reduces the environmental footprint of these devices. This not only benefits the planet but also promotes resource efficiency and long-term cost savings in healthcare operations.

Risks

We will be covering 4 characteristics that have potential for risks through their combined usage and emphasis within the Health sector for the pacemaker and remote patient monitoring.

The risks associated with risks themselves in the context of IoT devices within the healthcare sector, such as pacemakers and remote patient monitoring technology, include potential uncertainties and adverse outcomes stemming from inadequate risk management practices. This may involve failure to anticipate potential hazards, compromised patients, and legal or ethical implications arising from these scenarios.

The ethical and privacy considerations in the healthcare sector pose risks, including breaches of patient privacy, unauthorised access to sensitive health information, and potential misuse or unethical handling of patient data. This can lead to compromised patient confidentiality, and legal consequences, impacting the overall integrity of healthcare services provided by IoT devices.

The legal considerations in the healthcare sector introduce risks, including non-compliance with applicable laws and regulations governing data protection, patient rights, and cybersecurity. Failure to meet legal obligations can result in penalties, lawsuits, reputational damage, and disruptions in healthcare services.

The sustainability considerations in the healthcare sector involve risks such as increased energy consumption and limited availability of resources. Inadequate sustainability practices can also contribute to environmental ruin. Implementing sustainable approaches, including energy-efficient designs, is crucial to mitigate the risks and ensure long-term environmental sustainability.

Generalisation
I believe that the most important characteristics of the health sector in regards to the technology I have chosen are the benefits and the risks.

This is due to the fact that the benefits provided by the healthcare sector IoT systems are unmatched compared to any other characteristics. Not only does it help to save lives, which in turn allows people to experience *any* of the characteristics of IoT systems, but it helps to improve the user's health and quality of life, such as enabling them to perform exercise or sport activities.

Additionally, I believe that risk is also an important factor that must be considered as the risks of healthcare sector IoT systems usually have the most disastrous consequences.

An example of this would be an IoT pacemaker which, if something would go wrong, could lead to patient data and information being stolen, alongside putting their life at risk through the pacemaker performing/behaving irregularly and hurting the user/patient.

On the other hand, I believe that the least important factors for consideration, of those that apply to my chosen technology, might be the ethical and privacy considerations.

Although this is still a huge characteristic of the technology I have chosen, I believe that compared to the capability to save patients' lives and improve their ability to live a day to day lifestyle, the cost for this technology might not always be cheap and widely accessible unfortunately.

This leads to the fact that ethical and privacy concerns are not above the patients lives and should not be put first in the face of medical lifesaving technology.

Finally, just like the home sector, the context of the scenario, and in this case the context of the technology, always takes more priority compared to a predetermined opinion.

There are likely technologies out there where the ethics and privacy involved will take much higher priority compared to the benefits, and therefore the context of the situation should always be taken into consideration when discussing what characteristics have the highest impact on the IoT technology of health systems.

Conclusion

In conclusion, the Internet of Things encompasses an array of devices with diverse applications across various sectors. Each IoT device must be carefully evaluated within its specific context to determine its appropriateness. The wide range of IoT devices, from smart lightbulbs and doorbells to healthcare devices like pacemakers and remote patient monitoring technology, highlights the importance of considering the unique requirements, risks, and benefits associated with each scenario. By taking a context-specific approach, we can harness the potential of IoT technology to enhance efficiency and safety in our interconnected world.