

Understanding UK grocery supply chain resilience



This report has been produced by Arup specialists who advise our clients on a range of challenges from logistics to operational readiness, with input from experts from across the grocery industry and funding from our research programme, Invest in Arup. We would like to thank all authors, experts and research respondents for their contributions.

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Contents

Executive summary	4
Introduction	6
The grocery supply chain	8
Survey - supply chain resilience	12
<i>Key insights - politics</i>	14
<i>Key insights - environmental</i>	16
<i>Key insights - technology</i>	18
Survey - infrastructure resilience	20
<i>Key priorities - politics</i>	23
<i>Key priorities - environment</i>	24
<i>Key priorities - technology</i>	25
Mapping global supply chains	26
<i>Mapping the UK grocery sector</i>	28
Conclusion	30
<i>References</i>	32
<i>Publications</i>	35
Appendix A	36

Executive summary

The UK imports more groceries than it exports, through a network of global, complex supply chains. As national politics and trade become increasingly turbulent and extreme weather events and rapid climate change become the norm, it is important to test and identify improvements to the grocery supply chains and infrastructure that will ensure the resilience of the country's food sources.

As supply chains have become more global, and thus increasingly complex, they have become more susceptible and at greater risk of potential disruptions. Also, businesses have become leaner often with a reduction in suppliers.

This report looks at the the ability of the UK's food supply chain, in the face of growing risk, to maintain and improve its ability to reduce the impact of possible disruption and recover quickly. The report looks at both the resilience of the food supply chains themselves, worth £185bn in 2017, and the critical infrastructure they rely upon.

The research was carried out in November 2018, less than six months before the UK was due to leave the European Union (March 2019) and included a survey of 40 companies in the UK food supply sector such as producers, logistics firms, distributors, retailers and asset owners. The questions focused on the potential impact of political, technological and environmental factors on supply chains. The key findings when firms were asked about the resilience of their own supply chains are:

- 91% of firms expected some level of disruption to their supply chains from Britain leaving the European Union, but only half had contingency plans
- Just 58% of firms are already in discussions with their suppliers about mitigating the potential impact from Britain leaving the EU
- only 37% of all firms surveyed have sight of their suppliers' contingencies plans
- 70% expected disruption from adverse weather
- 69% of all survey respondents have a contingency plan for mitigating impacts to their supply chain from environmental disruptions
- only 46% have sight of their suppliers' contingency plans for environmental disruptions
- only 8% of firms believe they operate truly agile supply chains that can quickly respond to a disruption
- 51% of firms do not assess their firm's competitiveness based on technology and R&D innovation



- 30% of firms anticipate that drones will improve operation
- 100% agreed that technology would help to reduce supply chain risks
- 63% believe that an autonomous robotic workforce will improve the resilience of supply chains.

The research also looked at the importance of infrastructure to food supply chains and which infrastructure improvements the industry wants to see prioritised. The key findings of the survey and wider research are:

- Most firms and academics have focused on systems and supply chain elements under the control of the industry and there is little understanding or resilience planning around the infrastructure that supply chains rely upon
- When looking at the political dimension of infrastructure resilience and investment, the survey respondents ranked most highly (22%) expansion and improvements to HMRC physical infrastructure to facilitate quicker customs processing; increase of port infrastructure to accommodate increased

administrative haulage and containers (20%); and, an increased amount of warehousing in key strategic areas (20%)

- The largest proportion of survey respondents (21%) ranked alternative fuel supply sources as the number one priority to mitigate environmental risks, followed by new infrastructure/route options to reduce reliance on key strategic routes (new road; rail; air; sea routes) (15%) and renewable energy generation sources and alternative water irrigation infrastructure (15%)
- When considering the impact of technology on infrastructure resilience, the largest proportion of survey respondents (27%) ranked big data analytics as a priority to improve resilience, followed by advanced automation in manufacturing (22%); and more development of hybrid or electric vehicle infrastructure (14%).

The aim of this report is to help those managing the UK food supply chains prepare for expected and unexpected disruptions. It includes practical advice on tools that can be used to assess supply chain resilience and provides a practical example of this work.



DARREN BRIGGS
Director

Introduction

Globalisation has brought opportunities for firms to work more closely together with others from around the world, allowing many grocery goods, fresh produce and meat to be procured from afar – particularly as UK customers have become more acquainted to global tastes.

To meet customer demand of fresh, low-cost food produce, grocery supply chains have become leaner, operating just-in-time operations, coupled with improved manufacturing processes and technologies. They have done this while also implementing regulatory and sustainability requirements, which impact on the environment in which the sector operates (Harvard Business Review, 2007).

In recent years the world has become more volatile and less predictable than companies and consumers have become accustomed to expect. This report explores the potential impact on the resilience of supply chains in the grocery sector of three change scenarios - political, environmental and technological. It also considers whether resilient infrastructure can help to ensure the security of the UK's food supply.

The political landscape in the UK has changed dramatically in the past 3 years. Producers, logistics firms, manufacturers, retailers and the majority of the public may not have anticipated such political upheaval arising from the referendum on whether to leave the European Union (Financial Times, 2018e) or ongoing trade disputes in global trade (Financial Times, 2018f).

The 2015 Paris Agreement aligns efforts to reduce global emissions arising from production, manufacturing and transportation (United Nations, 2018). Recent flooding,

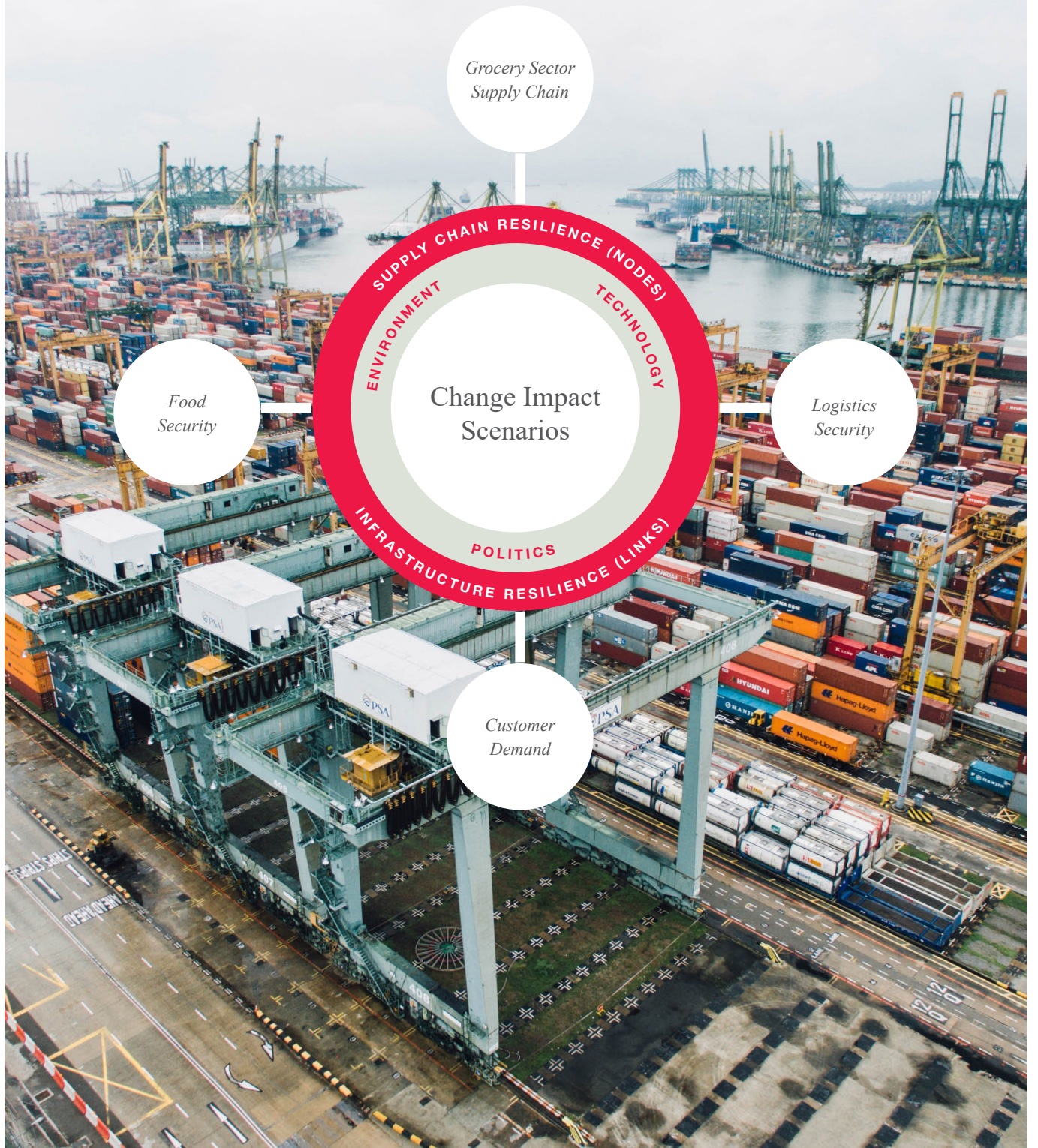
heatwaves and cold blasts have affected food supply chains at their source across the world, in addition to damaging major infrastructure and logistics centres.

Technological advances have recently provided small, incremental improvements in the grocery supply chain, yet there are opportunities for positive disruption within the sector as the pace of change has increased.

APPROACH

To thoroughly understand the impact of politics (mainly due to exiting the European Union), technology and environmental changes on supply chain resilience in the UK grocery sector, Arup has conducted surveys and interviews with a wide spectrum of firms within the supply chain, alongside secondary research. The three main themes that this report explores, are:

- Supply chain resilience
- Infrastructure resilience
- Mapping global supply chains.



The grocery supply chain

The UK grocery market as a whole was valued at £185bn in 2017 and forecast to increase by 15% to £213bn by 2022 as population growth rises (IGD, 2017), yet ongoing uncertainties arising from the country's relationship to the European Union could impact upon the resilience of the food supply chain.

Including supply chain costs, the UK consumes circa £100bn of grocery products (Moore Stephens UK, 2018), of which a significant 30% of unprocessed food (produce and meat) is imported into the UK from the European Union (EU) compared to 49% home-grown within the UK (Department for Environment, Food and Rural Affairs, 2017).

The UK grocery arena is also experiencing radical change, as the major traditional supermarket retailers are experiencing market share pressures from low price discounters, as well as disruption from new entrant online grocery retailers (Core Sight Research, 2016).

Although the UK's produce and meat export/import split is 50:50, this is closer to 2:1 when considering the whole food chain. The UK is therefore more reliant on imports and is susceptible to not only local shocks but to global shocks in its entire food supply chain.

For example, the UK imports more animal feed than it exports and for the UK's food chain and grocery sector to become more sustainable and resilient, it must be able to balance this deficit (among a wide range of other items to be resolved).

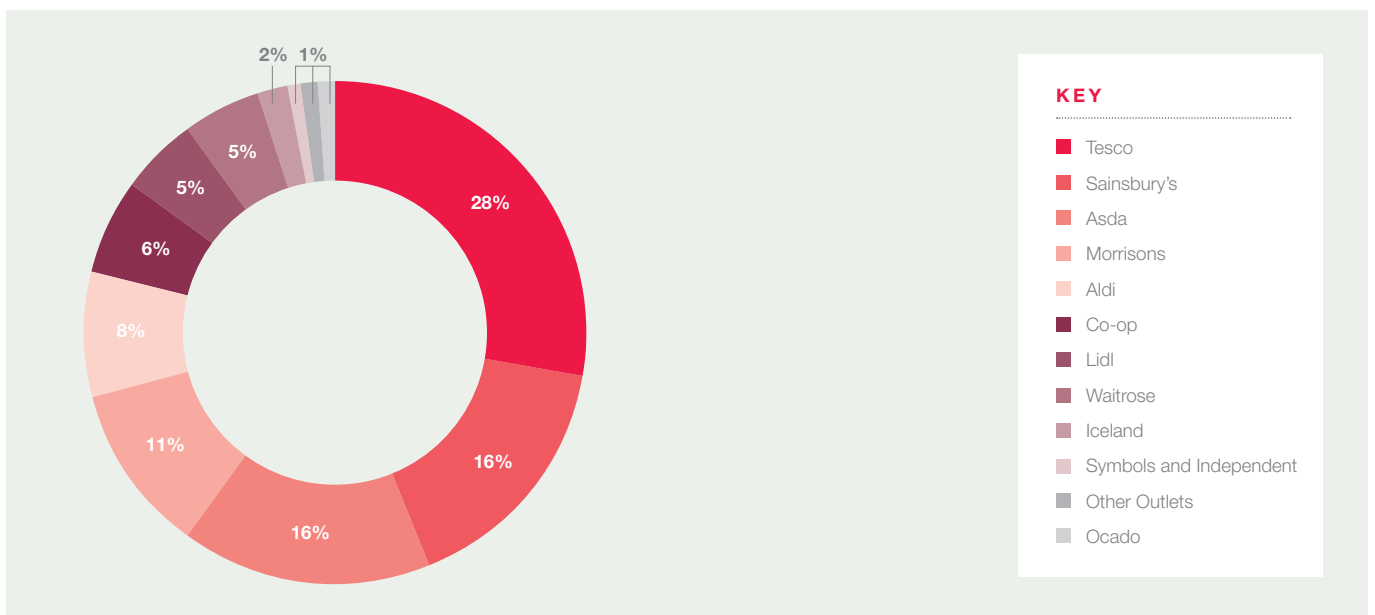
Recent extreme cold and hot weather during 2018 has led to a 12.3% increase in animal feed being used than in 2017, leading to livestock being slaughtered earlier to allow farmers to minimise rising cost pressures, whilst continuing to meet regulatory standards (Farmers Weekly, 2018).

As a result of this ongoing disruption, food prices in the UK are expected to rise and be passed on to customers (The Guardian, 2018c). This was seen in Australia, during the drought of 2005-07, where the country experienced food inflation of 12% (Quiggin, 2007) and is expected to see similar inflationary pressures due to the drought of 2018.

There are 42.6m acres of agricultural land in the UK, representing 71% of the total land mass. 45% of total UK land is used for crops and 26% used for grazing, leading to 1.5 tonnes of production per agriculture acre (Savills, 2018). The UK remains reliant on imports and is currently not productive nor self-sustaining enough to close the gap between import and self-sufficiency compared to its European peers (slate.com ranks the UK as one of the worst performing countries in the EU on the deficit between importing and

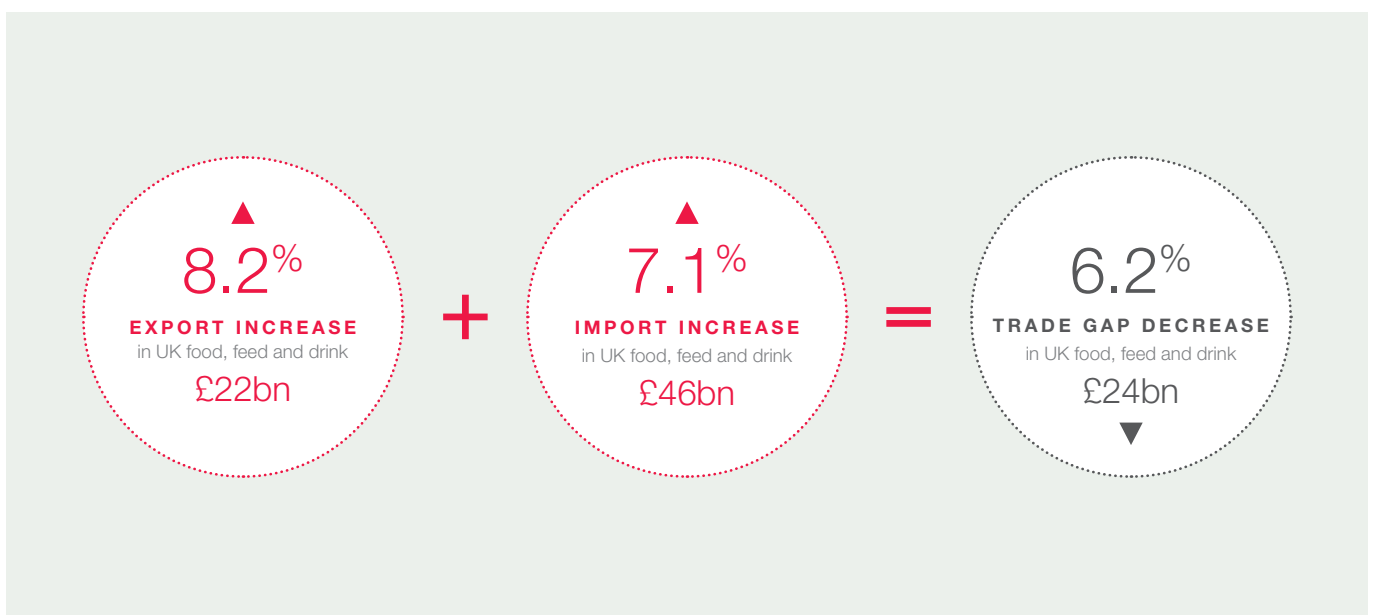
UK GROCERY MARKET SHARE

12 Weeks Ending 07/10/18 (Kantar Worldpanel, 2018)



REDUCING FOOD, FEED, DRINK TRADE GAP WITHIN THE UK (2016-2017)

UK Food, Feed and Drink Trade Gap (Department for Environment, Food and Rural Affairs, 2018)



exporting food). Nevertheless, the negotiation around Britain leaving the European Union has forced UK retailers, producers, and distributors to act and mitigate the potential risks arising, to protect their profits. Firms must realign their efforts to mitigate the potential impact of the negotiations and arrangements around Britain leaving the EU. This could potentially benefit UK suppliers and lead to an increase in the productivity of the UK agricultural sector so that it can remain competitive (Savills, 2018).

The UK Government should foster long-term strategies and planning, in addition to providing the necessary subsidies and investment to help facilitate this transition away from importing produce and meat, towards increasing the efficiency and self-sufficiency of UK food production. This will not only improve the long-term food security of the UK (Birmingham Food Council, 2018), but assist in narrowing the UK trade deficit of £2.8bn in August 2018 (Office of National Statistics, 2018).

While long term planning is difficult in a turbulent political environment driven by the short-term demands of the electoral cycle, the UK has begun to focus on long-term infrastructure planning. The National Infrastructure Commission has been created to take the long view and support the UK Government to make the right infrastructure spending decisions. This should help the grocery supply chain improve its resilience by improving infrastructure.

**CASE STUDY:
SCOTTISH WHISKY**

Scottish whisky has an export value of £4.5 billion annually for the UK economy (Department for Environment, Food and Rural Affairs, 2018).

The potential impact of Britain leaving the European Union has not been realised yet, but the UK's competitiveness could be put at risk by tariffs on supply chain inputs (e.g. glass bottles, corks, machinery and barley) of approximately 10% if World Trade Organisation tariffs are applied (The Scotch Whisky Association, 2018).

£4.5 billion
Exported



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**CASE STUDY:
FRESH FRUIT AND VEGETABLES**

Fresh fruit and vegetables remain the highest value product categories for imports, totalling £6.2 billion (Department for Environment, Food and Rural Affairs, 2018). The UK's reliance on imported fruit and vegetables demonstrates the unique just-in-time logistics and processes in place for retailers to import much of the fresh produce from the EU.

This relationship has been built upon for decades and made lean, yet it is likely to be a challenge for retailers to simply switch from imported produce to home-grown produce in the current timeframe for Britain leaving the European Union. Challenges include unavailability of land and resources and inability to grow some products due to the UK climate.

£6.2 billion
Imported



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**CASE STUDY:
COULD THE BRITISH BE
WITHOUT A TEA BREAK?**

The UK imports over 135,000 tonnes of tea onto its shores. Most shipments of tea arrive in containers into the UK via sea, particularly from Kenya, Malawi, India and China (Confederation of British Industry, 2016). Tea typically arrives at major ports such as Felixstowe and Dover, as well as feeder services into the Port of Tyne from Rotterdam for Tetley (Port of Tyne, 2018).

Britain leaving the EU is likely to cause only very minor delays to some tea shipments – particularly cargo coming through Europe (i.e. shipments from China and India that use the Suez Canal and switch at Southern European intermodal terminals onwards onto the UK via road). The majority of tea shipments then continue onwards via sea through Gibraltar and around the west coast of France (MAERSK, 2018). Most tea has a long shelf-life to cope at sea yet comply with EU compliance (maximum permitted residual levels (Confederation of British Industry, 2016)). Hence, Brits are more than likely not to miss out on their favourite brew.



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Survey - supply chain resilience

Identifying key insights

MEASURING SUPPLY CHAINS

Since globalisation in the 1980's, supply chains have become more complex and international, while product lifecycles have been made more efficient and leaner. By identifying performance factors used by the industry to measure and safeguard their supply chains, we can assess a country's food security.

This report does not focus on food security and globalisation, which benefits consumers by offering a year-round, wide and varied choice of food from across the world. However, the report does consider the impact of complexity and environmental factors on the food supply chain and concludes that this should be reduced in the long-term for any country to safeguard the security of its population's food.

Besides access to food sources and water, logistics and technology play a critical part in food security and need to be conducted in a sustainable manner for future generations (Birmingham Food Council, 2018). Improving the sustainability of supply chains can only be driven by the private sector assessing their supply chain resilience, with the encouragement of governments through planning, guidance and investment. Some key drivers/metrics for measuring and assessing a firm's supply chain resilience (APICS, 2016) are:

- Visibility
- Resilience
- Value segmentation and product rationalisation
- Risk management.

Any lack of resilience is likely to impact on consumers but also on firms in numerous ways – including financially and reputationally.

The key drivers for measuring a firm's supply chain enable firms to assess whether they are resilient, robust and agile enough to cope with any disruptions arising from volatile or unexpected internal or external events and market changes.

THE INDUSTRY SURVEY

The survey consisted of 30 questions around resilience to each of the change scenarios (politics, environment and technology). The responses enable the formulation of an overall assessment of the industry in its preparedness against these disruptions.

The findings of the survey can be seen on the following pages. A full view of the anonymised survey results (and the questions asked) is available in Appendix A.

Supply chain resilience focuses on how well a firm's supply chain responds when faced with potential disruptions arising from political, technology and environmental factors. The survey findings have been used to make an assessment of whether firms have contingencies in place to mitigate these disruptions and assess the impact of any disruption to their supply chain.

Firms within the grocery supply chain can mitigate against these three change scenarios through careful risk management and contingency planning.

The following are some measures/contingency planning tools that can be used to increase supply chain resilience (Department for Transport, 2003):

- Scenario planning in the event of attacks and disruptions
- Business Continuity Plan with other suppliers and stakeholders
- Media and legislation scanning
- Alternative route planning
- PESTLE analysis
- Stakeholder analysis (vs scenarios)
- Emergency planning procedures
- Failure Mode Effect Analysis
- Serious incident committee
- Multiple key suppliers (as opposed to having one major supplier).

43 organisations operating in the UK grocery sector were surveyed in November 2018. This was less than 5 months from the anticipated exit of Britain from the European Union, potentially without an agreement allowing for a planned transition to a permanent arrangement on trade, transport, etc. The organisations represented a mixture of:

- Asset owners
- Distributors
- Logistics service providers
- Producers
- Retailers

KEY DRIVERS OF SUPPLY CHAIN RESILIENCE:

Visibility

Visibility refers to whether a business is aware of its entire operations and tiered suppliers. Businesses must have as much real-time knowledge of their supply chain's operations as possible to act accordingly, adjust demand, inventory and their logistics. Having full visibility of an organisation's supply chain can help test its resilience. Visibility can be measured by:

- Identifying and mapping locations and supply chain data of an operation and its logistics geographically and relating any movements in real-time (DBIS, 2014)
- Measuring value and the impact value (if disrupted) of nodal locations and any movements (as well as potential disrupted links (or infrastructure)) (DFT 2003).

Resilience

Resilience is the ability to withstand, respond and recover from the expected and unexpected shocks and stresses. This includes the speed and acceleration of recovering to normal levels; referred to as agility. It can be achieved through:

- Increasing redundancy (although this may involve having more inventory)
- Building flexibility (having several key suppliers can mitigate disruption particularly if the relationship between several suppliers is strong enough to enable a quick response to return to normal during any disruptions)
- Ensuring corporate culture is in place to enact against any disruption.

Value segmentation and product rationalisation

It is important to measure the following impact parameters throughout the supply chain's products and materials to identify cost and value changes throughout the product's journey. These include (APICS, 2016):

- Revenue
- Margin
- Asset
- Cash flow
- Strategic
- Regulatory
- Brand
- Lifespan

Risk management

Managing risk can help ensure that supply chains are resilient and able to cope with disruption. Risk can be identified as the potential likelihood for an event to occur and the severity of any arising disruption. As businesses have become more global, complex and lean, risks to supply chains have increased (Department for Transport, 2003). Potential sources for risk include:

- Reduction to the supplier base (or increase)
- Just in time and lean supply chains
- Outsourced operations (and hence potential lack of visibility and control)
- Critical points (e.g. due to logistics or bottlenecks in production or even infrastructure)
- Communication and info sharing between supplier and firm
- Technology has been critical to improving risk management but also poses its own risks, such as potential cyber-attacks.

Key insights - politics

With Britain leaving the European Union looming - less than five months away at the time the survey was carried out - only 56% of firms have a plan to mitigate any potential disruptions. 91% of firms surveyed anticipate some level of disruption at the border – with 20 to 30 miles of queues anticipated on either side of the English Channel (The Guardian, 2018a).

In recent years national political agendas have taken centre stage from liberal trade-driven globalisation. Britain has decided to leave the European Union and is going through the process of defining and delivering this outcome. The United States has introduced a number of measures designed to protect its own industries and labour. Anti-immigration and globalisation sentiment is being fuelled by a surge in populist politicians and parties in many countries and regions. The potential impact on global grocery supply chains is far encompassing.

At the time of writing, to meet the future demands anticipated from the UK, the EU Withdrawal Bill aims to enshrine current EU legislation as UK legislation (UK Parliament, 2018). Yet, uncertainties remain regarding the Irish border and the Backstop and Customs Union (Financial Times, 2018a) – particularly given the former being the crunch political issue during negotiations (Financial Times, 2018g).

Given the change in Government leadership it is not yet clear whether the UK will maintain its determination to push the EU Withdrawal Bill forward through both Houses of Parliament and Lords. The aim of the Bill is to enable the Government to enter the next stage of EU negotiations with home support (Financial Times, 2018b). Nevertheless, at the

time and publication of this report, political uncertainty remains.

Besides the high-level publication of guidance from UK Government for businesses to prepare in the event of a “no-deal” scenario (UK Government, 2018a), optimism within the firms surveyed remains low. This is due in part to the intricacies of the grocery just-in-time food supply chain model, not being fully understood by those leading the national contingency planning. The recommendation to carry out “stockpiling” is not feasible nor practical due to the short shelf-life of produce, which for decades has benefited from frictionless trade (Financial Times, 2018e).

The lack of warehousing (vacancy rates are only at 7.5%, but 20% of existing warehousing stock is not fit for purpose) emphasises the point that stockpiling is not feasible (UK Warehouse Association, 2016) – particularly as planning, design and construction of new warehouses usually takes approximately 2-3 years.

From the survey conducted, 91% of businesses throughout the grocery supply chain (producers, distributors, logistics firms, retailers and asset owners) anticipate some level of disruption at the border and to the logistics and transportation of their goods if the trading relationship between Britain and the EU changes.

60%

of firms have anticipated medium to high levels of disruption to their supply chain post Britain's exit from the European Union.

91%

of firms have anticipated some level of disruption at the border when transporting their goods post Britain's exit from the European Union.

The survey shows that only 21% have alternate suppliers (away from EU suppliers) in place, while 40% will consider alternate suppliers in the future. For firms to be more resilient, they must plan for worst-case scenarios to ensure that food supplies are not disrupted.

60% of firms anticipate medium to high levels of disruption to their supply chain processes and 14% anticipate no impact at all in the event of a no-deal (or restriction on free movement of goods) scenario. Contingencies are recommended in the event of a no-deal and firms must be ready to be resilient and be able to recover to a normal level of service if there is disruption to their processes.

For firms in the grocery supply chain to be fully resilient, visibility of firms' entire supply chain is crucial (APICS, 2016).

Visibility is not just restricted to knowing who your suppliers are. Establishing effective communication across the several tiers of the supply chain is essential to ensuring that there is an open, responsive channel and relationship in place before the unexpected hits. Just 58% of firms are already in discussions with their suppliers about mitigating the potential impact from Britain leaving the EU, while another 19% plan to discuss this soon. With the unpredictable possibility of a planned or unmanaged departure in the near future, it is important for firms to talk to their supply chains and share contingency plans around potential delays, cost and reputational impacts, supply disruptions, etc.

30% of survey respondents anticipate a medium to high level demand reduction for their grocery goods and services after Britain has left the EU (producers and retailers mainly) and 30% anticipate no impact at all. No longer being in the EU produces potential disadvantages, as well as opportunities for firms, particularly if Pound Sterling remains low to encourage exports abroad. 56% have developed a contingency plan to ensure their business is resilient against any potential disruption from Britain leaving the EU, yet only 37% of all firms surveyed have sight of their suppliers' contingencies plans. A supply



chain can metaphorically be described as a set of interlinking chains; if one of the links is broken (or not prepared in this case), the rest of the chain will fail.

“The overlooked aspect of trade within logistics is what will happen to Holyhead Port and connections across the Irish Sea. With little known about the Irish border situation this could have a massive impact on supply chains...”

Retailer

“All of our produce inventory comes from Europe... which is our whole business and we're not sure how Brexit will impact us...”

Producer

30%

of respondents anticipate a medium to high level demand reduction for their goods and services post Brexit.

56%

of firms have developed a contingency plan to ensure their business is resilient against any potential disruption from Brexit

Key insights - environmental

Although, 69% of all survey respondents have a contingency plan for mitigating impacts to their supply chain from environmental disruptions, only 46% of all survey respondents have sight of their suppliers' contingency plans.

The 2015 Paris Agreement builds upon the previous 1992 Kyoto Protocol Agreement to align global efforts to reduce worldwide emissions arising from production, manufacturing and transportation (United Nations, 2018).

Recent global flooding, heatwaves and cold blasts have affected food supply chains across the world, including, for instance, pork supplies in China (WATTAgNet, 2016), while the hot weather over the summer of 2018 has presented difficulties for UK farmers (Financial Times, 2018d), who have requested aid and support from the UK Government.

In addition, the freezing weather across Northern Europe and the UK in 2018 compounded misery for farmers and businesses with reports of a £1bn hit per day to the UK economy alone (The Guardian, 2018b).

Infrastructure has an important role to play in mitigating the impact arising from environmental disruption. This can be supported by advances in technology in transport and energy generation. The Intergovernmental Panel on Climate Change (IPCC) states that "even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation unavoidable, and therefore changing and adapting our infrastructure, settlement and economic systems may be the solution" (International Transport Forum, 2014).

Infrastructure will need to be adapted to combat climate change, such as additional flood defences to protect crops and livestock (for example, preventing pigs perishing in floods in China) and protecting major ports. Ports are crucial to the global trade of food and goods and are required to be fully functional in an inter-connected world.

The environmental section of the survey mainly focused on the perceptions of firms and their appetite for risk within their supply chain. That is, how much risk they are able to live with when they consider the likely occurrence and damage caused by environmental disruptions.

This is something that firms and their supply chains need to carefully mitigate and manage, through risk management tools for example.

In terms of adverse weather, flooding, energy disruption and major environmental events, the majority of firms are likely to be impacted and the severity can be high. Firms must evolve and reinvest within themselves or their supply chains in order to mitigate or reduce any impact. Likelihood of unpredictable, adverse weather is increasing, whether cold or hot weather experienced in 2018 across Northern Europe or flooding and earthquake events, attributed to El Nino and climate change.

70% of firms indicated that they are likely to be affected by an adverse weather event, including two thirds of all the producers surveyed.

62%

of firms will be notified by their suppliers in the event of environmental disruption

54%

of firms do not have sight of their supplier's contingency plans against environmental impacts

62% of firms responded that they would be notified by their suppliers if they were disrupted by an environmental event. Visibility is not just restricted to knowing who your suppliers are, but communication is fundamental to reduce the impact from environmental disruptions. Having close relationships with key suppliers (whether that is through a supplier relationship management programme or scheme) helps to facilitate trust, commitment and ongoing communication between all parties.

Only 8% of all firms report that they are truly agile and able to return to a normal state of operations within 24 hours. 23% would take between 1 day to a week; 28% would take 1 week to a month and 8% (20% of all producers) would take more than a month to recover. 33% of all respondents are not sure, however, that may be due to lack of knowledge. Those with the fastest recovery responses indicated the importance of good communication with their employees in order for them to be able to act quickly in the case of an emergency event.

These findings around recovery could be due to the consideration of ‘unknown unknowns’, but firms must be able to plan and mitigate against any possible environmental disruption through risk management, risk assessments and contingency planning. 69% of all survey respondents have a contingency plan for mitigating against environmental disruptions. Although these firms have their own plans in place, it is important to also have visibility of their supply chain’s plans to cope with any disruption. Otherwise the firm’s own contingency plan could be a wasted effort that does not do the job of enabling the supply chain to recover quickly



69%

of all surveyed firms have a contingency plan for environmental events.

“Concerned about rising fuel prices (as our business burns so much fuel)...”

Distributor

8%

of firms claimed to be truly agile and are able to recover from events within 24 hours.

“Snow disruption earlier in the year (sic. 2018) cost us several £million over the 2-3 days in terms of sales across the whole of our business (affected several depots)...”

Distributor

Key insights - technology

The Institute of Grocery Distribution states that enhancing a supply chain's resilience and ability to respond to disruptions, can in turn become a competitive advantage (IGD, 2017b). Technological innovation in a firm's supply chain can certainly improve their offerings over competitors – particularly if it enables firms to respond quickly to a disruption whilst competitors struggle. However, unproven tech and high capital investment costs have deterred some firms from investing, particularly as some clients are not willing to pay towards innovation in their fees.

Technology has advanced exponentially in recent years. Communication and trade are now instantaneous and global, thanks to the revolutions of the mobile phone, email, e-commerce and globalisation.

We are now entering a new technological revolution, with tracking sensors, drones, sophisticated robots, artificial intelligence and machine learning, electric and autonomous vehicles and hyperloop among the innovations being proposed.

Firms within the grocery supply chain will need to consider and implement technological disruption and innovation to gain a competitive advantage to their business and ensure that their business and supply chain is resilient against their competitors. 51% of all firms surveyed do not assess their firm's competitiveness on technology and research and development. If the benefits and barriers to investment continue to cancel each other out, it may get to the stage where regulation needs to intervene to encourage or even force private sector investment in new technology for the collective benefit of businesses, clients, society and the environment. An example is Uber's recent surcharge on fares to help and

subsidise drivers to switch to low emission vehicles in London (Financial Times, 2018h), in order to meet the proposed strict new ultra-low emission zone requirements. Other cities and countries may follow suit. It is likely that retailers, logistics firms and distributors will need to evolve soon to mitigate against technological disruption. Otherwise they will face a dual threat of clients, customers and governments forcing technological innovation or failing to change and paying the price against their competitors.

30% of firms anticipate that drones will create a new mode of transport. 46% disagree and 24% are undecided. This is most likely due to the fact that current drone technology cannot carry much larger loads, concern around the cannibalisation of their existing services (75% of logistics firms disagreed that drones would create a new mode of transport) and strict regulatory issues which need to be overcome.

56% agree that the use of electric vehicles aids firm's supply chains, logistics and transportation, but logistics firms are slightly less likely to agree (50%). The lack of electric vehicle infrastructure, regulatory standards and high capital expenditure costs may be some

51%

of firms do not assess their firm's competitiveness based on technology and R&D innovation.

30%

of firms anticipate that drones will improve operation.

56%

agree that the use of electric vehicles aids their supply chain.

of the reasons deterring organisations from considering the move to electric vehicles in the short-to-medium term.

When asked about autonomous vehicles, only 49% believe that they will aid supply chains, yet only 25% of logistics firms agree. However, the industry is more positive about the potential of a robotic autonomous workforce. 63% of firms believe that they will improve their resilience of their supply chains. 66% of producers and 78% of retailers agree. All firms surveyed agree that technology will help reduce risks to their supply chains in some form.



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49%

agree that autonomous vehicles will improve supply chains.

63%

believe that an autonomous robotic workforce will improve the resilience of supply chains.

100%

agree that technological innovations will help to reduce risks in supply chains.

“Too many barriers for drone deliveries to be feasible in the foreseeable future. Impact of a no-deal Brexit will be utterly catastrophic for the food retail industry. Contingency planning within supply chain for environmental impacts should be a key component of due diligence (and this also comprises that of the entire supply base)...”

Retailer

“It is important to follow trends such as autonomous vehicles; but such trends will require plenty of CAPEX investment, which clients and customers are unlikely to pay for...”

Distributor

Survey - infrastructure resilience

Identifying key priorities

WHY IS INFRASTRUCTURE IMPORTANT?

Infrastructure is vital. If businesses are the life blood of our economy, infrastructure is the arteries, veins and capillaries that enable the transport of services and goods (such as food, livestock, raw materials) around the world.

Most businesses are focused on mitigating risk through the elements of the supply chain that they can control – which is typically at nodal points, such as distribution centres owned either directly or operated by a third party. Subsequently, most industry and academic research on supply chain resilience focuses primarily on continuity such as supplier base and flexibility, internal process improvements, scenario planning, and dealing with issues at logistics nodal points.

In terms of infrastructure, besides route planning and ‘internal infrastructure’ (such as IT or internal automated warehouse systems and processes), external logistics network links are rarely improved upon by businesses.

These actual links (i.e. major infrastructure) are beyond the control of firms, who are wholly dependent and reliant on the actions of infrastructure asset owners and operators.

Within this report Arup explores the intricate details of these major infrastructure links between nodal points. Arup asked businesses involved throughout the grocery supply chain their views on the infrastructure priorities that government, local authorities and transportation bodies should consider to improve supply chain resilience and ultimately UK food chain security.

DO COMPANIES PRIORITISE INFRASTRUCTURE?

Arup’s survey of firms within the grocery supply chain also consisted of three ranking exercises for participating firms to outline their thoughts on what businesses, economies, governments and transportation bodies should focus on in the future. Businesses do fundamentally recognise the value of infrastructure as vital to their ability to deliver goods, products and services from A to B. They need this process to be efficient and not to add to other general supply chain issues and concerns.

The survey questions are focused on each of the three change scenarios previously discussed (political, environmental and technological), which has allowed the formulation of an overall assessment of how the industry is prepared against these disruptions.

Key insights from the findings can be seen on the following pages, whilst a full assessment of the anonymised survey results can be seen in Appendix A.

**CASE STUDY:
CRITICAL INFRASTRUCTURE TO THE UK**



1 UK LEAVING EU:

Strait of Dover -
Potential tailbacks between Dover/Felixstowe
and Calais/Le Havre

2 LEAVING EU:

Northern Ireland and Holyhead vs. Irish
border dilemma

3 GENOA:

Morandi Bridge collapse impacts Southern
Riviera and Port of Genoa

4 LEAVING EU:

Strait of Gibraltar –
bringing in rice, rum, sugar, maize from the
Americas and refuelling of ships

5 NORWAY:

LNG/LPG Terminals
(inc. Kollsnes; Melkoya Island) to enable
heating and refrigeration

6 TURKEY:

Istanbul Connections
connecting the East and West (e.g. E80
and the rest of Europe's International E-road
network)

**7 NORTHERN EUROPEAN
PORT HUBS:**

Rotterdam port (€360m food industry cargo
(Port of Rotterdam (2018); Hamburg and
Antwerp – integral food links

8 RUSSIA:

Port of St. Petersburg and port of Primorsk
(Cargo; Oil and Gas Terminals)

9 PYRENEES:

Few road routes connecting fresh produce of
Spain with mainland Europe

10 SWITZERLAND:

Gotthard Tunnel; Gotthard Road Tunnel and
Gotthard Base Tunnel connecting Genoa and
Southern Europe with Northern Europe

11 EGYPT:

Suez Canal connecting the spices of the
Middle East and Tea of India/Africa with
European demand

12 PANAMA:

Panama Canal connecting Atlantic Ocean
and Pacific Ocean trade

13 CHINA:

The Belt and Road Initiative –
The Silk Road Economic Belt and 21st
Century Maritime Silk Road

14 QATAR:

Maritime constraints due to political blockade
by neighbouring countries (Turkey (Turkish
Straits); Egypt (Suez Canal); Saudi Arabia
and UAE

**CASE STUDY:
CRITICAL INFRASTRUCTURE**

Infrastructure is crucial for the grocery supply chain to fully function. The map above adopts a similar approach to the Chatham House Report on Chokepoints and Vulnerabilities in Global Food Trade (Bailey & Wellesley, 2017), which outlined food chokepoints to Qatar when it was politically isolated by its neighbours in 2017. Due to the maritime blockade, there has been a significant drop in imports of food that Qatar relies heavily upon. This map outlines critical infrastructure that are seen to be crucial to the grocery supply chain and food security (including that for the UK). The UK could potentially be isolated, albeit to a lesser extent than experienced by Qatar, if through the process of leaving the EU its European neighbours impose additional tariffs on goods imported into the UK across the Irish border, Irish Sea and Straits of Dover. Increased costs from potential tariffs and delays at the border due to potential increased queues from customs processing will affect businesses and the UK supply chain.

The Morandi Bridge collapse at Genoa affected the cargo trade through the Port of Genoa, which is the busiest trade port in Italy by cargo tonnage. Trade with Genoa is crucial as it links the Mediterranean with Northern Europe and, besides the road link being disrupted, the rail freight lines were also severely damaged. It took over 2 months to return two of three lines back to operating service (Port of Genoa, 2018). Equally with the CO₂ shortages during 2018, LPG and LNG supplies from Scandinavia and Russia are crucial to the heating and refrigeration of food produce whether that be through warehousing, processing and manufacturing, powering forklifts or other logistics considerations (Warehouse News, 2017). Crucial Infrastructure connecting East with West exists in the Middle East, through Egypt (Suez Canal) and Turkey (Straits of Turkey and Istanbul road connections). Recent political tensions in the area and should be observed closely by businesses whose trade travel through these areas, to mitigate any potential disruption.

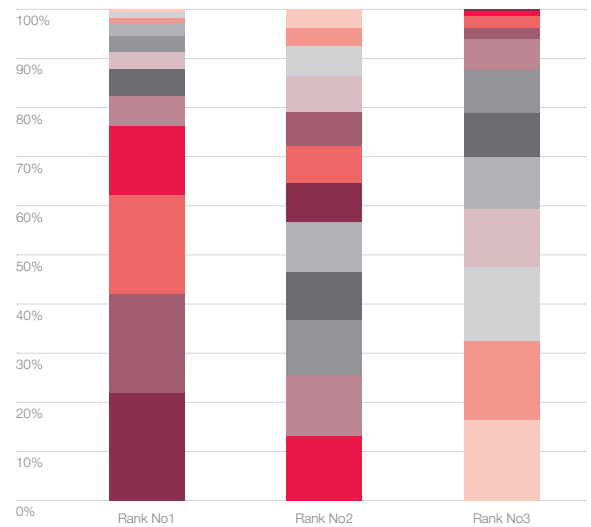


INFRASTRUCTURE RESILIENCE

Key priorities - politics

Infrastructure improvements to mitigate the risks against supply chain resilience arising from Britain leaving the EU

- Key**
- Smart cities - traffic automation
 - Road widening of M20 and other major route networks leading to ports
 - Reduction in major road network congestion through new road building schemes
 - Reduction in major road network congestion through road widening schemes
 - Minor road improvements in rural areas
 - Increase runway capacity
 - Increase port infrastructure to accommodate increased administrative processing of haulage and containers
 - Increase amount of warehousing in key strategic areas
 - Increase airport cargo terminals
 - Expansion of the rail cargo network
 - Expansion of other UK ports and sea routes
 - Expansion and improvements to HMRC physical infrastructure (Customs processing)



The largest proportion of survey respondents (22%) ranked expansion and improvements to HMRC physical infrastructure to facilitate quicker customs processing as the number one business priority. This is followed by expansion of other UK ports and sea routes (20%), increase of port infrastructure to accommodate increased administrative haulage and containers (20%), and, an increased amount of warehousing in key strategic areas (14%).

Given the time that these prioritised infrastructure improvements take to agree, design and deliver, it is unlikely that these priorities can be acted upon before the UK’s current timetabled departure from the European Union. The survey shows businesses do not feel that the measures are in place to protect grocery supply chain from the shocks, stresses and disruption expected when Britain leaves the EU.

Operation Stack (Kent Police, 2018) and its proposed successor – Operation Brock (Highways England, 2018) can only be deemed a short-term measure (as both require setting up contra-flows on the M20 to manage freight traffic to Dover and the Eurotunnel) and are likely to cause significant delays. Operation Brock – in the event of a departure from the EU without a withdrawal agreement, is not automatic and could cause at least 14 days of significant disruption as Highways England and Kent Police manage the transition (The Guardian, 2018e). Ultimately, the UK Government, intermodal terminal operators, transportation agencies, warehouse providers and port asset owners must work together to increase infrastructure now in anticipation of the future. This is particularly important given it typically takes at least 3-5 years to seek planning permission, design and construct major infrastructure projects.

22% of respondents ranked expansion and improvements to physical HMRC infrastructure as top priority.

20% would like to see increased port infrastructure to facilitate increased processing as a top priority.

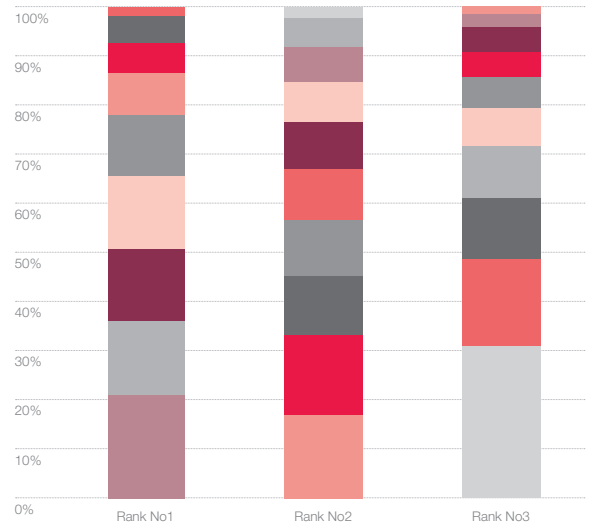
20% would like expansion of other UK ports and routes as a priority.

INFRASTRUCTURE RESILIENCE

Key priorities - environment

Infrastructure improvements to mitigate the risks against supply chain resilience arising from environmental factors

- Key**
- Seismic protection of assets in areas of earthquake prone areas of your supply chain
 - Renewable energy generation sources
 - Protection of communications network (e.g. radio, fibre optic, telephone networks)
 - New or expansion of existing water storage and supplies (e.g. reservoirs and towers) in anticipation of heatwaves and potential droughts
 - New Infrastructure to reduce reliance on key strategic routes and provide additional route options (e.g. new roads, rail, air or sea routes)
 - Flood defences (e.g. walls; managing flood defences; improving drainage networks; planting trees)
 - Floating structures (e.g. floating farms; warehouses; ports structures)
 - Additional fire protection of own assets (e.g. facilities, warehouses and buildings)
 - Alternative fuel supply sources
 - Additional water irrigation infrastructure



The largest proportion of survey respondents (21%) ranked alternative fuel supply sources as the number one priority to mitigate the risks to grocery supply chains caused by environmental factors. This is followed by new infrastructure/route options to reduce reliance on key strategic routes (new road; rail; air; sea routes) (15%), renewable energy generation sources and alternative water irrigation infrastructure (15%).

Fuel supply is a major concern, as higher oil prices (Oct. 2018) and reliance on overseas oil imports threatens the delivery of food imports and internal logistics deliveries. The UK Government, businesses and the economy have previously seen the impact of strike action on fuel depots – most recently in 2000, where oil refineries and petrol forecourts were blockaded by protestors (BBC News, 2000). This led to food and fuel rationing and significant short-term price increases during

the industrial action. If countries around the world are not able to secure their supply of fuel and energy generation for decades to come, particularly during the political turbulence and environmental crises of late, fuel as a commodity is in danger of causing economies to grind to a halt immediately.

New infrastructure provides additional route options and resilience for numerous logistics firms should routes be impacted by environmental disruptions (such as flooding).

Climate change has led to sea level rises of 3 inches (77 millimetres) in 2017 from 1993 (Climate.Gov, 2018). Governments, designers and businesses must take action to ensure that flooding does not disrupt their operations and firms must future-proof against such risks. Energy generation can also be impacted, as can be seen by the Fukushima Daiichi nuclear disaster in 2011, caused primarily by tsunami flooding following an earthquake.

21%
ranked alternative fuel supply sources infrastructure is a priority.

15%
would like new infrastructure to reduce reliance on key strategic routes, providing route options.

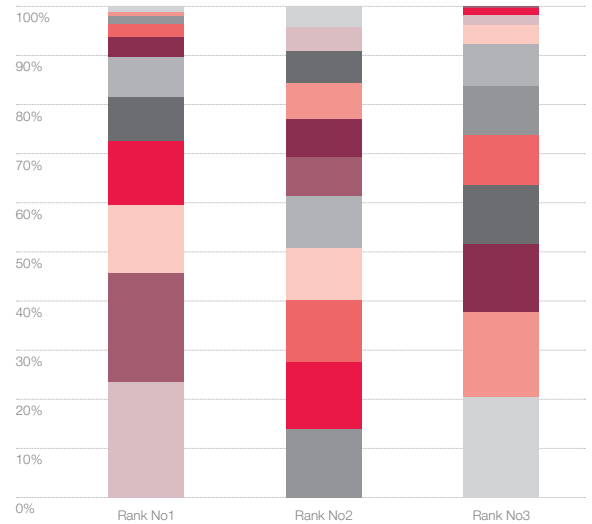
15%
would like to see more renewable energy generation sources.

INFRASTRUCTURE RESILIENCE

Key priorities - technology

Infrastructure improvements to mitigate the risks against supply chain resilience arising from technological change

- Key**
- Vertical farms in urban areas
 - Robotic workforce
 - Advanced automation in manufacturing
 - Big data and advanced analytics
 - Driverless and autonomous vehicles
 - Drone deliveries
 - Drone irrigation
 - Hybrid or electric vehicles and infrastructure
 - Hydrogen power vehicles
 - Remote manufacturing
 - 3D printing



The largest proportion of survey respondents (27%) ranked big data analytics as a priority to improve the resilience of grocery supply chains against shocks and stresses. This is followed by advanced automation in manufacturing (22%); hybrid or electric vehicle infrastructure (HEV) (14%) and driverless and autonomous vehicles (13%).

Big data analytics provides firms the ability to fine-tune their supply chain efficiencies or even help locate a new warehouse. It is a low-cost method, yet provides conclusive insights that help businesses drive important decision-making based on quantitative data. Advanced automation in manufacturing provides benefits but requires large capital expenditure. As we have seen with Moore’s Law for computer processors, the cost of future technology will ultimately go down with improved cost-manufacturing and automation as economies of scale are eventually achieved.

It is fundamental for electric vehicle infrastructure to be in place throughout the UK and beyond, before welcoming the era of autonomous vehicles. Asset owners, vehicle manufacturers, governments need to co-operate and outline global regulatory standards.

Although the UK Government has introduced the Automated and Electric Vehicles Act 2018, it is crucial for not only the UK but for countries around the world to develop a global regulatory standard for electric vehicle infrastructure and autonomous vehicles. During the Industrial Revolution of the 1800s, numerous individual rail companies operated different fleets and different rail line specifications that hindered initial progress and cost £millions in duplicated efforts.

24%

believed development of increased capabilities in big data analysing as a priority.

22%

believed that developing more advanced automation in manufacturing is a priority.

14%

would like to see more development in hybrid or electric vehicles and associated infrastructure.

Mapping global supply chains

This report also explores some of the tools that are currently used to help firms map out their global supply chains.

WHY MAP SUPPLY CHAINS?

It is important for firms to map their supply chains, particularly as they have become more complex, intertwined and global.

As previously identified, ‘visibility’ is an important factor in measuring supply chain performance that helps firms to trace their grocery supply chain throughout the supply chain tiers.

Hence the need to map global supply chains, particularly as firms become more reliant on others’ services within the UK and abroad. Mapping can be facilitated by technological advances in computing to track information in real-time across the entire supply chain.

Arup maps supply chains, logistics routes and potential improvements for an array of clients and firms within the grocery supply chain (ranging from logistics firms, retailers, producers and asset owners who oversee major infrastructure).

TOOLS USED TO MAP SUPPLY CHAINS

The following tools are a selection of off-the-shelf solutions that firms can use to assist in mapping their global supply chains.

Sourcemap

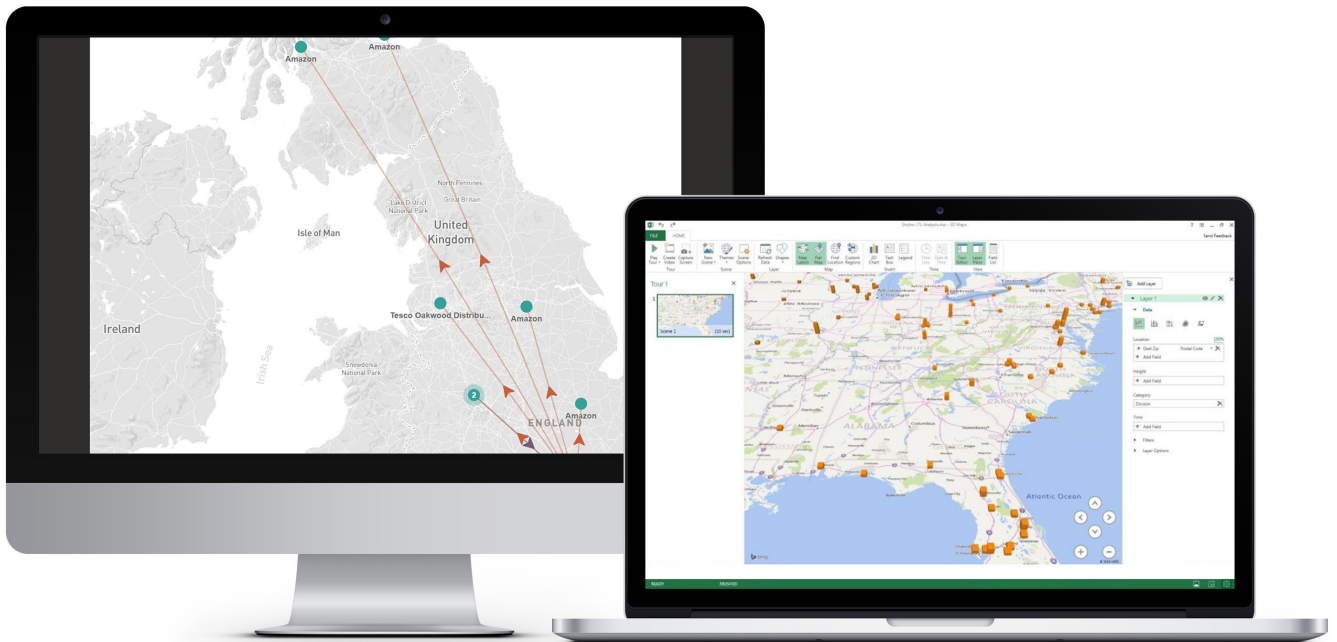
Sourcemap is an open source supply chain mapping HTML5 web platform, which originated from MIT in 2008 (Sourcemap, 2018). Users can opt for secure (private) or open source options to assist in mapping their supply chain activities.

Tableau

Tableau is an online web platform that allows data to be visually interpreted and for that data to be understood. There is a free version of Tableau for experimentation, in addition to a commercial version (Tableau, 2018).

Excel 3D Maps and Power BI

Excel 3D Maps is part of Microsoft Office 2016’s package and is a 3D data visualisation tool that enables users with any co-ordinate points to be plotted on a map within Excel (Microsoft, 2018). It enables new insights to be gathered by viewing data in geographic space, with the option of viewing the data to be changed over a period of time.



Mapping the UK grocery sector

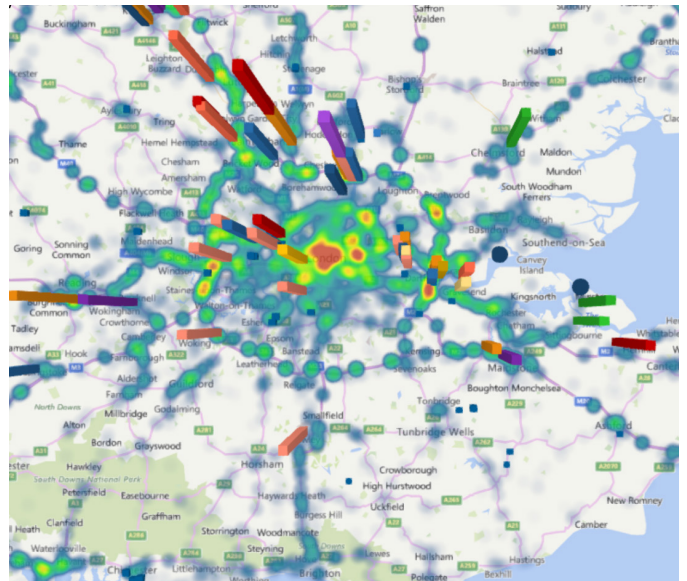
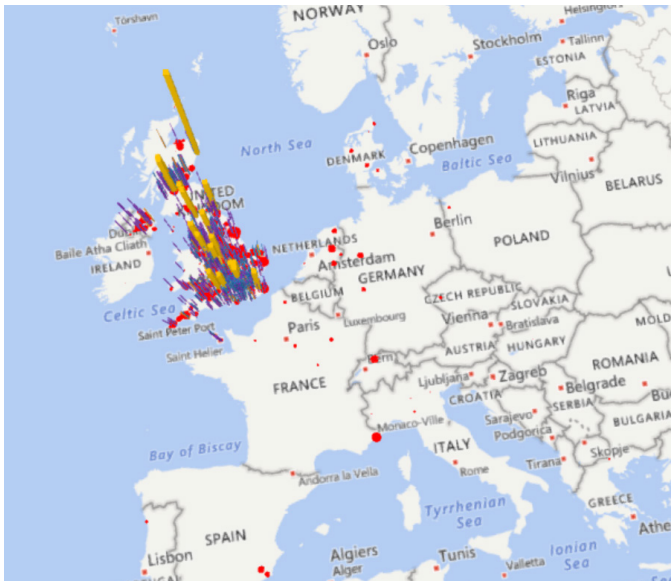
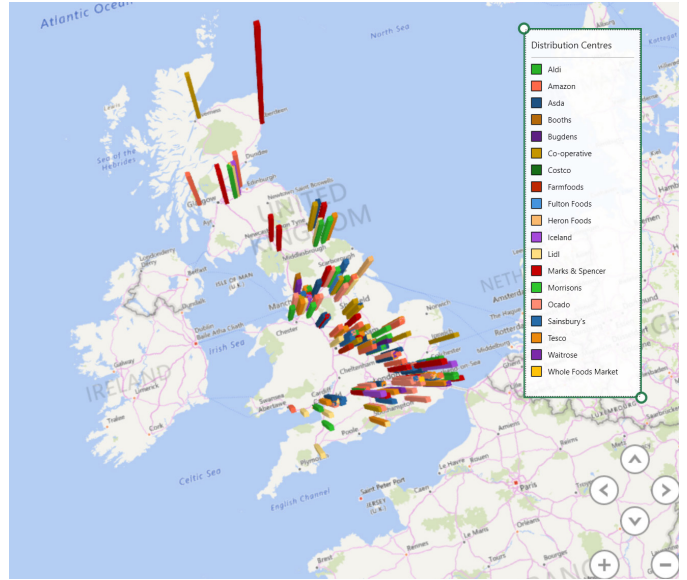
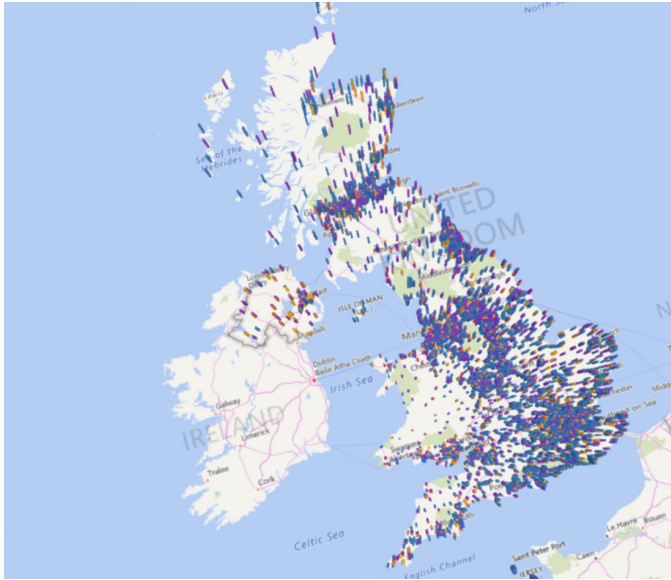
For this report, the grocery supply chain of one UK retailer, has been mapped at a high level using one of the tools mentioned above – Excel 3D Maps with PowerPivot.

By obtaining or creating datasets of individual units of major supermarkets across the UK, retailers' distribution centres and one of the retailer's suppliers, the UK grocery supply chain can be illustrated and additional insights drawn.

From overlapping the datasets, it can be identified from viewing both the distribution centre and retail unit maps that there is a heavy correlation of units towards large, dense population areas – i.e. major cities. Further data manipulation can be used to assess how other competing retailers' supply chains function, in addition to conducting general competitive analysis.

From quickly viewing the above correlation, it can be concluded that although a majority of the suppliers of one retailer are UK based, there remain a number of operations outside the UK within the European Union. Food and drinks from these EU suppliers are potentially subject to increased tariffs upon entering the UK at the border after the UK leaves the EU. We can use this to measure the potential impact to the retailers in terms of cost increases and delays.

Additionally, other datasets can be superimposed into the grocery supply chains dataset to gather further insights to drive business decisions for their clients. The subsequent heatmaps showcase superimposed datasets containing port locations, intermodal terminals and major UK grocery retailers mapped over traffic-count data over a period of time. Using the approach of analysing combined data, Arup can assist clients to locate a new warehouse or distribution centre in a more visual and spatial manner in conjunction with other parameters and datasets (such as population sizes, flooding etc).



IMAGES LEFT TO RIGHT, TOP TO BOTTOM:

- Mapping Retailer Shop Units across the UK
- Mapping UK Distribution Centres
- Mapping a retailer's UK and international suppliers
- Mapping a retailer's UK and international suppliers

Conclusion

It is more essential than ever for all parties involved in the grocery supply chain to be more adaptable in order to be resilient, so that they can react and recover quickly in response to unexpected events.

The incoming headwinds of Britain leaving the EU, environmental disruption and the exponential increase in the pace of technological change mean that producers, logistics firms, distributors, retailers and asset owners in the supply chain must take action to be as resilient as possible.

Firms must brace themselves for the potential eventualities and various internal and external scenarios of Britain leaving the EU. More firms must communicate and begin dialogue with their supply chains to mitigate the potential disruptions and utilise risk management tools such as contingency planning.

As the climate across the world is changing rapidly, firms must assess and mitigate the risks to their business in the face of various environmental disruptions, whether that is adverse weather, major environmental events or a potential fuel crisis. This should include a review of their reliance on certain infrastructure and putting mitigation plans in place.

Finally, firms must ensure that they remain ahead of the competition. A technologically advanced grocery supply chain will ensure that a firm and its supply chain are prepared and agile to bounce back from any disruptions.

The grocery supply chain needs to identify and manage risk through technological advancements to ensure that consumers have the food they need to survive and thrive.



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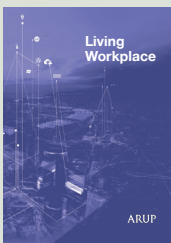
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Publications



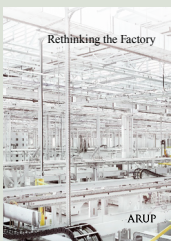
Living workplace considers a broad spectrum of research and trends relevant to this transforming typology, including digital services, emerging business models and workforce wellbeing. By analysing what aspects need immediate attention and action, the report aims to help developers, tenants and designers better understand the forces shaping the workplace of the future



Reimagining property in a digital world highlights that the property sector has not yet fully committed to operating digital property portfolios. Individual initiatives are often isolated, and as a result the full benefits are not realised. The message for developers and corporate real estate executives is that every business will need its own digital strategy if it wants to achieve improved operational performance, a better end user experience and consequently higher long-term valuations.



The circular economy in the built environment identifies how the circular economy can benefit Arup, our clients, and the built environment sector. We reflect on the economic, social and environmental advantages of employing circular principles. We propose strategies to progress our offering, deliver new services, engage a wider network of stakeholders and unlock opportunities for all parties in the value chain.



Rethinking the factory describes the emerging trends, processes and technologies that will transform the manufacturing landscape. The inevitable shift to leaner, smarter and more flexible forms of production will have a range of impacts on how the factory is designed, how supply chains operate, how people experience changing operational environments and how the future spaces of production will be organised.

Appendix A

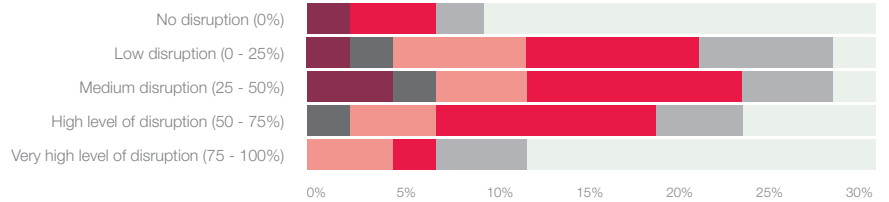
Ranking exercise lists

Key

■ Retailer ■ Producer ■ Logistics ■ Distributor ■ Asset Owner

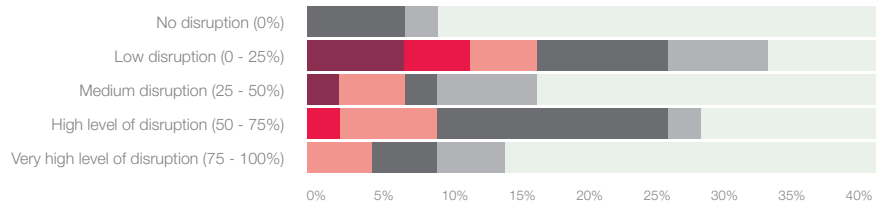
Q1. POLITICS

In the event of a no-deal scenario or lack of a freedom of goods scenario (i.e. Customs Union), will your suppliers be disrupted?



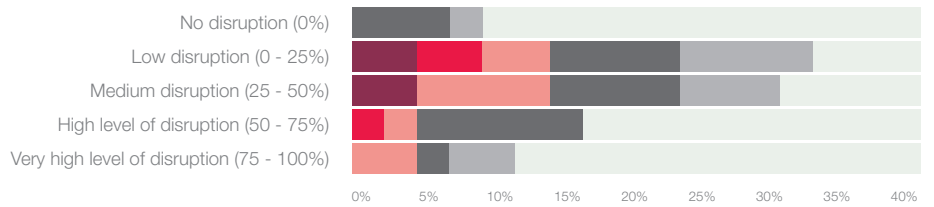
Q2. POLITICS

Do you anticipate disruption at the Border arising from Brexit within your supply chain (e.g. Port; Rail; Road; Air)



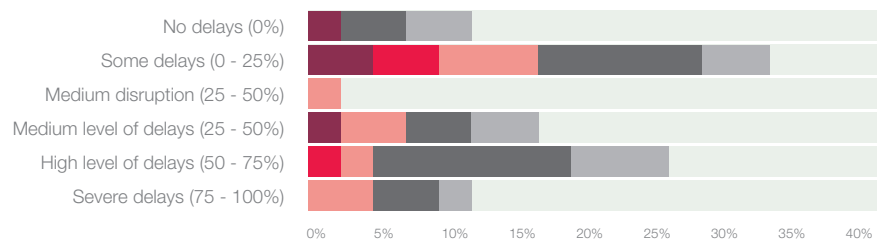
Q3. POLITICS

Do you anticipate disruption to the logistics and transportation of supplies to your firm?



Q4. POLITICS

Do you anticipate delays to the supply of goods to your firm arising on the road, rail, sea and air due to Brexit?

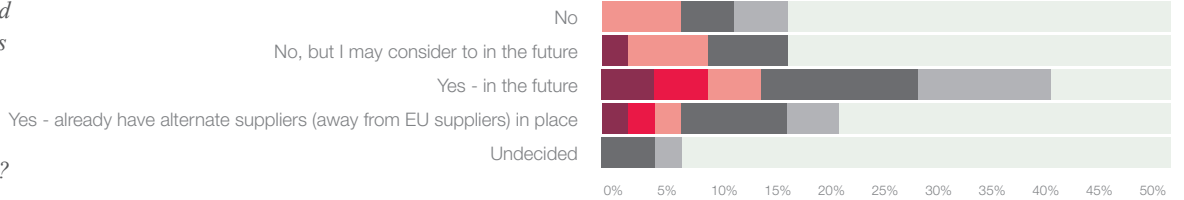


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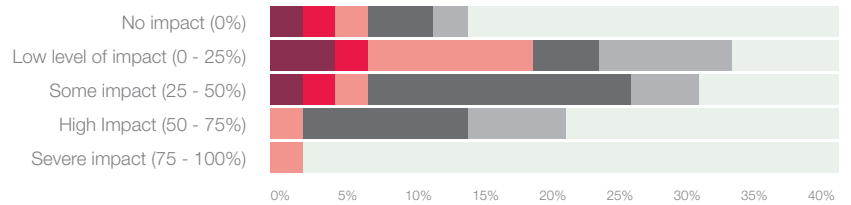
Q5. POLITICS

Have you considered alternative suppliers (away from EU suppliers) to mitigate against the impact of Brexit?



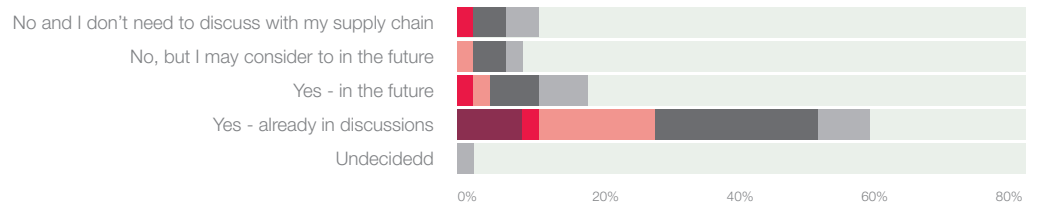
Q6. POLITICS

In the event of a no-deal scenario or lack of a freedom of goods scenario (Customs Union), will there be an impact to your internal processes?



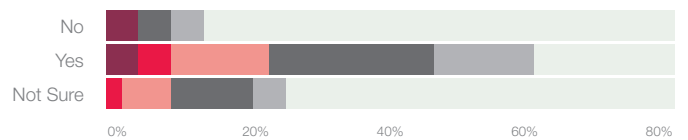
Q7. POLITICS

Will you be communicating with your supply chain to mitigate the potential impacts of Brexit?



Q8. POLITICS

Do you anticipate processes in your supply chain to be more complicated following Brexit?



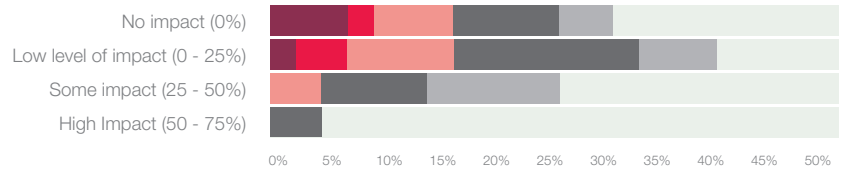
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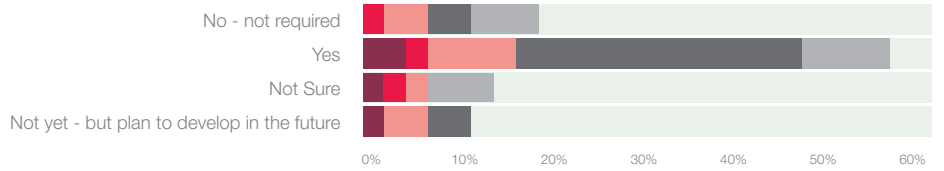
Q9. POLITICS

In the event of a no-deal scenario or lack of a freedom of goods scenario (Customs Union), do you anticipate a reduction in demand of your firm's goods?



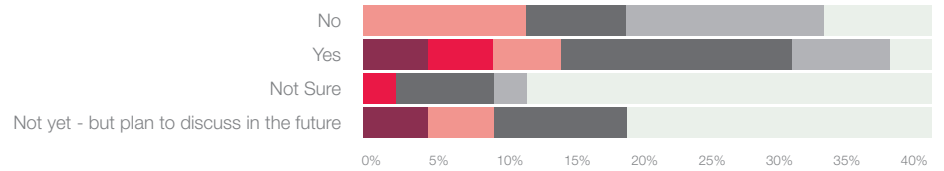
Q10. POLITICS

Have you developed a business continuity plan to ensure your supply chain is resilient against any potential impacts and disruption of Brexit?



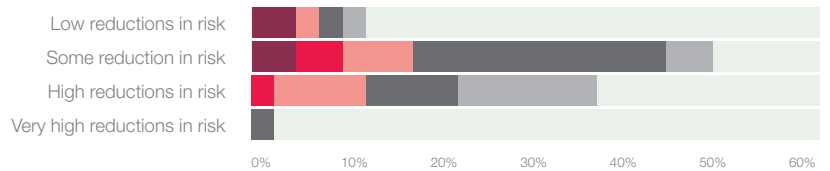
Q11. POLITICS

Do you have sight of your suppliers' proposed mitigations and plans against any potential supply chain disruptions arising from Brexit?



Q12. TECHNOLOGY

Do you think technology would reduce supply risks in the future?

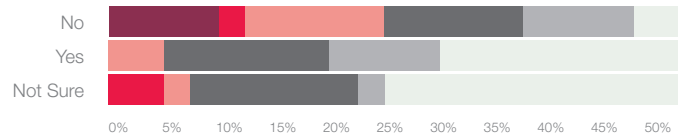


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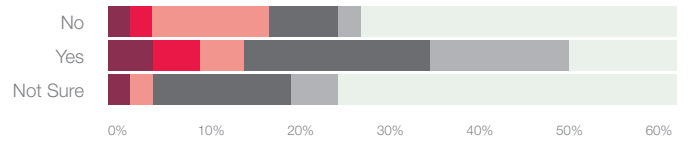
Q13. TECHNOLOGY

Do you anticipate the use of aerial drones would create a new mode of transportation of goods?



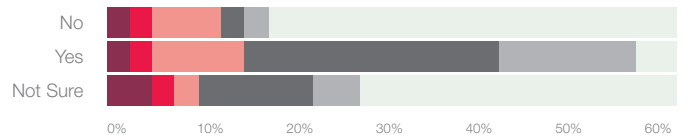
Q14. TECHNOLOGY

Will the use of autonomous vehicles aid your supply chains' logistics and transportation?



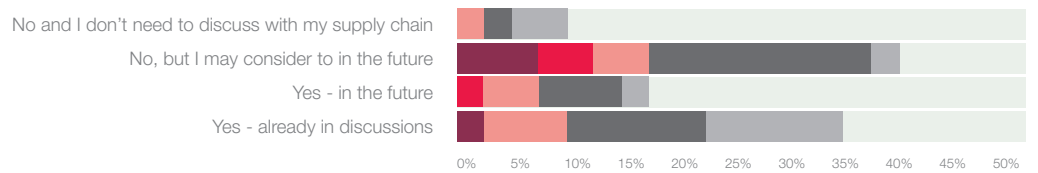
Q15. TECHNOLOGY

Will the use of electric vehicles aid your supply chains' logistics and transportation?



Q18. TECHNOLOGY

How often do you communicate with your supply chain to improve technology advancements through collaborative R&D?



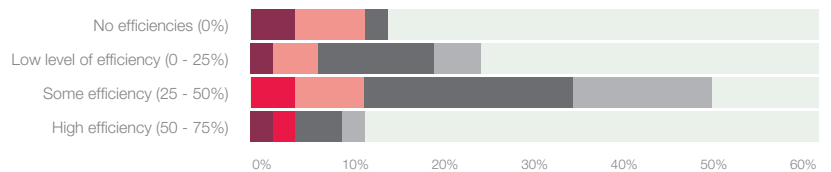
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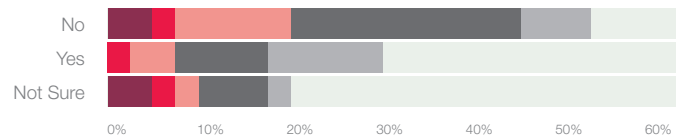
Q19. TECHNOLOGY

Has your firm recently implemented any new technology improvements to manage/ reduce complex supply chains and processes within the past 12 months and if so, what level of efficiencies have they achieved?



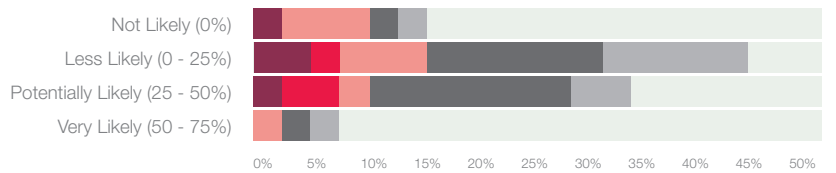
Q20. TECHNOLOGY

Do you assess your firm's competitiveness with others based on technology and R&D innovation?



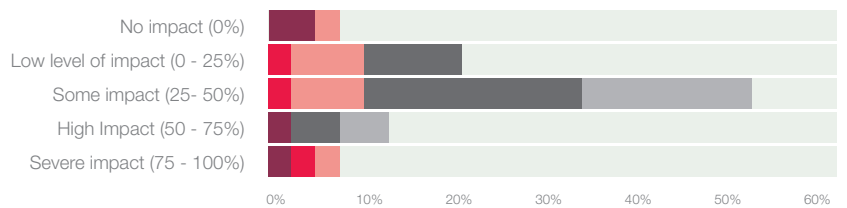
Q21A. ENVIRONMENTAL

What is the likelihood of your business being affected by a major flooding event on a key supplier (whether in the UK or abroad)?



Q21B. ENVIRONMENTAL

What is the severity of the impact to your business if a major flooding event affected a key supplier (whether in the UK or abroad)?

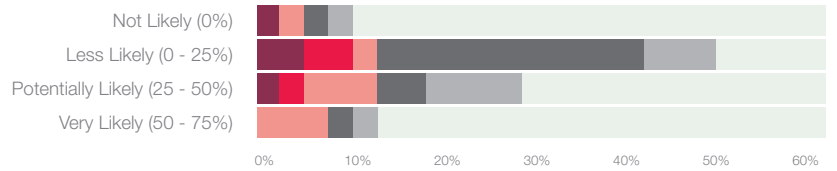


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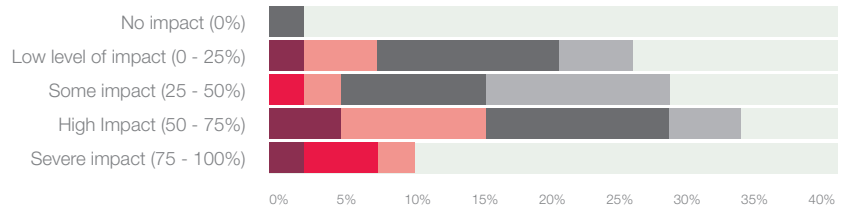
Q22A. ENVIRONMENTAL

What is the likelihood of your business being affected by a major energy disruption event (i.e. fuel; electricity) on a key supplier (whether in the UK or abroad)?



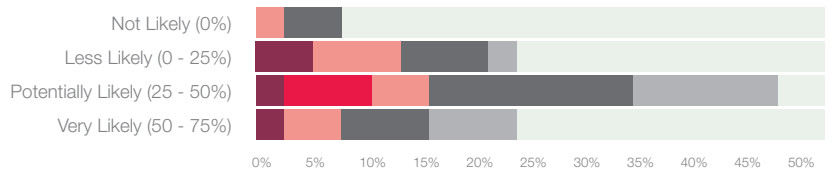
Q22B. ENVIRONMENTAL

What is the severity of the impact to your business if a major energy disruption event (i.e. fuel; electricity) affected a key supplier (whether in the UK or abroad)?



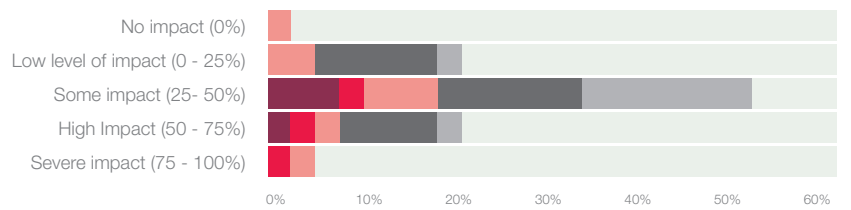
Q23A. ENVIRONMENTAL

What is the likelihood of your business being affected by a major adverse weather event (i.e. heatwave or cold spell) on a key supplier (whether in the UK or abroad)?



Q23B. ENVIRONMENTAL

What is the severity of the impact to your business if a major adverse weather event (i.e. heatwave or cold spell) affected a key supplier (whether in the UK or abroad)?



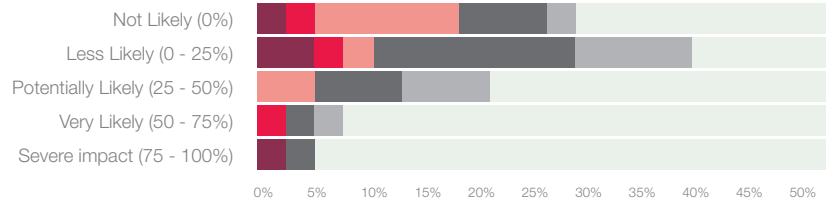
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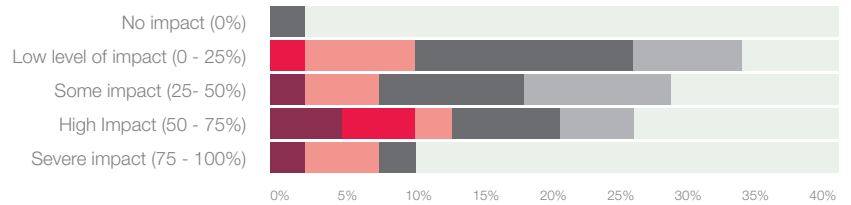
Q24A. ENVIRONMENTAL

What is the likelihood of your business being affected by a major environmental event (i.e. earthquake, storm; volcanic ash; wildfire) if it damaged or disrupted a major infrastructure route (whether in the UK or abroad)?



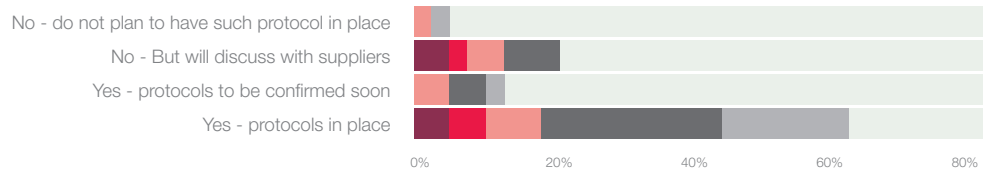
Q24B. ENVIRONMENTAL

What is the severity of the impact to your business if a major environmental event (i.e. earthquake, storm; volcanic ash; wildfire) damaged or disrupted a major infrastructure route (whether in the UK or abroad)?



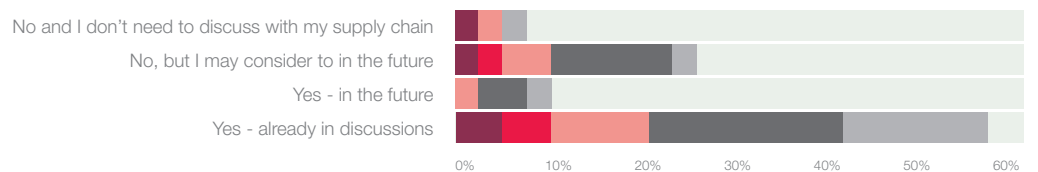
Q25. ENVIRONMENTAL

Will a supplier notify you if they had a disruption arising from an environmental event?



Q26. ENVIRONMENTAL

How often do you communicate with your supply chain to gather updates on issues or disruptions?

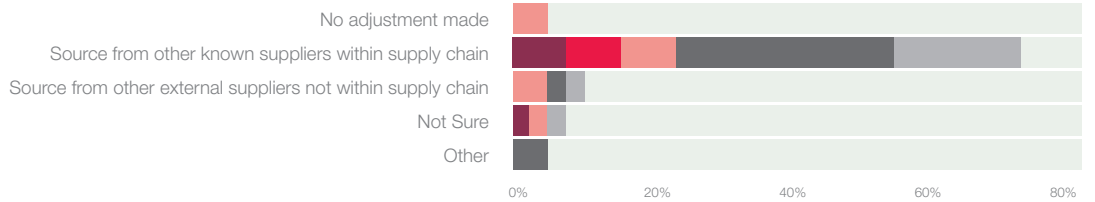


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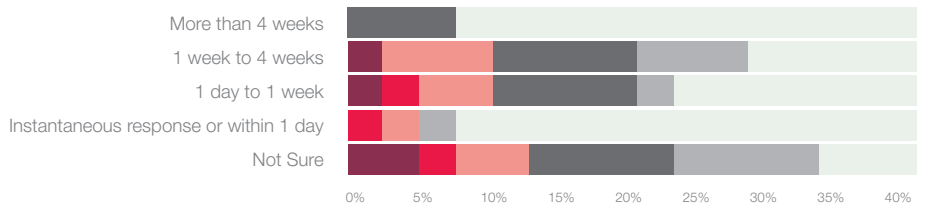
Q27. ENVIRONMENTAL

How do you adjust the availability of your products accordingly to reflect any issues or disruption arising in your supply chain from environmental events?



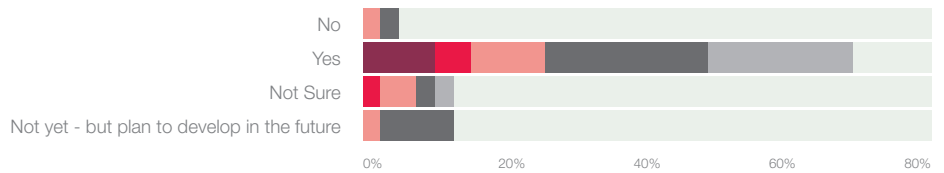
Q28. ENVIRONMENTAL

If a supplier in your supply chain was disrupted following an environmental event, how long will it approximately take for your firm to return your supply back to normal?



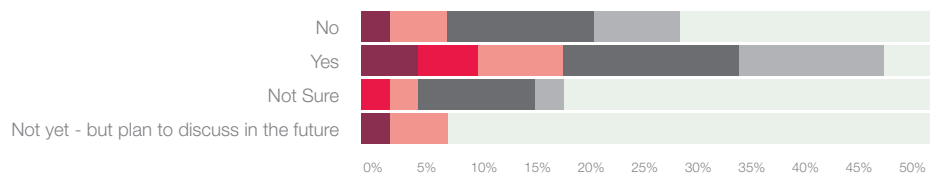
Q29. ENVIRONMENTAL

Have you developed a business continuity plan to ensure your supply chain is resilient against the potential impacts and disruption of environmental events?



Q30. ENVIRONMENTAL

Do you have sight of your suppliers' proposed mitigations and plans against supply chain disruptions arising from such environmental events?



About Arup

Arup is the creative force at the heart of many of the world's most prominent projects in the built environment and across industry.

We offer a broad range of professional services that combine to make a real difference to our clients and the communities in which we work.

We are truly global. From 100 offices in 38 countries our 11,000 planners, designers, engineers and consultants deliver innovative projects across the world with creativity and passion. Founded in 1946 with an enduring set of values, our unique trust ownership fosters a distinctive culture and an intellectual independence that encourages collaborative working. This is reflected in everything we do, allowing us to develop meaningful ideas, help shape agendas and deliver results that frequently surpass the expectations of our clients.

The people at Arup are driven to find a better way and to deliver better solutions for our clients.

We shape a better world.

We shape a better world