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5.9 Management and information systems (HL)

Critical infrastructures

Facial recognition technology is a rapidly growing industry that shows the combined power of artificial intelligence and digital technologies. Facial recognition technology is now used in all kinds of everyday situations, such as at airport passport control, in security systems, in shops and supermarkets and in profiling for marketing purposes.

Figure 1. Facial recognition technology in action.

Credit: Monty Rakusen, Getty Images

The marketing company AdMov, for example, uses tablets with facial recognition technology in a number of vehicles belonging to Grab. Grab is a multinational technology company, based in Singapore, that has a successful ride-hailing app. The facial recognition technology within these tablets can determine the age, gender and mood of the rider. It then provides each individual rider with targeted content, specifically for them, via the tablet. The technology can even track eye movements and change advertisements when it detects a loss of interest. DeNaCo Ltd is another company that offers similar marketing services in Japan.

Facial recognition and other digital applications require critical technological infrastructure, including:

- data centres
- cloud computing

- artificial neural networks

Databases, data analytics and data centres

A database is an organised collection of information that is stored in an electronic system. This information can be processed and filtered for a specific purpose. Data analytics refers to the science of analysing data to establish patterns, trends and behaviours in order to draw conclusions. Databases are analysed by data mining, a process of searching for and finding patterns and trends within large data sets.

Figure 2. Data mining helps find patterns and trends in human behaviour that can inform business strategy.

Credit: Yuichiro Chino, Getty Images

Data is very valuable for businesses. In marketing, for example, patterns and trends in human behaviour can be used to develop strategies that increase sales and profits. Links between demographic data and consumer purchases can help businesses improve market segmentation and develop more personalised marketing strategies. Data can also help businesses improve sales forecasting (Subtopic 4.3 HL (/study/app/y12-business-management-a-hl-may-2024/sid-351-cid-174702/book/the-big-picture-id-38737)).

In human resource management, a business may be interested in information on employee productivity. Businesses can collect and analyse how much time employees spend on certain tasks, such as the number of emails sent, or the number of products processed within a fulfilment centre.

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Making connections

Popular documentaries such as *The Great Hack* and *The Social Dilemma* have highlighted just how valuable data is for businesses. They also highlight the ethical issues faced by businesses as they gather, process, use and sell the data of their customers. If you have access to one or other of these documentaries, you may want to watch them to learn more.

As valuable as data is to businesses, there are significant ethical concerns with the wide-scale collection and mining of large databases. Concerns include:

- How much data is being collected? At what point does data collection and data mining begin to violate privacy rights?
- Do consumers know how much and what data is being collected about them and how it is being used? Have they really given permission for businesses to engage with their data?
- Who has access to this data and under what circumstances? Can the data collected by one business be sold or given to another business or organisation?
- Is the data secure?
- Is the data being used for malicious purposes?

Activity

Learner profile: Knowledgeable
Approaches to learning: Thinking skills (transfer)

Amazon is the world's largest retail store. It has detailed records on its 59 million plus customers and businesses. This includes customer details, preferences, inventory and wish lists, as well as data collected via its many products and services. There is data collected from Amazon's e-commerce platform, Amazon web services, audiobooks, e-readers, music and video platforms, fitness trackers, home security systems and Alexa-enabled devices.

All this data is used to help Amazon build up extensive profiles of its clients, which can then be used to market products or services to them.

Imagine that you wanted to do an investigation related to how Amazon collects, processes and uses customer data.

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- Consider the information in this section and develop an appropriate research (inquiry) question for this topic.

- Then develop several sub-questions that you would need to answer in order to address your main research question.

- Finally, brainstorm some ideas for primary research methods or secondary research sources you could use to get the information you need to answer your research question.

Theory of Knowledge

Increasingly, information about people's medical conditions and medical histories are being stored in databases so that medical professionals have access to patient information when they need it. This is obviously hugely advantageous when it comes to improving medical care, particularly for example when a doctor needs to treat a patient with whom they are not familiar.

However, these databases could provide valuable information for other kinds of services too. Health insurance businesses might like to access medical information on individuals to determine insurance fees. These businesses would likely want to charge higher insurance fees to patients who have a greater risk of medical problems. Pharmaceutical companies might also be keen to access patient data in order to determine drug prices for individual consumers.

Clearly, it is more controversial for insurance and pharmaceutical companies to access and use patient information than it is for doctors to do so. This highlights the ethical issues associated with the use of personal data for business purposes.

- What are the moral implications of possessing large amounts of information about people and their behaviour? (IBDP Business Management guide)

Data centres are either buildings or sub-sections of buildings that contain servers, support computer networks and run the systems needed to provide digital technologies or services. They are an important part of the critical infrastructure that enables businesses to collect and process vast quantities of information. Without data centres, e-commerce platforms, apps, computerised systems and almost every piece of technology used today would cease to function.

However, there are significant costs associated with building, operating and keeping data centres secure. There are also sustainability issues with data centres. They consume large amounts of energy and, as more and more data needs to be stored and processed, they require constant upgrading of hardware and scale.

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Cloud computing

Data centres make cloud computing possible. Cloud computing involves data storage and networking of computers, software, databases and servers. Cloud computing allows information to be stored and accessed from anywhere in the world where there is a network.

You have likely experienced cloud computing at school using virtual learning platforms. Use of these cloud computing platforms increased greatly during the COVID-19 pandemic, as schools and universities needed to deliver their services online. Many classrooms are now virtual; their resources are accessible from anywhere in the world. Teachers can stream lessons live from wherever there is an internet connection, and students can access lessons and resources from an educational institution that is located on the other side of the world. Vast amounts of data is stored within the cloud.

Concept

Sustainability

Environmental sustainability is a growing concern with the increasing use of technologies in business. Data centres consume very large amounts of energy. They require extensive use of rare earth metals, consume huge amounts of power (particularly electricity) and produce a vast amount of electronic waste. In some countries, such as Denmark, data centres have been built to be powered entirely by renewable energy. Whilst this reduces the environmental damage, it does not resolve the issue entirely.

International Mindedness

Operating data centres is expensive and requires high levels of expertise. For many businesses, the cost is too high. For this reason, a number of larger companies provide data storage for the third parties. These providers include Google (https://www.google.com/about/datacenters), Amazon (https://aws.amazon.com/compliance/data-center/data-centers/) and Microsoft (https://azure.microsoft.com/en-us/global-infrastructure/), who between them own approximately half of the world's hyperscale (very large) data centres located in dozens of countries. There are also large companies outside of the United States, such as América Móvil (https://www.americamovil.com/English/overview/default.aspx), that provide data centres for others.

The market for data storage globally is concentrated, with a small handful of dominant providers.

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- Do you think that the concentration in this industry increases or reduces the concerns around ethics and sustainability?

Artificial neural networks (ANN)

The facial recognition technology mentioned at the start of this section requires the use of deep learning. Deep learning mimics human intelligence by connecting computing systems and nodes, like the neurons of a human brain. These connections are called artificial neural networks (ANN). These networks function as sophisticated systems, with inputs, processes and outputs.

Figure 3. Artificial neural networks are sophisticated systems that can process information as well as, or better than, the human brain.

Credit: AF-studio, Getty Images

Large quantities of data are gathered by management technology systems. These inputs (data) are used to train algorithms. An algorithm is a set of instructions to solve a problem or complete a task. With your (or other) data input into an algorithm, a computer system can make an appropriate decision or action (output).

These computer systems can spot patterns and trends in data, which they can use to make decisions better and faster than human beings can. This capability can support many business functions. Financial services such as banking use these systems to automate loan applications, for example, because they can quickly calculate risk based on a borrower's characteristics.

Operations and human resources use ANNs too. You may have seen or used a chatbot to get customer service. These services can provide 24-hour customer service for most common customer requests. ANNs can also track patterns in sales and stocks

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(inventory) to better manage inventory. In human resources, these systems monitor staff performance, measuring time spent on projects, on emails or away from the computer, and using data analysis to appraise workers.

Figure 4. Chatbots are frequently used on websites to provide fast customer service.

Credit: Blue Planet Studio, Getty Images

In marketing, ANNs are being used to:

- predict and influence consumer behaviours
- automate marketing services
- create and target content such as music, film, and TV streaming suggestions and relevant social media content
- forecast sales trends
- personalise marketing

Alibaba's e-commerce platform, for example, is changing the shopping experience for consumers. ANNs provide more precise search engine results that showcase personalised goods and services by providing personalised virtual storefronts and targeted internet advertising based on a customer's user profile. In addition, products are delivered in hours rather than days, and chatbots resolve specific customer complaints without any need for human interaction.

ANNs are also being used in smart factories to improve manufacturing processes. Artificial neural networks can even teach themselves using data input, in the way that a human brain does, so that the decisions and actions of the ANNs and their algorithms improve results over time.

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Concept

Social scientists have raised ethical concerns about artificial neural networks. For example, the algorithms behind Google's YouTube recommendations are designed to keep users' attention for as long as possible.

These systems are incredibly effective, manipulating users to stay on their screens, leading to addiction and exposure to extremist views designed to keep the viewer hooked. In addition, social media platforms have come under pressure for not managing the swarms of bots that regularly spread misinformation or harmful content.

Cybersecurity

Data is extremely valuable and the loss or theft of data is a major concern of businesses that collect and store data.

Cybercrime refers to criminal activity carried out using computers, networks and digital technologies. It is estimated that cybercrime will cost businesses more than 10 trillion USD by 2025 (https://cybersecurityventures.com/cybersecurity-almanac-2022/). Most cybercrime either takes place on or ends up on the 'dark web'. The dark web is a world wide web network accessed via specialist encrypted web browsers that keep users largely anonymous. This is therefore a place where criminal activity, such as selling stolen data, may take place.

Figure 5. Businesses must protect the data they collect and store.

Credit: MF3d, Getty Images

Cybersecurity involves the use of technologies and systems designed to block access to technology systems by criminals. Cybersecurity is used to protect against:

- **Hacking.** This refers to exploiting weaknesses in computer systems and networks to gain access to data.
- **Ransomware.** This is software planted on a computer system designed to block access to those systems until a sum of money is paid. In 2021, the Taiwanese electronics company Acer was attacked, with hackers demanding 50 million USD. Businesses of all kinds, including critical services such as hospitals and government offices, have been hit by ransomware attacks.
- **Distributed denial of service (DDoS) attacks.** This is an attack on a computer system designed to slow down website traffic by overwhelming it with activity. In 2021, Yandex, Russia's largest search engine and internet service provider was hit with a DDoS attack and Amazon's web services platform also reported a significant DDoS attack. Both attacks were successfully repelled by cybersecurity.

Cybercrime is a major threat to both private consumers and business operations. Consumers are harmed by cybercrime when their financial or personal data is lost or taken. A person's identity can be stolen, reputations and finances can be ruined and lives can even be put at risk when essential health, energy or emergency systems are compromised by cybercrime. And businesses can lose valuable data and intellectual property (IP) as a result of cybercrime. When a business's services are disrupted, revenue can be lost and costs of cybersecurity increase. A business's reputation can be permanently damaged by poor data security.

Making connections

In 2016, Yahoo suffered what is still considered to be one of the largest data breaches ever. Over 500 million accounts were stolen in one breach and another 3 billion customer accounts were compromised in another breach shortly afterwards.

HL (/study/app/y12-business-management-a-hl-may-2024/sid-351-cid-174702/book/the-big-picture-id-39527)Subtopic 5.7 (/study/app/y12-business-management-a-hl-may-2024/sid-351-cid-174702/book/the-big-picture-id-39527) on crisis management and contingency planning is about how businesses deal with

crises. A large data breach, or a ransomware or DDoS attack, is considered a crisis that needs to be managed well to avoid significant harm to consumers and damage to the business's reputation.

Evaluation of critical data infrastructure

Management information systems rely on data gathering, storing and processing. These functions of critical data infrastructure have a number of uses and limitations for businesses, which are summarised in **Table 1**.

Table 1. Uses and limitations of critical data infrastructure.

Uses of critical data infrastructure	Limitations of critical data infrastructure
Profits. Access to large amounts of data on consumers, and on the business itself, can increase revenues and lower costs, increasing profits. The costs of cloud computing can be lower than the costs of in-house data storage.	**Cost.** Data collection, data storage, data mining, data centres and cloud computing services are costly to run and maintain. Businesses need hardware and software to access and use stored data, whether on-site or in the cloud.
Consumer satisfaction. Access to large amounts of data can help businesses to meet customer needs and expectations.	**Consumer manipulation.** Having access to large amounts of data enables businesses to influence consumer attention, leading them to buy things they do not need and leading to excessive use of technological devices.

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Sustainability. Access to large amounts of data can help businesses avoid waste in production.

Using cloud computing reduces the need to build data infrastructure for each individual business, reducing resource use.

Sustainability. Data centres consume large amounts of energy, and the hardware needs to be upgraded frequently, requiring mining and plastics and contributing to e-waste.

Security. Data storage with large companies providing cloud computing services is likely to be more secure than individual inhouse data storage; larger companies will also have more robust back-up data in case of system failure.

Ethical and legal concerns. Storing and using customer data can violate privacy and raises ethics issues, especially where customers do not know what data is being gathered about them and how it is being used.

Complying with frequently changing privacy and security laws in different countries can be difficult for businesses that operate across borders.

Non-profit social enterprises and for-profit social enterprises may deal with critical data infrastructures differently from for-profit commercial enterprises. They are likely to give more weight to ethical concerns and are less likely to use data to exploit consumers for commercial gain. They are also more likely to use databases and data analytics to meet a genuine human need or solve a real problem, whereas for-profit commercial enterprises may use data mining purely for their own profit objectives, regardless of its contribution to society. Thus, social enterprises are likely to weigh up the uses and limitations of critical data infrastructures differently than for-profit commercial enterprises when faced with choices about collecting, storing and processing data.

Activity

Learner profile: Inquirers
Approaches to learning: Thinking skills (transfer)

There are several interesting activities related to critical data infrastructures that you could undertake.

- Invite the head of IT to your Business Management class to talk about how the school collects, stores and processes information about students. Before

they arrive, identify some questions related to the content presented in this section that you could ask them.

- Research a recent news story about data collection, data storage or data processing in business. This could, for example, be about an innovation that is improving marketing, finance, human resource management or operations. Or it could be a scandal involving mishandling of data.

  Share your story with a partner or with the class.

Activity

Learner profile: Open minded
Approaches to learning: Thinking skills (critical thinking)

Hacking receives a lot of negative media attention. It is true that many hacking incidents are malicious and destructive.

However, there are a number of interesting questions we can ask about hacking.

- What exactly is hacking? Is it possible to draw a clear line?

- Is hacking always unethical? Under what circumstances might it be justified?

- When a hacking incident occurs, how much responsibility should a business bear for it?

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