SMART CITIES: TECHNOLOGY FRIEND OR FOE?

Institution of
MECHANICAL
ENGINEERS

Improving the world through engineering

CONTENTS.

Welcome to the eBook version of the IMechE Smart Cities report.

The full document can be downloaded here.

URBANISATION AND THE NEED FOR SMARTER LIVING.

> “”
>
> By the end of the century humans will be almost entirely an urban species, with urbanites making up 80–90% of the world’s population.

Urbanisation is a principal characteristic of modern life. Today, about 54% of the 7.3 billion humans on the planet live in an urban setting, and as global population rises to an estimated 9.5 billion by 2050, the proportion of urban dwellers is projected to increase to 66%. It is conceivable that by the end of the century humans will be almost entirely an urban species, with urbanites making up 80–90% of the world’s population.

Given the prospect of a world dominated by megacities and vast sprawling urban conurbations, much is at stake. Climate change, natural resource depletion and the impacts of ecological and environmental degradation all need to be addressed. Technology has a role to play here – and digitally-connected infrastructure holds the potential to ensure that cities are fairer, safer, and more socially cohesive places to live.

But the development of smarter cities brings both opportunity and challenge, and questions around cyber security and energy provision need careful consideration.

SMART CITIES RELY ON CONNECTED INFRASTRUCTURE.

Imagine a city where technology connects seamlessly for the benefit of all its citizens. Commuting would be made easier, with parking bay sensors communicating with drivers to let them know of available spaces, and traffic lights coordinated with live data to reduce congestion. Street lights could be made more energy efficient, being turned on/off as pedestrians approach. Meanwhile, waste bins would let local authorities know when they are full and needed emptying.

That's the vision for a smart city and from an engineering perspective, it's all achievable. Such connected infrastructure will be based on the Internet of Things (IoT) – a concept which, in itself, is not new. The use of a computer network to connect sensors and control systems on machines, with operators located remotely in control centres, is something engineers have been doing for many years. Indeed, since the mid-1960s, computer-based supervisory control and data acquisition (SCADA) systems have been a core tool used by engineers for the efficient operation of industrial plant such as power stations, oil refineries, gas processing facilities, chemical works and car factories.

Over the years, though, these systems have evolved from isolated networks of sensors and controllers to today's sophisticated internet-connected versions that fully utilise open networks and cloud computing. But bringing a substantial number of applications together in a city, each of which has thousands of sensors and devices associated with it (estimates of 15,000+ connected devices per 100,000 people), requires an extension of the IoT concept to another order of magnitude. This has led to the widespread adoption of what's referred to as the 'Massive Internet of Things' (MIoT), characterised by a rapid growth in connectivity which is likely to place enormous demands on electricity systems.

CONNECTED LIVING WILL PUSH ELECTRICITY NETWORKS TO THEIR LIMIT.

Since the pioneering work in the late 19th century by engineers such as Thomas Edison, Nikola Tesla, Werner von Siemens and George Westinghouse to successfully harness the power of electricity, it has become ubiquitous in homes, businesses and industrial premises worldwide. Today about 19,800TWh of electricity is consumed globally every year. About 1.5% of that total, or 304TWh, is the power consumption in the UK. This is projected to potentially double by 2050, as the UK further electrifies domestic homes, commercial premises, industrial sectors and infrastructure to help meet its decarbonisation obligations. Indeed, it may conceivably exceed that value if the MIoT is realised to the extent envisioned in the next 20 to 30 years.

It is predicted that by 2020 alone, just two years into the future, global networks will be handling 40,000EB of data, up from 130EB in 2005, a factor of 300 times greater. It is important to recognise that the devices, sensors, computers, networks and power-hungry data centres fuelling this explosive growth will be reliant entirely on the availability of electrical power to function. For example, city-wide utilisation of the MIoT will require the provision of substantial amounts of additional data handling and storing capability, and in this regard data centres illustrate the scale of the electricity challenge ahead. The world's eight million data centres currently use about 3% of global power production, as much as 50% of which is for cooling provision. To meet increasing data volumes in the near term, approximately 600,000 new centres are currently being added to the global network.

WHAT HAPPENS IF THE POWER GOES OFF, AND SYSTEMS START TO FAIL?

> In the UK city of the future, if the power goes off, even for a very short time, the disruption could be widespread and have far-reaching economic and social consequences.

Today, the entire ICT infrastructure of the world is estimated to account for about 10% of global energy consumption and as IoT and MIoT adoption grows, alongside a broad range of other ICT applications, so too will the sector's electricity demand.

The Institution of Mechanical Engineers recognises the scale of this challenge and is concerned that to date the impact of the ICT sector, and in particular the deployment of the IoT and MIoT in the context of smart cities, has not been included in UK Government's planning of pathways to the nation's power infrastructure for 2050. Digital technology of all types, and the IT infrastructure that supports it, are not only power-demanding, they also depend on 24/7 reliability 365 days a year. The worldwide disruption to British Airways flights and UK airport operations that resulted from a short interruption of the power supply to the airline's computer system in May 2017, illustrates the latter point clearly. This new demand will require not just increases in the amount of electricity generated and distributed, but also a new level of system resilience and reliability.

In the UK city of the future, if the power goes off, even for a very short time, the disruption could be widespread and have far-reaching economic and social consequences. Across an integrated smart city, there would soon be no communications, no transport, no security surveillance, no heating, no cooling, no lights, no water, no trading in a cashless world and, in a short space of time, no food.

THE UK NEEDS MORE RESILIENT AND RELIABLE ENERGY NETWORKS.

Government must absolutely ensure that as well as meeting demand, the electricity supply to future UK cities is highly resilient to uncertain external physical shocks and cyber security threats.

The emergence of smart cities, and their increasing energy demands, means that the UK needs to build new levels of resilience and reliability into its electricity networks.

The continued adoption of internet-connected digital technology for the monitoring and control of engineered infrastructure, makes city services increasingly dependent on electrical power. Not only does this potentially lead to a substantial increase in the scale of power demand in cities, particularly with the anticipated use of the Internet of Things and Massive Internet of Things, but it also creates a requirement for 24/7 reliability of supply in cities 365 days a year.

In future UK cities, even relatively short interruptions to supply will potentially lead to substantial economic and social impacts. The institution believes that government must absolutely ensure that as well as meeting demand, the electricity supply to future UK cities is highly resilient to uncertain external physical shocks and cyber security threats, as well as to normal operational faults and breakdowns.

SMART CITIES REQUIRE NEW SKILLS AND EFFECTIVE PLANNING.

“”

City authorities need to pay more attention to working together in networks, as well as creating stronger physical connectedness with each other and nearby communities, to improve quality of life.

Smart cities will also require new thinking. Local authorities will need to focus more on collaborative working and sharing of best practice and learning across global networks of urban environments. Today’s culture of cities competitively positioning themselves against one another for smart city status, and for access to public funding for smart city initiatives, is against people’s overwhelming desire for equality of access across the UK to the benefits of digital integration. Instead, city authorities need to pay more attention to working together in networks, as well as creating stronger physical connectedness with each other and nearby communities, to improve quality of life.

The education profession also acknowledges the new skill sets needed for living and working in a digitally-enabled urbanised society, with education and training likely to be radically reconfigured to be fit for purpose in a 21st–century smart city future.

Substantive shifts are already taking place in the character of life and paid employment in UK cities as a result of digitisation, bringing into sharp focus the need to address people’s concerns regarding the acquisition of skills to meet the requirements of future jobs. The UK education community needs to recognise these changes and concerns and work with the engineering profession, as well as relevant others, to consider a radical repurposing of education, training and skills development in the UK to ensure fitness for purpose in a 21st century digitally-enabled urban world.

Institution of Mechanical Engineers

1 Birdcage Walk
Westminster
London
SW1H 9JJ

www.imeche.org