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COVID-19: The Internet of Things and Supply Chains

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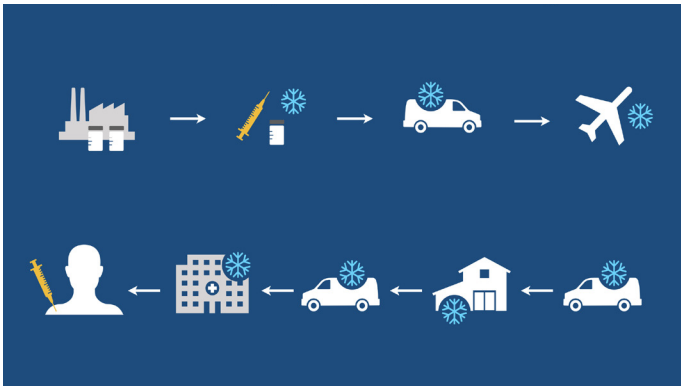

The COVID-19 pandemic has inspired a range of Internet of Things (IoT) and AI innovations to help stop the spread of the virus.

This is a sector-specific landscape review providing a short overview of technological innovations within the IoT domain to tackle supply chains logistical challenges brought by COVID-19 and Brexit, including benefits as well as risks.

Past editions are found on the PETRAS website.

During the COVID-19 pandemic, managing supply chain disruptions for food, medicines and services has been high on the UK government's agenda. The part of the supply chain visibly affected by travel restrictions, lockdowns and border closures was (and is) logistics.

The Council of Supply Chain Management Professionals defines logistics as "part of the supply chain process that plans, implements and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customer's requirements."[1]

Overview:

- Supply chain logistics have seen severe disruptions during the pandemic: restricting the movement of goods, labour shortages, shifts in patterns of demand, delivery delays, congestion and higher freight costs
- Further challenges due to Brexit can be anticipated, in particular due to uncertain supply, increased costs due to customs duties and processing costs, and time delays at the border
- IoT technologies have the potential to assist with future frictionless borders, tackling labour shortages and Brexit-induced stock-pilling, delivery of goods to consumers, and vaccine cold chain monitoring
- Yet IoT technologies pose limitations, like limited battery life or lack of skilled teams to implement tailored IoT solutions, as well as cybersecurity risks

Challenges on logistics posed by the pandemic and where IoT can help

A June 2020 report of the International Finance Corporation/World Bank Group indicates[2] the main COVID-19 impacts on logistics of the global supply chains:

- Restricting the movement of goods through lockdowns and border closure
- Shortage of truck drivers
- Shifts in patterns of demand which reduce ocean and air freight and place extra pressure on land freight due to increased demand for food and medical supplies
- Delivery delays, congestion and higher freight costs

The same report indicates that technologies such as the Internet of Things (IoT), cloud computing, or automation (some already deployed in supply

chain logistics), can help meet demands for **increased cargo inspection and cross-border controls**, c**argo visibility and traceability**, **labour shortages**, as well as a **reconfiguration of global value chains** (through nearshoring—reliance on alternative partners, or reshoring—bring home strategic value chains).

Challenges on logistics posed by the Brexit and where IoT can help

In addition to the challenges posed by COVID-19, the UK might also be facing supply chain logistics disruptions due to Brexit, which are, according to experts:

- Uncertain supply
- Increased costs due to customs duties and processing costs
- Time delays at the border[3].

A Brexit Impact Assessment by Deloitte[4] summarises potential border control challenges depending on the outcome of negotiations. These include changes to:

- Customs declarations
- Proof of origin
- Northern Ireland in UK customs territory
- Customs duties
- Safety and security declarations
- The UK Border Operating Model[5]
- Operations of the Northern Ireland Protocol[6]
- New logistics systems such as the Goods Vehicle Movement Service and Smart Freight
- Road transport permits.

In September, the UK freight transport association Logistics UK expressed concern about reported delays[7] to the 'SMART Freight' road freight technology system. The system is required to manage road freight movements to UK Channel ports after 1 January 2021, and is an online portal that ensures that trucks are carrying the correct documentation before they travel to ports. The UK Border Operating Model notes that the system is on schedule to be ready for December 2020'[8].

The new border operating model does not include the use of IoT (for more information, please see Box 1), but they can still be used to track and monitor goods and for further security controls, as detailed in the following section.

Box 1: Official government resources

The UK Border Operating Model (8 October 2020)
Moving goods under the Northern Ireland Protocol (17 November 2020)
Transporting goods between Great Britain and the EU from 1 January 2021: guidance for hauliers and commercial drivers (18 November 2020)
Customs Grant Scheme - to help businesses prepare for new customs arrangements from 1 January 2021 and to assist with training, new IT and recruitment costs.

Technical solutions to these challenges can include the distribution of IoT systems such as number plate recognition systems, and tags with GPS data to allow quicker authorised access through border control. These systems would result in the collection of large amounts of data, some of which would be commercially sensitive and personal, and would so require compliance with data law.

Frictionless borders

Within the EU's Customs Union and Single Market goods move freely, meaning no internal tariffs between member countries, no checks and no customs formalities. Yet COVID-19 introduced some restrictions of the free movement of goods, mainly due to the need to follow hygiene and social distancing measures[9]. For the UK, starting 1st of January 2021 transporting goods to and from the EU will need to follow a new set of rules, which include documents, licences and permits for both drivers and hauliers[10]. All these rules and restrictions can lead to delays and increased costs within the supply chains.

Delays in moving goods across the borders can particularly impact industries trading in perishable goods such as food and medicines. An end-to-end visibility of the supply chain is viewed by industry sources as crucial for allowing the development of contingency plans in case of border delays[11]. An example of such technology already in use include Michelin the French tyre manufacturer.

Michelin introduced a low-power IoT tracking system, developed by Sigfox, for its intercontinental sea freight flows. The IoT solution allowed monitoring of loading or unloading of shipments,

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of temperature, humidity and shocks and it led to a 40% increase in Estimated Time of Arrival (ETA) accuracy[12].

IoT is allowing industrial container transportation provider Maersk to transform into an end-to-end supply chain logistics provider by providing location tracking of shipments in real-time and the ability to monitor and adjust atmospheric parameters on sensitive goods like perishable food and medication[13].

Sigfox also partnered with Deutsche Post DHL Group to optimise its supply chain by systematic use of networked sensors[14].

Tracking and monitoring solutions can also support compliance with regulatory requirements. Two American companies, Senet, a provider of provider of cloud-based software, and NanoThings, a developer of long-range, temperature-tracking smart labels, have partnered to deliver a contactless remote monitoring system. The smart label, called NanoTag, has a temperature sensor with a 0.5 degree accuracy, over two years of active battery life, ultra long range connectivity, buttonless, disposable, equipped with damage detection, stores up to 24,000 temperature readings, and is made of food grade materials[15]. The system provides end-to-end temperature monitoring and secure cloud storage and supports compliance with the Food Safety Modernization Act (FSMA)[16].

Traditionally cargos are sealed by using mechanical seals. Yet they are not standardised, not fool-proof and do not provide information on the movement of a shipment. Electronic seals however check all these boxes. In 2017 Indian Customs decided to require that some traders use electronic seals. RFID e-seals are devices that transmit container information via radio frequency to a RFID portal or mobile reader and thus enable Customs to retrieve data on the cargo[17].

Cargo also needs to be scanned for the presence of weapons or radioactive substances. The UK based company Kromek developed a wearable gamma neutron Radio-Isotope Identifier Device (RIID)[18]. The wearable has been deployed by the New Jersey Port Authority in the US[19].

As part of security controls are also automatic number plate recognition (ANPR). One example in use comes from the VECTOR camera and TraffiData solutions from the company Jenoptik[20].

Automated warehouses: tackling labour shortages and Brexit-induced stock-pilling

Supply chain logistics have seen labour shortages for both truck drivers[21] and warehouse personnel[22] during the pandemic. While technologies for driverless tucks are still unavailable for large deployment, automated warehouses can reduce the need for human personnel. Both Amazon and Walmart have automated their warehouses using automated packing technology, automated loading and unloading, robotic inventory tracking as well as robots for hygiene enforcing and cleaning[23].

Pharmaceutical industry companies are preparing for a no-deal Brexit by stock-pilling medicines. Novartis has announced securing additional warehousing in the UK as it hopes to keep 14 weeks' worth of medicine supply[24]. Pharma companies also prepare by stock-pilling active pharmaceutical ingredients (APIs)[25]. Inventory costs can be reduced using sensors like 2-D barcodes, RFID tags, and smart labels which can inform a better optimisation of stock levels[26].

Delivery of goods to consumers

Cleveron and Globe Tracker announced a partnership in cold chain monitoring for grocery pick up in October 2020. Cleveron, an Estonian technology company developing automated parcel delivery solutions, has partnered with Globe Tracker, a Danish company offering IoT solutions for visibility in the cold chain, to monitor location and container parameters for self-standing automated pickup solutions[27].

There is an increasing interest in drones for the delivery of goods to consumers. UPS is the first company to receive full Part 135 certification from the Federal Aviation Administration for its drone airline. They are transporting medical samples to testing labs and online shopping door-to-door delivery[28].

Vaccine cold chain monitoring

Some of the greatest hopes in controlling the pandemic come from finding efficient and safe vaccines. With several strong vaccine candidates coming close to regulatory approval, logistics need to prepare for their distribution. Maintaining constant a certain temperature is a key factor in vaccine transportation, as temperature fluctuations can lead to compromised efficacy.

IoT innovations have been proposed to aid in vaccine transportation and distribution:

- The Electronic Vaccine Intelligence Network, developed by the UNDP and the Indian government which is digitising vaccine stocks and providing real-time monitoring of storage temperatures; the initiative has resulted in savings of 90 million doses of vaccines previously lost due to wastage and mismanagement[29]
- Pfizer indicated that they would use their packaging and storage innovations for the vaccine transport, thermal shippers equipped with GPS-enabled thermal sensors tracking location and temperature[30]
- FedEx has launched a lightweight sensor-based device, SenseAware ID, that provides detailed location data[31]
- Scannable barcodes, that could register details concerning the safety and the preservation mode of the vaccines[32].

IoT limitations and risks

Although promising, many IoT technologies have significant technology limitations and high implementation costs. For example, drones can have limited battery life which makes them useful only for short distance deliveries and they can have a limited carrier capacity of around 5 kg. Drones also face legal restrictions, with many areas off-limits to drones[33]. Weather is another concern as they can have limited operability in high winds or rain[34].

For IoT devices used in cargo visibility and tracing, the lack of skilled teams to create IoT solutions tailored to the needs of an individual company, issues with increased data storage (data governance issues, finding data analysts), connectivity problems and security threats are some of the best-known challenges[35].

As IoT devices at border controls would be collecting commercially sensitive and personal data, data law compliance will also be important. The provisions of EU's General Data Protection Regulation (GDPR) will be replaced post-Brexit by the UK's Data Protection Act[36].

With an increase in the number of IoT devices, comes an increase in security risks. To manage IoT end-to-end security, companies can address the following areas, according to an RSA Security analyst[37]:

1. Visibility: each endpoint needs to be registered, including specific information about the device
2. Risk management is constant assessment: IoT risk profiles as well as 3rd party risks change over time
3. Not just devices, but also data: data collected by the devices, at rest, in transit or in process, need to be protected as well
4. Who is accessing devices: all users should be authenticated
5. Monitoring: connecting risk monitoring with access policies

Responsibility for cybersecurity protection does not rely solely with haulage companies. In July this year, U.N. World Forum's Working Party on Automated/Autonomous and Connected Vehicles adopted an agreement requiring national authorities responsible for approving car models to ensure that new car models, including trucks, have in-built cybersecurity protection[38]. They also require certain components to meet the same regulatory standards, and of companies to provide information on how they can protect against certain attacks, and to annually inform authorities about how efficient cybersecurity measures have been[39].

Yet even if trucks have in-built cybersecurity protection, ensuring cybersecurity after vehicle purchase (protecting against hacks that can manipulate trucks or divert routes) requires additional resources which small freight companies often lack. Additionally, they also lack drivers with IT and cybersecurity knowledge and need to clarify the legal issue of liability for cyberattacks on connected vehicles[40].

Box 2: The Parliamentary Office for Science and Technology has released Areas of Research Interest for Supply Chains. Presented below are questions to consider from an IoT perspective:

8.1. What are the likely impacts on global and internal supply chains following the COVID-19 outbreak? How can global and internal supply chains be made more resilient? What role are parallel supply chains likely to play in the future? How can UK businesses reliant on imports and exports be supported? How can the UK best secure consumer choice and national food security?

- *How can the IoT make global and internal supply chains more resilient considering COVID-19 and Brexit?*

8.2. What has the COVID-19 outbreak revealed about the advantages and disadvantages of different responses (such as reshoring, onshoring and near-shoring) to supply chain vulnerability? What responses are likely to be the most effective in the event of future supply chain shocks?

- *Can IoT help in making reshoring/onshoring/near-shoring more cost-efficient?*

8.3. What are the most effective ways for the UK to support domestic manufacturing and increase economic diversification? How able is the UK's infrastructure to deal with an increase in internal trade?

- *How can IoT help make internal trade more efficient?*

8.4. Which industries are most at-risk of labour shortages following an end to freedom of movement? How can immigration policy best ensure the UK has access to the labour it needs in these industries? What are the likely skill shortages that the UK will face in the future? How can people out of work best be reskilled to address shortages? What will be the role of automation in addressing labour shortages?

- *What will be the role of automation in addressing labour shortages?*

8.5. What changes should be made to the Government's Industrial Strategy following COVID-19?

- *What recommendations on IoT/smart machines/data twins could be made to the Government's Industrial Strategy following COVID-19?*

Box 3: Let's talk cybersecurity - points of discussion from PETRAS

Are there issues associated with multi-vendor supply of IoT devices in terms of a common cybersecurity approach?

Are we able to deploy robust cybersecurity threat mitigation on IoT/edge devices across supply chains, or do we need an alternative lightweight/tiered approach?

Traditional IT systems are often managed within a security perimeter, which we are aware is being phased out, with new challenges being faced in remote device / Cloud adoption - but how do we deal with de-perimeterisation at scale with potentially millions of endpoints outside the perimeter?

With a dependency on IoT devices in the supply chain, is there a risk of cascading failure across supply chains should a small number of IoT devices fail? If so, how do we plan to manage this?

Box 4: Key points from the PETRAS webinar - Securing the Future: Supply Chains
Available to watch online

The panellist's discussion centred around several main themes:

Resilience:

- Many companies have lost supply chain resilience skills (not well prepared with buffers and stock) since increased use of digital tools made them unnecessary.
- If the system is not resilient then the structure is not resilient.
- Ideally, companies should have the capability to respond to changes in real time, yet many companies do not have the flexibility and visibility of the supply chain to react fast.
- Access to data is crucial to respond quickly to challenges.
- Events that are rare are not given proper attention.
- The resilience of the supply chain will be the main competitive advantage in the future replacing intellectual property rights.

Provenance and trust:

- Within the IoT hype there are few conversations on provenance and trust.
- In some industries like shipping there is a huge element of trust (containers are not opened at every step, the description provided by the sender is accepted).
- Yet too much trust can have negative repercussions (built-in device weakness can affect entire supply chains as for example a chip can be used in multiple points in the supply chain).
- To guarantee the integrity of materials (high importance in healthcare) labelling can be a solution. Yet it would increase the cost of goods.
- The provenance of substances and data are points of weakness in the health sector supply chain.
- Vaccine distribution is the 'poster child' for the use of IoT.

Security and regulations:

- Several agencies, including the IoT Security Foundation, devised standards recommendations on basic principles for IoT devices. Yet for some manufacturers it proves problematic because it raises production costs.
- Bigger companies are very keen on including security measures in IoT devices.
- Multinationals have more power to regulate as governments only have jurisdiction at national level.
- Who takes responsibility for security issues on devices used in multiple locations in the supply chain?
- An unresolved issue is how to protect consumer information, for example when the manufacturer goes out of business.
- Not enough attention is being given to public trust in these technologies from a regulatory point of view.

Challenges in emerging nations:

- Access to the internet is unreliable, but the situation is changing fast. Large companies like Google play a huge part in leading that development.
- Challenges for people include usability and accessibility.
- The global supply chain has become increasingly complex and there is still a lack of trusted regulators.

Endnotes

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