

THE INTERNET OF THINGS

Over the past 10 years, the Internet of Things (IoT) has slowly crept into the daily lives of consumers through smartwatches, vehicle tracking systems, public transport apps, home alarm systems and food delivery services. These technologies offer many conveniences, such as tracking transport schedules, parcel deliveries, the location of assets like vehicles, or local weather conditions. It takes existing expert domains, such as smart factories, process automation, flexible manufacturing and process control, and combines these with the extensive reach of internet and telecommunication technologies.

For industry, the Industrial Internet of Things (IIOT) offers increased oversight and connectivity between different manufacturing and business processes, and closer integration with suppliers, logistics providers, warehouses, and even clients. It allows for improved efficiency and better analysis of process flows, often over large distances. At the same time, it allows for new services to be offered to clients such as predictive maintenance, management systems, analytical services and software updates.

At the heart of IoT technology is the capability to integrate the data streams from distributed sensors into management systems and user interfaces. While some sensors mainly collect and transmit data, other sensors could be programmed to automatically trigger programmed functions. As these different sensors and devices perform their functions, rich data is collected that allows for improved process management and efficiency, data analysis and value to be offered.

The spread of IoT technologies has reached more traditional sectors like agriculture as well scale-intensive sectors such as chemical engineering, freight and logistics, mining and automotive production. While consumers are getting used to a continuous stream of improvements in how they order groceries, book travel, monitor personal health, or manage their fixed and movable assets, behind the scenes, the changes in how industries and companies are organised and managed are disruptive on many fronts.

TECHNOLOGICAL NOVELTY OR MERIT

IoT refers to networks of physical objects (such as devices, vehicles, buildings, equipment) containing micro-electronic sensors, software and processors, that enable them to be connected via the internet. This allows objects to collect and exchange data, and for cloud-based processing and analysis of data and communications between different devices.

The dissemination of IoT technologies is driven by:

- The rapid increase in the diversity of sensors and range of applications.
- The rapid miniaturisation of sensor technologies, power systems and data storage technologies.
- Improvements in micro-processing power and energy-efficient electronics.
- The improved reach and reliability of the connectivity, wireless range and other telecommunications infrastructure.
- The rapid decrease in costs and increased performance of online data hosting and processing.

TECHNOLOGICAL CHANGE AND INNOVATION SYSTEM OBSERVATORY

The aim of the Technological Change and Innovation System Observatory project is to support the Department of Trade, Industry and Competition (the dtic) and industry sectors to develop an integrated, strategic response to discontinuous technological change and disruptive innovation. It aims to equip public and private organisations to become more sensitive to global technological shifts, and the changing demands placed on the innovation system, the manufacturing sector and its stakeholders.

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June 2022

NEW COMPETENCE REQUIREMENTS

For many entrepreneurs, the application of IoT is a business opportunity. However, for manufacturers, the IoT offers creative ways of improving efficiency, reducing costs, improving process management, and integration and managing distributed devices.

To leverage IoT capabilities, a management team would have to know:

- Where the critical control points in their processes are;
- Where efficiencies can be improved through better data analysis and process integration;
- How new value can be created for different markets;
- How the processes of external providers, clients/users and intermediaries can be strengthened; and
- What their internal IoT and Information and Communications Technology (ICT) capabilities are, and how they can procure advice or solutions from external service providers.

For some companies, the IoT process will be an incremental improvement on their current process management and ICT capabilities. Perhaps they only require the installation of more recent sensors, process control and network management systems from a reputable supplier. For others, the IoT will make it possible to track jobs, items, or orders better through software development that combines the data of disconnected data systems that are perhaps combined with off-the-shelf sensors. Yet, for another, the IoT might allow customers to manage their own systems better through the development of data exchange protocols and a secure website or mobile app.

Skills and knowledge

While many IoT sensors can be ordered from catalogues or local suppliers, figuring out how to collect and then act on all the data collected requires ICT, data analyses and engineering skills. To connect different kinds of sensors within an organisation may require networking and basic ICT skills, while building IoT capabilities into a product may require more electronics and digital engineering skills. Optimising and integrating different systems might draw on operations management, software development and industrial or process engineering skills.

IoT skills, like many digital skills, often work best when combined with a deep understanding of the dominant knowledge domains within the application context. For instance, improving the management of a food processing plant may combine the existing food and process management with industrial networking, data analysis and IoT skills. Improving the monitoring of movable assets may require an understanding of a given environment (an open cast mine or public transport assets) with cellular communication, satellite tracking, global positioning expertise and security technologies.

Engineers and technicians implementing IoT solutions for smaller manufacturers often report that making machines communicate with other machines is the easy part. Many recent machines and process technologies have network or communication interfaces. More difficult to figure out is what needs to be communicated, and what the potential actions of different measurements or alerts should be. Once the business processes and the interrelations between different critical processes are configured, collecting, processing and using data to improve performance becomes much easier. However, many smaller producers do not really know where they are losing money due to inefficiencies or the poor integration of disconnected systems. It is hard for an IoT solution provider to offer options when the value of a saving or the potential revenue streams of a new market opportunity is not clear.

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Network management, cyber security, infrastructure management, data analysis and network management skills are in high demand in both the IoT and cloud computing environments.

Organisational arrangements

To leverage IoT capabilities, a management team must understand which processes must be monitored, how the data will be used, or how integrated communications with external partners can add value (or reduce costs).

Management teams and investors must be willing to rethink how their business units and operations are organised, as technologies that integrate different processes may not work so well within rigid business structures. For instance, when a customer places an order for an item from a mobile phone several simultaneous processes could be triggered in the background.

- A financial transaction is being processed
- An order is placed with the production unit
- Replacement stock is allocated to a regional distribution centre
- An efficient route and the amalgamation of orders to a specific region are calculated based on the availability of freight logistics.
- Final delivery is scheduled with an available transport intermediary
- All while the customer is kept informed of the progress of the order

As the interrelations between different datasets and process points are collected and analysed, more opportunities to improve processes, materials and quality become possible.

Value chain effects

When a specific manufacturer improves the management and integration of different functions through IoT, all the suppliers, intermediaries and even client systems may be required to adapt. In order to improve integration, independent suppliers and other intermediaries might have to implement IoT solutions as well to remain compatible with their clients.

The pressure to continuously invest in data security, reliable and fast communication technologies and newer sensor technologies will increase. As more users depend on being able to manage and remotely monitor key processes and assets, the pressure on IoT laggards to modernise will intensify. As the technology becomes more pervasive, the demands on standards and interoperability between different systems will increase.

As more sensors and devices are integrated into the system, the harder it becomes for everybody to switch to different technologies. It will become harder for new entrants to enter into networks where manufacturers have already established deep integration with suppliers and markets.

Internationally, manufacturers are increasingly co-located in industrial parks where shared high-speed communications and ICT infrastructure is available. The emergence of specialised service providers offering cybersecurity, IoT and advanced logistics solutions is made easier when an appropriate concentration of manufacturers rely on these services. This is visible in South Africa where IoT service providers are often located near the major industrial hubs that are often formed around the automotive and international food, pharma or logistics industries.

MARKET NOVELTY AND NEW FUNCTIONS

One benefit of the internet of things is that it allows manufacturers to collect data from their products out in the marketplace. This not only enables valuable feedback on improving the performance of devices, but also for manufacturers to provide value-added services to clients such as predictive maintenance, analytical services and other services.

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Source: Jeferrb, Pixabay

As more machines, devices and operations collect and exchange data, adding more devices and building ecosystems or networks of devices becomes easier. This creates opportunities for management services or interfaces to be launched, which also ensures customer loyalty.

At the same time, users are increasingly expecting to be able to monitor and remotely manage their devices, assets, infrastructure and processes. The companies that offer users access to this data, and that can develop appropriate management and monitoring solutions, will establish an important leading position in the marketplace.

The IoT is also creating new markets for software development companies, ICT providers, consulting engineering companies and many other professional services.

The digitalisation of manufacturing, logistics, packaging and even distribution will lead to a concentration of companies in urban areas where the physical and telecommunications infrastructure and supporting ICT and engineering services are available and reliable

STRATEGIC IMPACT ON FIRMS

Being able to share and exchange data with markets, suppliers and service providers allows processes to become more integrated and transparent. Companies operating in global markets are under constant pressure to not only improve their efficiency through technologies like IoT, but to improve the resilience of their logistics and the quality of their technical services by building in intelligence into their products.

With the high pace of development on many fronts, smaller companies are under pressure to improve their processes and services on many fronts. For those companies operating in global value chains, the pressure to adopt already widely used IoT technologies is high. Often these companies are challenged by the fact that key equipment in their processes might not have digital interfaces, so IoT solutions in South Africa often have to integrate legacy (or offline) equipment with state-of-the-art technology with digital interfaces.

The digitalisation of manufacturing, logistics, packaging and even distribution will lead to a concentration of companies in urban areas where the physical and telecommunications infrastructure and supporting ICT and engineering services are available and reliable.

At the same time, developments in other industries or sectors can quickly disrupt incumbents. For example, the rapid growth of wearable devices like smartwatches or other devices has disrupted many established medical device manufacturers. The uptake of IoT technologies in the restaurant industry has enabled franchised restaurants to expand their market share at the expense of independent restaurants. The COVID pandemic also accelerated the shift to online ordering, freight amalgamation and regional warehousing solutions, which all draw on IoT capabilities.

REGULATORY REQUIREMENTS

The security and protection of sensitive data security and mechanisms to enforce trust are probably the most important regulatory requirements. However, with the deeper integration of different companies into IoT-enabled production and fulfilment networks, it can be expected that competition policy to regulate cartel behaviour or market dominance will become more important.

TECHNOLOGICAL CAPABILITY IN SOUTH AFRICA

Many IoT devices, sensors and process control technologies from international vendors are available in South Africa from electronics wholesalers, solution providers and gadget retailers. However, South Africa also has several developers of sensor technologies in the public and private sectors. Furthermore, the domestic electronics manufacturing and communications sector has enabled many specialised hardware and software companies to expand from South Africa into global markets. Local automation and process control service providers have emerged that are serving the automotive, packaging and multinational manufacturers in the major cities.

Due to the large distances in South Africa between places, sophisticated demand has emerged from the logistics, asset management, transport and agricultural sectors. Many manufacturers that are part of international supply chains have already implemented IoT solutions to some degree. Furthermore, the retail sector is exerting pressure on local manufacturers and distributors to improve efficiency of production, distribution and order tracking.

Public demonstration, technology application and advisory contacts

- The Technology Station in Electronics at the Tshwane University of Technology assists small manufacturers to identify which sensors could be used to monitor key processes. The Technology Station team is able to combine off-the-shelf sensor and control technologies, but can also design and manufacture custom sensors and processing solutions.
- The CSIR Future Production: Manufacturing cluster (<https://www.csir.co.za/future-production-manufacturing>) can demonstrate various IoT technologies and can also assist companies to develop or integrate solutions. The Industrial Sensors research group can assist with developing specialised sensors in the manufacturing, healthcare and mining sectors. The Centre for Robotics and Future Production can assist with robotics, assembly and automation solutions that are combined with sensors and artificial intelligence solutions.
- Prof Thinus Booysen holds the IoT Chair at the Faculty of Engineering of the Stellenbosch University. His past research was focused on smart energy, water and vehicles.

Local private sector champions

- lot.nxt (<https://www.iotnxt.com>) was founded in South Africa in 2015 and then expanded globally to serve large clients in Europe and the United States. It is recognised for its interoperability of different platforms, data streams and business decision support systems.
- Trinity (www.trinity.co.za) is known for its track record in communication systems and integrated management solutions for managing IoT deployments over large areas. For example, the company worked behind the scenes for a connectivity and communications solution for Mr D Food (previously Mr Delivery) that included software, hardware, tracking and management system integrations for more than 8 000 vendors.
- Jendamark (www.jendamark.co.za) is recognised for its leadership in automation and digital solutions, especially in the automotive sectors. The company has expanded its South African footprint to the automotive sector in Germany.

In 2019, an IoT Industry Council was established to accelerate the uptake of IoT technologies in Southern Africa. For more information visit <https://www.iotcouncil.org.za>.

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