5.3.2 Environment monitoring and surveillance

IoT environmental monitoring is a process that uses Internet of Things (IoT) technology to collect data about the environment, such as air quality, temperature, and humidity levels. This data can then be analysed to better understand the indoor and outdoor environment and make informed decisions about how to reduce the impact of negative aspects of the local environment on the business. Alternatively, it can be used to change business activities to help protect the planet or the local community.

These IoT-based systems can be used to detect issues in the environment that are largely invisible, normalised or taken for granted. Allowing businesses to take action by reducing their negative environmental footprint and protecting employees, visitors and the community at large.

IoT connectivity plays a crucial role in Environmental Monitoring by enabling the collection and transmission of real-time data from various sensors and devices. IoT devices such as air quality monitors, water quality sensors, and weather stations are commonly used to monitor environmental parameters. These devices utilise specific connectivity technologies such as GSM, 4G LTE, LoRa, SigFox, and NB-IoT to ensure that data is efficiently transmitted to the cloud for analysis. This real-time data allows for better decision-making, early detection of environmental issues, and ultimately helps in the conservation and protection of our natural resources. With IoT connectivity, environmental monitoring becomes more efficient, accurate, and sustainable.

IoT environmental monitoring relies on individual devices and IoT ecosystems, IoT network, IoT monitoring tool(s) and applications, IoT device monitoring and IoT device management systems, remote monitoring equipment and analytics. The technical complexity of IoT for intelligent IoT monitoring is the requirement for interfacing of a variety of products, systems and protocols. To utilise the scalability and performance benefits of IoT for centralised control and intelligent end monitoring requires the engagement with IoT experts and IoT services as well as engineering the best form of IoT traffic utilization to avoid system failures.

There are four critical components for IoT-based environmental monitoring to support vital insights and decision-making:

1) Observation (Monitor the Environment and Collect Data):

The first step in the environmental monitoring process is to observe and collect data. This involves using sensors or other IoT devices to measure factors such as air quality, temperature, and humidity levels.

These connected IoT devices gather data about the environment and transmit it to a central hub. From here, the data can be reviewed in real-time or used for further analysis off line. Often these systems produce unexpected results and temporal variances. For example, high CO2 levels when offices are highly populated could explain drowsiness or loss of concentration. This can also apply to public spaces such as bars and restaurants where invisible environmental factors may be making the consumer experience uncomfortable.

2) Analysis (Measure Data):

The next step is to analyse the data collected by IoT devices. This includes looking at trends over time, identifying areas of concern, and any correlations between environmental variables, time of day, behaviours and the relationships between indoor and outdoor metrics. IoT sensing devices pick out key points of the data that indicate everything from chemical and water leaks to air pollution levels. This data analysis can help businesses measure

their environmental footprint and make informed decisions about how to reduce their environmental impact.
For some businesses, this can be relatively benign or related to levels of comfort for workers, whereas others are related to safety. For example, monitoring systems placed in drains can be on the lookout for external pollutants such as diesel, oil, and paints that can stress the environment or harm livestock, fisheries or members of the public.

3) Storage (Catalogue Data):

Once the data has been analysed, it needs to be stored so that it can be accessed in the future. IoT environmental monitoring systems make this easy by storing the data in a secure cloud-based database, allowing businesses to access the data whenever they need it and analyse how their environmental impact is changing over time.
Global databases, such as the Microsoft Planetary Computer, catalogue enormous quantities of environmental data from around the world – although not every cloud database is that large.

4) Action (Provide Actionable Insights From the Data and Analysis):

Finally, businesses need to be able to take action based on the data that has been gathered and analysed.
IoT-enabled environmental monitoring systems can provide insights into how businesses can best reduce their environmental impact, such as by using renewable energy sources or introducing water conservation measures.
These actionable insights may involve changing operational processes, implementing new technologies, or even making changes to their overall business strategy.

There are a number of benefits associated with an IoT-based environmental monitoring system, including:

- **Improved understanding of the environment via data**: With real-time data feeds being supplied by remotely deployed IoT sensors, businesses and organisations can better understand and quantify the environment. From here, targeted actions can be taken to reduce environmental impact or to spot problems, such as excessive CO2, noise or airborne chemicals as they occur.

- **Improved efficiency**: With real-time data, organisations can identify and address any problems long before they become more serious. By employing warning alarms, businesses can be more reactive and proactive. This can result in a better working environment, cost savings and less downtime.

- **Increased sustainability:** IoT environmental monitoring systems help organisations identify areas where they can reduce their areas of environmental stress for employees and stakeholders, thus helping them be more sustainable in the long term.

- **Business Growth**: Companies often need to comply with environmental standards in order to assure their customers that they are a progressive organisation whose values chime and adhere to their own policies and direction of travel. Producing evidence-based systems and results can provide greater surety that measures and controls are in place, fitting both the contexts of the business and its (or its customers) environmental concerns.