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Supply chain resilience in UK seafood processing: lessons from COVID-19

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ABSTRACT

The UK seafood supply chain's heavy reliance on international trade, with 81% of consumption imported and 70% of production exported, creates vulnerability to global disruptions. While COVID-19 impacts on seafood production are well-documented, the processing sector remains under-researched despite its vital role connecting producers to consumers. This paper examines how UK seafood processing businesses responded to COVID-19 and Brexit disruptions, focusing on flexibility, diversity, and connectivity as key characteristics of resilience. We conduct semi-structured interviews with shellfish companies, fish processors, mixed seafood processors, and industry experts across the UK. We find that during the crisis, UK processors demonstrated flexibility through proactive management, financial stability, and rapid business model pivoting. Businesses with diversified products, customers, labour force, and suppliers showed greater resilience. Local social capital and digital connectivity also strengthened responses, whilst severed international connections particularly challenged export-dependent shellfish processors. To build adaptive capacity, we recommend strengthening industry forums to support geographically isolated processors, developing UK processing capacity to reduce dependence on overseas supply chains, and expanding digital infrastructure for direct-to-consumer sales to counteract future disruptions from labour shortages, consolidation in aquaculture, and volatile export markets. This paper makes a theoretical contribution by further refining conceptualisations of resilience in the context of seafood systems and by characterising three firm-level antecedents for adaptations. It also highlights the relational nature of resilience noting that resilience for one business may not increase the resilience of the system as a whole.

1. Introduction

Seafood products are traded internationally through supply chains linking global markets via networks of producers, processors, intermediaries, distributors, and retailers (Graziano et al., 2018; Jennings et al., 2016; Love et al., 2021). Global seafood supply chains create employment and contribute to food security, however their interconnected and complex nature makes them vulnerable to disruptions of varying intensities and geographical scales (Jennings et al., 2016; Stoll et al., 2021; Subramaniam et al., 2023). As the frequency of shocks increases (Cottrell et al., 2019), it becomes more important to understand the adaptive responses of businesses within the seafood sector in order to build future supply chain resilience and to mitigate impacts on marine sustainability (Cordova et al., 2025).

The UK seafood system mirrors global patterns of internationalisation, experiencing a particularly rapid period of global expansion during the second half of the twentieth century (Campling and Havice, 2018). The shift towards an internationalised seafood supply has altered the distribution and activities of seafood businesses over time. Over a few decades, the UK has transformed from nearly meeting its own domestic demand to being heavily dependent on imports (Harrison et al., 2023; Jennings et al., 2016; Symes and Phillipson, 2019). Approximately 81% of seafood consumed in the UK is imported and 70% of UK-produced seafood is exported (WWF, 2022). The majority of UK seafood consumption is limited to five species: cod, salmon, tuna, haddock, and prawns, in order of highest to lowest volume. While most of the salmon consumed in the UK is produced domestically (with the proportion rising due to the growth and consolidation of salmon aquaculture, particularly in Scotland) (Graziano et al., 2018; Jennings et al., 2016), the majority of cod, tuna, haddock and prawns consumed in the UK is imported (MMO, 2023).

The UK's reliance on imported seafood has allowed flexibility in its ability to respond to a variety of challenges and changes in consumption patterns (Symes and Phillipson, 2019). For example, imports have buffered shocks that resulted from decreased landings by UK vessels during the latter half of the twentieth century (Jennings et al., 2016).

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However, the limited diversity of seafood consumed in the UK, and the UK's dependence on internationally traded products has prompted suggestions that the UK should increase consumption (proportion and diversity) of domestically produced seafood to support food security, economic and environmental sustainability, and resilience (Harrison et al., 2023; Willer and Aldridge, 2023).

The COVID-19 pandemic provides a particularly instructive example of a global event that was disruptive to international supply chains (Love et al., 2021; Stoll et al., 2021). The impacts of COVID-19 on the seafood system resulted in a growing body of literature, upon which this paper seeks to build. While much of the literature focuses on fish production (wild caught or aquaculture), there is very little focus on the 'hidden middle' of the supply chain: seafood processors, which play a vital role in seafood systems, but have been historically underrepresented in academic literature (Cramer et al., 2023). This study focuses on the UK seafood processing sector, which provides a vital link, connecting producers to retailers and consumers. This paper also responds to the ongoing need to share experiences and adaptations of supply chain actors (Love et al., 2021). We contribute further by exploring ongoing and anticipated threats to the UK seafood system to understand how UK seafood businesses can build adaptive capacity for the future. The theoretical contribution of the paper is to refine conceptualisations of resilience in the context of seafood systems, by exploring the role of diversity, flexibility, and connectivity of seafood businesses in responding and adapting in the face of disruptions.

We address the following research questions through our narrative review and interviews:

1. What were the early impacts of the COVID-19 pandemic on the global seafood industry?
2. How were UK seafood processing businesses impacted by the COVID-19 pandemic and how did they adapt to manage these impacts?
3. How do seafood processors view some of the ongoing and future threats to the UK seafood industry?
4. Which key characteristics of resilience (diversity, connectivity, flexibility) are involved in responses to disruption and how can seafood businesses build adaptive capacity?

The remainder of the paper is structured as follows: The literature review provides an overview of the concept of resilience and explains key resilience mechanisms drawn upon in this research. A narrative review then begins to address RQ1 and RQ4 by presenting an analysis of early impacts of the pandemic on the global seafood industry and assessing which key resilience mechanisms were most relevant. Our methodological approach is summarised in the next section, followed by the presentation of results, which explore the early impacts of the pandemic on the UK seafood industry and associated adaptations (RQ2) followed by a section on future threats to the sector (RQ3). The discussion is presented according to key characteristics of resilience and provides recommendations for building adaptive capacity in the seafood industry (RQ4). The article finishes with a conclusion, including theoretical and managerial implications.

2. Literature review

2.1. Resilient supply chains and seafood systems

Resilience is defined in various ways across disciplines and traditions, from engineering to ecology, and is broadly conceptualised as the ability of a system to absorb disruptions and to adapt, reorganise, recover and continue to function (Walker et al., 2004). Supply chain resilience can be viewed in terms of the different phases of resilience (pre-, during-, and post-disruption); strategies to facilitate resilience (proactive, concurrent or reactive); and capabilities necessary to achieve resilience (e.g. anticipation, monitoring, learning), which should be considered in the context of firm-level vulnerabilities (Ali et al., 2017; Pettit et al., 2019). Elements within supply chains that enable resilience include agility, robustness, flexibility, redundancy, connectivity, visibility, circularity, investment and collaboration (Ali et al., 2017; Altuntas Vural et al., 2025; Pettit et al., 2019; Sutar et al., 2026).

In food systems research more specifically, resilience is conceptualised as a feature of a system that allows it to continue to feed populations in the face of specific identified shocks and unexpected disruptions (Stoll et al., 2021; Subramaniam et al., 2023; Tendall et al., 2015). In order to retain their primary function, organisations and sectors at multiple scales within food systems must perpetually navigate complexities, and continuously adapt and transform (Graziano et al., 2018; Prosperi et al., 2019; Smith et al., 2020; Stoll et al., 2021). In this sense, food systems resilience is a dynamic process, rather than an unchanging state.

Building on characterisations from existing literature on seafood systems (Fletcher et al., 2021; Love et al., 2021; St. Clair et al., 2023; Stoll et al., 2021; Subramaniam et al., 2023), we have distilled three characteristics that we consider to be necessary for seafood businesses' resilience along with one foundational process. The three characteristics are *diversity, connectivity* and *flexibility*, which enable businesses to cope with and recover from shocks and stresses. *Diversity* can be represented by a diverse range of products, consumers, or supply chains. *Flexibility* can be seen as the ability and willingness to adjust behaviour in the face of challenges, which can include the motivations and determination of individuals (psychosocial factors (Béné, 2020)), economic stability that provides a financial buffer in times of stress, and the flexibility to substitute products during lack of availability or demand. Examples of *connectivity* can include strong networks between businesses, knowledge exchange opportunities (for example between policymakers and businesses), or strong links with the surrounding community.

We have identified *building adaptive capacity* as a foundational process, which takes place before, during, and after a crisis. Building adaptive capacity means proactively engaging in forward looking activities that will create space and provide a buffer in times of stress. As we have argued elsewhere (St. Clair et al., 2023), seafood businesses are more resilient when they have the capacity and foresight to focus on future planning such as limiting resource use, supporting ecosystems and avoiding wasteful practices. Building adaptive capacity is necessary for general resilience (the ability to respond to unforeseen shocks), but also for specified resilience as it entails a consideration of wider threats and disruptive events. Diversity, connectivity and flexibility are the visible characteristics – or phenotypes - of resilient organisations or systems, whereas building adaptive capacity is the foundational process that supports their emergence and development over time.

2.2. COVID-19 and seafood systems

This review begins by addressing RQ1 (What were the early impacts of the COVID-19 pandemic on the global seafood industry?), by exploring the ways in which seafood businesses were affected by the early stages of the pandemic-related disruptions. It then presents a range of adaptation measures adopted by businesses and concludes by categorising business responses by resilience mechanism (RQ4).

2.3. Impacts

The COVID-19 pandemic impacted seafood supply chains globally, affecting production, trade, and consumption. Initial impacts were experienced in China, the largest global importer of seafood (Love et al., 2021), but disruptions quickly spread, affecting many of the 260 million people whose livelihoods rely on seafood production globally (Smith et al., 2020; Stoll et al., 2021). Pandemic-related restrictions in 2020 led to a fall in demand for certain seafood products, a decline in global seafood trade, associated collapses in commodity prices (Amos et al., 2022), and a reduction in the size of the available workforce (Ruiz-Salmón et al., 2021; Straume et al., 2022). Government-mandated

health and safety measures were implemented in many businesses, limiting contact between employees, and restricting working hours and productivity (Stoll et al., 2021).

Research has documented various disruptions to seafood production during the early stages of the pandemic. Fish farmers were subject to higher production costs and decreased access to essential inputs such as fish seed or feed due to disruption to international fishing (Dorji et al., 2023; Khan et al., 2023). Producers also experienced lower demand, logistical issues and an inability to sell fish through international markets (Azra et al., 2021). Once international sales became possible, the cost and availability of freight was a limiting factor (Smith et al., 2020). Many local auctions closed, which, along with restrictions over movement, led to higher costs of production as fish continued to mature but could not be sold within expected timeframes (Khan et al., 2023).

Early stages of the pandemic also resulted in lower consumption of fish in many regions (Husain and Ashkanani, 2020; Mignogna et al., 2022; Skotnicka et al., 2021). Lower consumer demand depressed prices, lowering profits, income and employment levels (Rahman et al., 2021). Reduced seafood consumption was attributed partly to the temporary closure of the hospitality industry, which was associated with an increase in retail revenue (Love et al., 2021). In certain areas, reduced demand caused by restaurant closures meant that large seafood processors had to close or reduce their processing capacity (Stoll et al., 2021).

During 2020, demand for frozen seafood and tinned seafood products increased relative to fresh seafood in some regions, due to longer shelf-life and lower cost (Smith et al., 2020). While the early stages of the lockdown period led to a general move away from the purchase of fresh seafood, restaurant closures sparked interest in cooking seafood at home for some. Local seafood producers who were able to sell directly to consumers benefited from this shift, although for many, sales volumes could not bridge the gap in income caused by the collapse of export markets (Smith et al., 2020).

2.4. Responses to COVID-19

Literature on adaptations of seafood businesses to COVID-19 demonstrates the ability of organisations to diversify their products and consumer base, to connect with local consumers through new networks, and to demonstrate flexibility in response to new circumstances. Some farmers and fishers coped by reducing sales and staff, and diversifying income sources (Khan et al., 2023). Businesses with a broad and diverse customer base, a variety of products and several different means of distribution appeared to be more resilient to disruption caused by the pandemic (Love et al., 2021; Stoll et al., 2021).

Alternative seafood markets were established in many countries during the early stages of the pandemic, adding further diversity to the system (Stoll et al., 2021), and digital tools and online platforms were also widely used to sell seafood direct to consumers (Azra et al., 2021; Costa et al., 2022). This process of building local networks was beneficial for some seafood producers, who described a renewed sense of connection to their products, environments and customers, however flexibility of businesses was sometimes constrained by regulatory restrictions around direct sales (Stoll et al., 2021).

While some fishers and small businesses struggled to find alternative ways of reaching consumers, there is evidence of a smoother transition for some larger businesses. In Norway, large fishing vessels appeared resilient in the face of challenges and were not affected by price drops during the lockdown period (Asche et al., 2022). They were able to sell their product through new supply chains and had the capacity to catch, freeze and store fish (Asche et al., 2022). Similarly, in the West Sumatra Province in Indonesia, the profit and proportion of small scale fish producers decreased while ownership of medium and large scale producers increased (Hendri and Yulinda, 2022).

This finding illustrates a tension, whereby an ongoing pattern of internationalisation and consolidation can signal both positive and negative implications for resilience. While the shift towards large export-oriented multinational companies can confer a level of resilience by allowing risks (environmental, political and economic) to be spread across several different regions (Graziano et al., 2018), it can also leave supply chains exposed to disruption when one part of the chain experiences a shock (Stoll et al., 2021). For example, globally traded products are subject to changes in national stock management programmes, geopolitical relations, sanctions, or fluctuating resource prices (Graziano et al., 2018; Symes and Phillipson, 2019).

Stoll et al. (2021) suggest that there can be an 'inverse, yet complementary relationship' between small-scale local seafood systems and global supply chains, whereby during times of stress, supply chains tend to revert to the local scale. However, a thriving network of local seafood businesses needs to exist for this relationship to maintain a synergistic balance. There is potentially a longer-term risk that the broader pattern of consolidation can displace smaller businesses who may have a closer connection to - and knowledge about - their local communities, leaving communities and businesses vulnerable when global supply chains fail (Stoll et al., 2021; Tolley et al., 2015).

In summary, our narrative review presents a selection of early impacts of the COVID-19 pandemic on the global seafood system and highlighted adaptive measures taken by businesses (outlined in Table 1). While these adaptations demonstrated diversity, connectivity and flexibility, it is notable that we found very little discussion of ongoing threats and companies' efforts to build capacity to buffer themselves from future shocks. This focus on short-term recovery has also been observed in literature across the wider food system (Hirth et al., 2025). Additionally, we found that the weight of literature focused on seafood production and consumption but that very few articles that discussed the impact on the middle of the supply chain, and none explicitly focused on seafood processing businesses. This is an omission more generally across literature on seafood systems and resilience (Cramer et al., 2023) that our paper begins to address.

2.5. Context: UK seafood processing

In the UK, seafood processing accounts for approximately 5% of employment within food and drink manufacturing (Mason et al., 2020). As of 2023, there were 353 processing sites in the UK, employing the equivalent of approximately 17,246 full-time workers, with a turnover of approximately £4 billion (Seafish, 2024). Processing units are unevenly distributed across the country, with particularly large fish processing hubs in eastern England and northeast Scotland, generally close to historic and active ports such as Grimsby and Peterhead. Shellfish companies tend to be more geographically dispersed.

Companies process a combination of domestic and imported seafood

Table 1
Summary of resilience mechanisms with examples from literature on COVID-19 impacts on the global seafood system.

Resilience mechanism	Examples from literature
Diversity	• Diversifying income sources (Khan et al., 2023). • Alternative seafood markets established (Stoll et al., 2021). • Diverse customer base, a diversity of products (Love et al., 2021; Stoll et al., 2021).
Flexibility	• Different sizes of business appeared to have different strengths with larger businesses able to buffer shocks, withstand changing market conditions, and store products (Asche et al., 2022; Hendri and Yulinda, 2022).
Connectivity	• Local seafood supply increased a sense of connection to products, environments and customers (Stoll et al., 2021). • Businesses remained up to date with government-mandated health and safety measures that limited contact between employees and supported staff safety (Stoll et al., 2021). • Digital tools/online platforms used to sell seafood direct to consumers (Azra et al., 2021; Costa et al., 2022).

from wild fisheries and aquaculture (Jennings et al., 2016). Fish processing companies carry out a combination of primary processing (e.g. cleaning, filleting) and secondary processing (e.g. smoking, breading, preparation for ready meals), whereas shellfish processing is often minimal (e.g. shucking, cleaning, purification).

3. Methodology

To gain a diverse range of experiences and to reflect the different types of seafood processors in the UK (see Fig. 1), we held ten semi-structured interviews. Participants included representatives of four shellfish companies (two in Northern Scotland and two in Southern England), three fish processors (eastern England), two mixed seafood processors (one in eastern England and one with processing depots across England), and two industry experts (northern Scotland and eastern England) (see Table 2 and Fig. 2).

Participants were purposively sampled for their sectoral knowledge, senior position, and geographical spread. Given the level of expertise required from participants, and the need for detailed in-depth accounts, the sample obtained provided a rich and varied range of perspectives, which allowed for saturation (Guest et al., 2006). Rather than seeking to generalise to wider contexts, or statistically analyse data, our qualitative approach sought to explore the dynamics of resilience within a complex industry.

Participants were initially contacted by email and interviews were held remotely over Teams, lasting for approximately one hour. To enhance quality, consistency and reliability (Yin, 2018) in our approach,

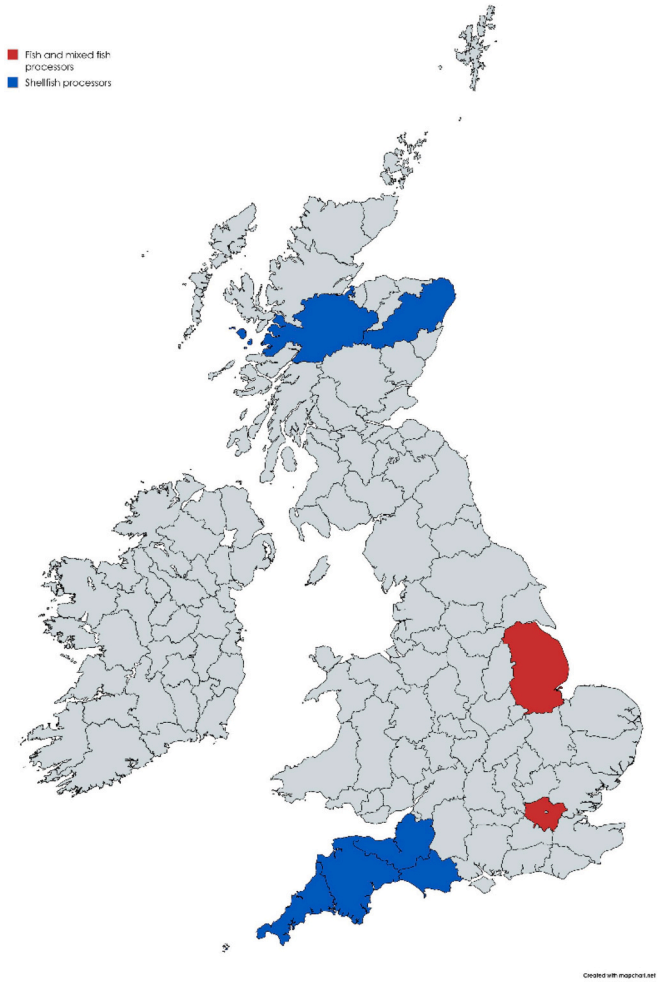

Fig. 1. Approximate locations of participating businesses.

Table 2
Code and description for seafood companies participating in this study.

Interview Code	Description
P1_SNES	Participant 1 Shellfish Northeast Scotland
P2_SNS	Participant 2 Shellfish North Scotland
P3_SSWE	Participant 3 Shellfish Southwest England
P4_SSE	Participant 4 Shellfish South England
P5_MN	Participant 5 Mixed seafood Nationwide
P6_MEE	Participant 6 Mixed seafood Eastern England
P7_FEE1	Participant 7 Fish Eastern England (1)
P8_FEE2	Participant 8 Fish Eastern England (2)
P9_FEE3	Participant 9 Fish Eastern England (3)
P10_INES	Participant 10 Industry Expert Scotland

all interviews were conducted using a common interview guide, but with enough flexibility to respond to and explore issues specific to each participant's circumstances. Participants were asked about specific aspects of their business model (e.g. turnover, staff numbers, suppliers, customers, value proposition, costs – summarised in Table 2 and presented in detail in Supplementary Table S1), their experiences during the COVID-19 pandemic (impacts, responses, government support, lessons learnt), and ongoing and future trends for the sector.

Data collection was carried out in accordance with the university ethics policies. All participants were provided with an information sheet and gave informed consent prior to interview. Interviews were conducted by the first author, who is a qualitative social scientist, with research experience in seafood systems and resilience. We were interested in exploring businesses' experiences of disruptions and were positioned as informed outsiders. Interviews were conducted during a time of potential stress for many businesses, and assurance of confidentiality was key to enabling discussions of adaptations and points of vulnerability. Company descriptors were checked and agreed with participants during interviews.

Interviews were recorded, transcribed verbatim and thematically analysed. We followed Braun and Clarke (2006) in using a combination of deductive coding with broad pre-determined categories (impacts, adaptations, environmental sustainability, government measures, future trends) and inductive coding, leaving space for unexpected themes to emerge. Initial coding was conducted by the first author using NVivo software, with regular discussions between both authors as themes were developed and clarified. Saturation was assessed through ongoing comparison against the developing framework to establish whether new data during later interviews enhanced or extended existing themes. An overview of the final thematic structure is summarised in Figs. 3, 4 and 5.

4. Results

Our findings illustrate some early impacts of the COVID-19 pandemic on the UK seafood industry and detail a range of measures adopted by UK seafood processing businesses to manage impacts (RQ2). Results are structured according to the following themes: routes to market; supply and distribution; operational impacts and responses; economic impacts and opportunities; and environmental impacts and opportunities (see Figs. 3 and 4). In the following section, future trends and threats to the industry (RQ3) are categorised as: continued supply of product; rising costs of energy and emissions targets; labour: recruitment, retention and automation; unsupportive media and regulatory environment; and UK consumption patterns (see Fig. 5).

4.1. Routes to Market

4.1.1. Closure of Service Industry, Exports Disrupted

An early impact of the pandemic was the closure of the service industry, in the UK and internationally, meaning that processors who supplied hotels, cafes, or restaurants (direct or through wholesalers) lost

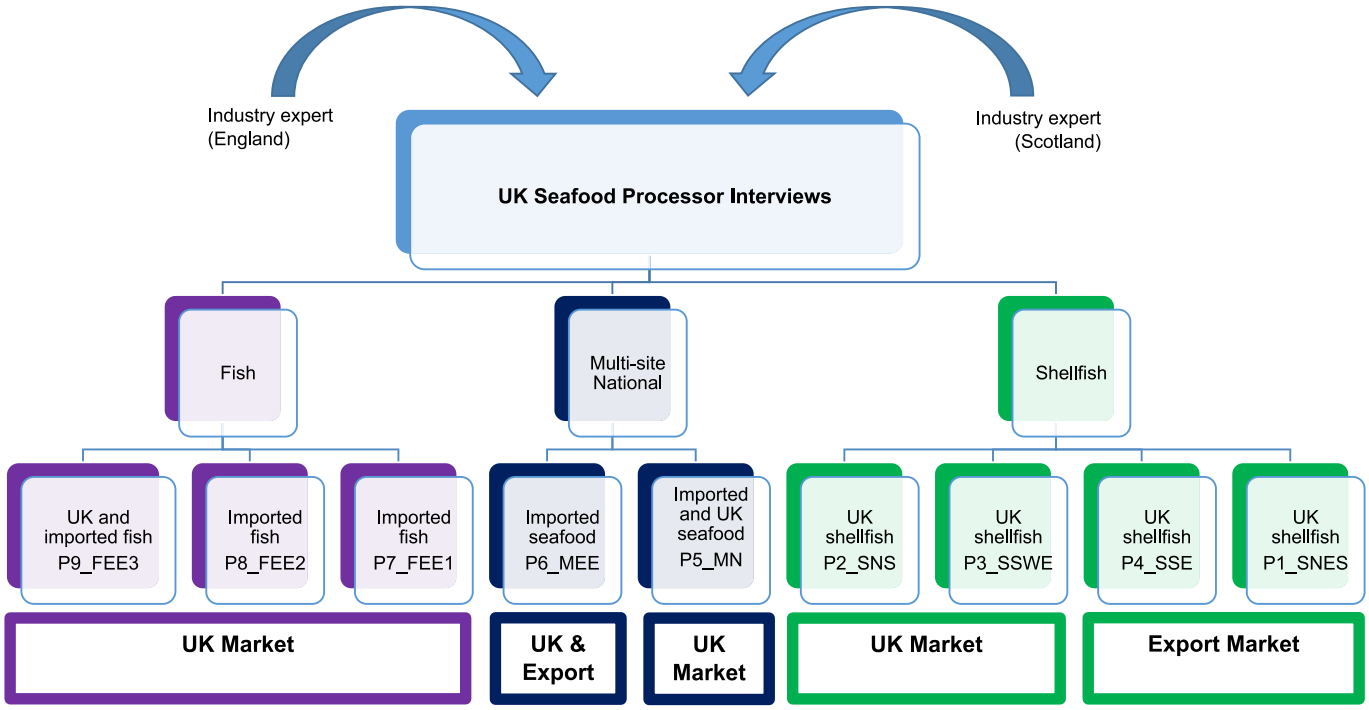

Fig. 2. Interview participants, consisting of two industry experts, three fish processors, two multi-site seafood processors, and four shellfish processors. Note: The Industry expert (England) holds two separate roles: Industry expert and representative of one of the fish processing businesses. Fish processors may also process some other categories of seafood, however they have been categorised as 'fish' as it makes up most of their product output. Shellfish companies deal solely in shellfish (including crustaceans and molluscs).

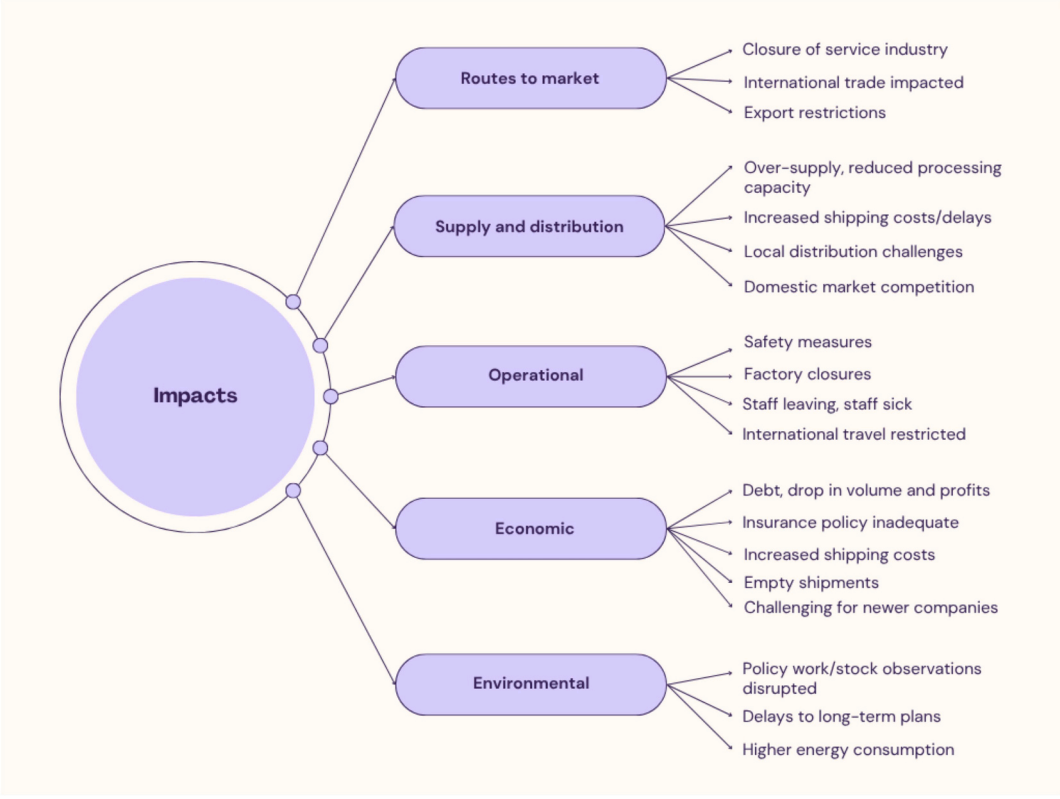

Fig. 3. Coding tree showing impacts of COVID-19 on seafood processing businesses in the UK.

a key market. This was particularly challenging for shellfish processors, whose product is largely destined for food service and export (P10_INES). One shellfish company noted that their markets *"almost evaporate[ed] within the first couple of months"*, stating, *"Italy's our main*

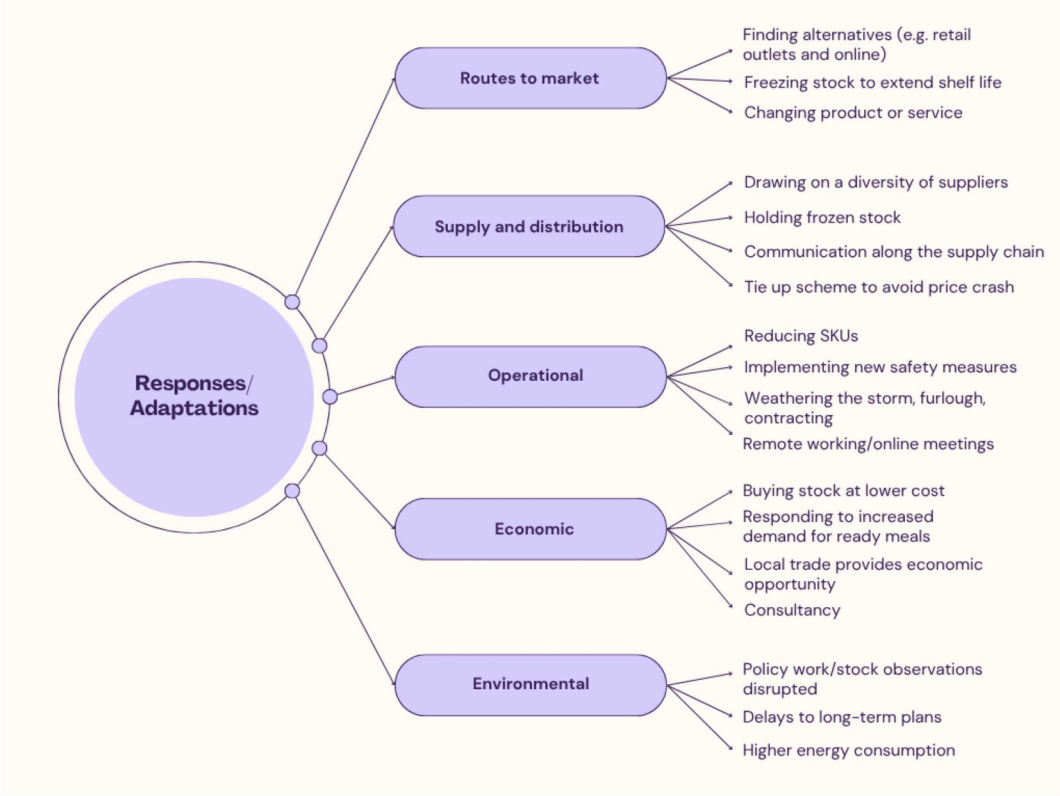

Fig. 4. Coding tree showing responses/adaptations of seafood processing businesses in the UK.

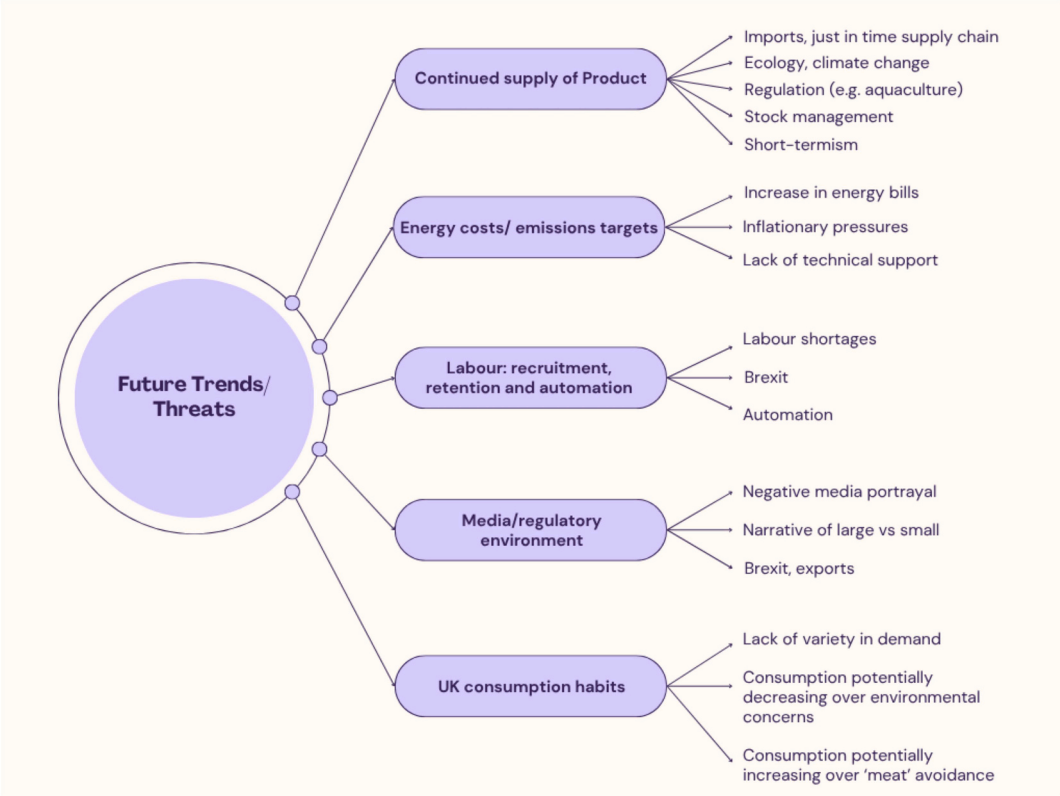

Fig. 5. Coding tree showing perceived future trends/threats to UK seafood processing businesses.

cuttlefish market… that just fell through the floor… And scallops to Italy was decimated" (P4_SSE). When hospitality began to reopen, shellfish producers whose main market was domestic (UK) found restaurants reluctant to sell fresh shellfish due to short shelf-life and unpredictable

footfall (P3_SSWE). Loss of sales meant that catches were reduced or halted (P1_SNES).

Processors engaged in import and export navigated rapidly changing standards and procedures. Several companies reported difficulties in exporting to China and processing fish within the usual timescales (P6_MEE). One experienced a ban on exports to China due to an incident in their factory, which affected approximately 40% of their export market for a year until they were relisted (P1_SNES). These experiences mirror a broader period of declining value of seafood exports. According to Seafish (2020), between January and March 2020, UK seafood export value was 19% lower than the previous year, and 28% lower in April to June than the same period in 2019.

4.1.2. Alternative Products, Services or Markets

In response to international lockdowns, shellfish exporters shifted to alternative products for different markets. Two companies increased their sales of whelks to South Korea (P4_SSE, P1_SNES), as it was *"one of the few markets that remained open"* (P1_SNES). This provided a temporary solution, however, supply soon outstripped demand: *"People were chasing the whelk suppliers… so the whelk [buying] price… was going up, whilst the selling price because we were flooding the market, was beginning to drop"* (P4_SSE). This led to a rapid reduction in whelk orders from South Korea (P1_SNES).

One shellfish processor who did not export suspected that larger export-oriented shellfish companies were turning towards the domestic market and feared their market share would reduce (P2_SNS). They decided to reorient their business towards restoration and consultancy, while maintaining a low level of online sales direct to the consumer, stating that consultancy had become more valuable than growing oysters for food (P2_SNS).

Forums and associations helped businesses through information sharing, collaboration, crisis management, and linking businesses to customers (P8_FEE2). One forum supported businesses by setting up alternative supply chains and new routes to sell fish (P10_INES).

4.1.3. Shifting to Retail

Several businesses adapted by redistributing sales among existing customers, with one seafood processor stating that retail sales had *"picked up massively"* (P9_FEE3). This increase in retail sales reflects a trend across the UK seafood industry where consumption through retail saw a temporary increase, while foodservice sales fell (Seafish, 2022). One shellfish company directed product to retail but saw a reduction overall (P1_SNES), while another reduced the size of their fillets to accommodate the rise in demand from retailers (P6_MEE). One fish processor (P9_FEE3) increased sales via a recipe box company, citing an increase in *"fancy dining at home"*, as consumers were unable to go out to eat. Similarly, one shellfish company reported *"phenomenal sales"* through an existing online retailer (P3_SSWE).

Selling direct to consumers was not feasible for all businesses, particularly if connections and infrastructure were not already in place. An example of a company that did not pivot was P5_MN, a national supplier to the service industry with processing units at different sites nationwide. They stated that *"90% of the company was put on furlough, pretty much immediately, because essentially [they] lost all [their] customers overnight"* with only a very small pool of customers left who were looked after by a *"skeleton crew"*. They *"just plodded on"*, noting that the experience made them realise they could be more productive with fewer staff, leading the organisation to become *"leaner"*. They did initially consider setting up a home delivery service, but decided that the effort required made it unfeasible (P5_MN).

4.2. Supply and distribution

4.2.1. Disrupted Supply Chains

Disrupted supply chains presented a challenge for procuring raw materials and product distribution, which exacerbated problems for processors in the middle of the supply chain, who were also balancing disruption to markets. One company noted that global shipping had become *"very slow and very expensive"*, stating that they had *"400 tonnes of raw material sitting in cold store just outside Ho Chi Minh [which] should have been processed a month ago"* (P6_MEE). They attributed the disruption to closed factories and an imbalance in trade between the UK and Asia, stating that there were "*ships anchored, and ships scrapped"* and *"containers and ships in the wrong place"* (P6_MEE). The participant's experience is in line with secondary sources, highlighting that shipping was subject to 'unprecedented volatility' and delays (British Ports Association, 2021; UNCTAD, 2022). There were also issues with local UK distribution due to an insufficient volume of product and a shortage of drivers (P3_SSWE; British Ports Association, 2021).

4.3. Frozen stock, diversity of suppliers and regulation of supply

For one company dealing entirely in frozen food, supply was not initially an issue, given the longer shelf life of their product (P5_MN). A diversity of suppliers and established relationships with producers also allowed one fish processor to maintain supply (P9_FEE3).

Early in lockdown, there were concerns over potential oversupply due to processor closures and reduced capacity. To regulate the supply of fish, a tie-up scheme was initiated in early lockdown, which prevented oversupply and price crashes (P10_INES).

4.4. Operational Impacts and Responses

During lockdown, the UK Government mandated safety measures such as ensuring a safe distance between workers to lower the risk of disease transmission. Companies had to consider new health and safety requirements, taking into account new protocols from governments and insurance companies (P10_INES). Social distancing regulations meant that for smaller factories, fewer workers could be on site. Where companies were unable to facilitate new requirements, factories were forced to close temporarily (P10_INES). Periods of 'self-isolation' due to staff sickness led to a reduced workforce (P8_FEE2, P4_SSE).

To maintain staff safety, companies intensified cleaning and closed off sections of break rooms, offered staff on-site accommodation (P4_SSE), lengthened working days and changed shift patterns (P6_MEE, P1_SNES), staggered staff breaks (P7_FEE1), installed plastic screens between staff (P8_FEE2, P9_FEE3), introduced bracelets that tracked proximity to other workers, and reassessed and reduced product lines due to restrictions on space and staff (P1_SNES). Some companies allowed administrative staff to work from home (P8_FEE2, P4_SSE) noting benefits such as "*better work-life balance"* (P4_SSE).

4.5. Economic impacts and opportunities

4.5.1. Loss of profit, increased debt and increased costs

COVID-19 caused economic uncertainty and loss for several companies. One less established shellfish company did not meet the income thresholds for government support (P2_SNS). Another shellfish company was recovering from a period of financial difficulties when the pandemic arrived: *"We'd just got [the business] back up and running and really going again in February 2020… Covid came in in March 2020 and took the wind back out of our sails"* (P3_SSWE). Most reported financial losses were linked to reduced sales; however, an unforeseen financial risk was a travel insurance policy not covering losses due to transmissible diseases (P9_FEE3).

Costs also increased. For companies that imported and exported products, increased shipping costs became *"very significant"* (P6_MEE), a phenomenon that has been widely documented elsewhere (Mahmud et al., 2025; UNCTAD, 2021).

One company was able to mitigate some economic loss by selling a higher-value product: *"The value of processed whelk is significantly higher than the cuttlefish, so our turnover didn't suffer quite so badly. In terms of*

throughput… I'd say we probably dropped 50 or 60%" (P4_SSE).

4.5.2. Economic opportunities

While the pandemic had adverse effects on many businesses, some were able to take advantage of opportunities. Without cash reserves and financial liquidity, some struggled to fund stranded stock, presenting an opportunity for those with financial buffer to buy fish at significantly lower prices due to lack of demand (P6_MEE).

One company temporarily expanded part of its business due to a rise in demand for ready meals (P6_MEE). They noted that having a UK-based processing facility during disruption helped to ensure *"continuity of supply"*, observing the vulnerabilities associated with processing in Asia (P6_MEE).

Another fish processor had contracts with fish vans ("van lads") that delivered nationwide, stating that, *"my van lads do door-to-door deliveries. We quadrupled our fish sales during Covid"* (P8_FEE2). They also felt that they benefited from returning customers due to being in a close community – *"a word-of-mouth place"*, where *"everybody knows everybody"* (P8_FEE2).

4.6. Environmental Impacts and Opportunities

4.6.1. Stock Monitoring and Energy Use

One industry expert noted that early lockdowns impeded access to fishing vessels, meaning that "*observation became impossible… the scientists couldn't do their surveys."* This resulted in a concerning gap in the data (P10_INES). A shellfish company admitted that stock management policy work had been disrupted and delayed, including ongoing work within the Scallop Industry Consultation Group (P1_SNES). As with several disruptions, the cause was thought to be a combination of Brexit and COVID-19 (P1_SNES).

A potentially significant environmental impact was a sudden increase in demand for whelk. In the UK, whelk is a 'non-quota' species, which means that while there are regional regulations, it is not subject to national catch quotas. As one shellfish processor put it, *"whether the whelk stock can take that or not remains to be seen"* (P1_SNES). While whelk stocks may have suffered, one processor suggested that at least temporarily, *"the marine environment benefited from a reduction in fishing, [and] overall fishing pressure in 2020"* (P1_SNES).

Whelks are also energy intensive to process, with one company estimating that compared to scallops, they used approximately seven times the amount of electricity per ton of product (P4_SSE). P4_SSE had various plans to reduce their environmental impact for the longer term, however the financial instability caused by the pandemic prevented or delayed plans (P4_SSE).

4.6.2. Environmental opportunities

One benefit of lockdown was a reduction in what one processor saw as the industry's *"superfluous travel"*, noting that, *"to sell one product you probably fly to Asia six or eight times with one company"* (P6_MEE). Particularly given the cost savings (in a "normal" year, P6_MEE spent £100,000–£150,000 on flights), they saw a reduction in international travel as a long-term benefit. They decided to not to return to pre-COVID levels, because businesses have become more comfortable with working and meeting online (P6_MEE).

One shellfish processor reflected that the pandemic allowed space to make positive changes such as joining the National Lobster Hatchery 'Buy One Set One Free' scheme that releases one baby lobster for every lobster bought, joining the Crab and Lobster Management Group, and signing a contract with a scallop farmer due to concerns over local stock depletion and health and safety issues associated with hand-dived scallops (P3_SSWE).

4.7. Beyond the Pandemic: Future Trends and Threats for UK Seafood Businesses

4.7.1. Continued Supply of Product

Seafood processors were concerned about ongoing stability of supply, with reference to fragile supply chains, emerging environmental regulations, climate change, and overfishing.

Several interviewees saw the reliance on seafood imports as a serious threat (P7_FEE1; P8_FEE2; P6_MEE; P5_MN), with one processor stating that "*90% of our fish supplies are imports"* (P8_FEE2). Another shared concerns about *"the fragility of just-in-time supply chains"*, which they saw as vulnerable to sudden shocks (P6_MEE). The just-in-time model is recognised as a point of potential vulnerability across the UK food system, particularly during periods of disruption, as it relies on a functioning system of supply and distribution rather than holding large quantities of stock (DEFRA, 2024). P6_MEE saw this risk as an argument for increasing UK processing capacity as they predicted that large retailers would begin to demand products that have been processed locally as they realise the vulnerabilities associated with long distance supply chains.

Participants were concerned about *"the ecology of the seas"* (P3_SSWE) and *"warming sea temperatures"* leading to impacts on non-mobile species such as scallops and migration of more mobile species (P4_SSE). Availability of seafood stocks is under constant review. For example, the sustainability of open-ocean stocks in the Northeast Atlantic (e.g. mackerel and herring) is currently under pressure, which has a direct impact on quotas (Seafish, 2025a).

One processor who relied on farmed salmon conveyed uncertainty around potential tightening of regulations on aquaculture following the UN Conference of the Parties (COP26) in 2021 (P9_FEE3). They were relieved that the UN recognised aquaculture as *"low emission"* and *"high efficiency"* but acknowledged the need to remain open to exploring alternative products such as synthetic seafood, to remain competitive (P9_FEE3). Continued growth in the UK salmon production industry is anticipated, however issues such as rising sea temperatures, export friction and concerns related to salmon production's environmental impact are ongoing (Seafish, 2025a).

Management of some stocks such as whelks, crabs and scallops, was described by one business as *"pretty loose"* (P1_SNES). They emphasised the importance of long-term investment in stock stability, recognising that without systems in place, *"fisheries will remain unstable and vulnerable to things like Covid, Brexit, those kinds of shocks which disturb the peace and means that the stock just booms and busts"* (P1_SNES).

While several companies were actively considering the sustainability of their activities, one industry expert reflected that long-term planning is lacking in the seafood industry, lamenting the industry's *"short-termism"* (P10_INES). Similarly, one processor claimed that seafood businesses are often *"too focused in the here and now"* to invest in green energy (P7_FEE1).

Responsible sourcing and the avoidance of overfishing have been highlighted by Seafish (2025a) as key considerations facing the UK seafood industry, noting that consumers are beginning to demand more transparency and sustainability in the supply chain.

4.7.2. Rising Costs of Energy and Emissions Targets

Businesses were concerned about increases in energy bills (P4_SSE), the impact of inflationary pressures on the cost of product (P5_MN), and *"ever-tightening targets on emissions"* (P4_SSE). Although emissions targets may reduce energy use, one company felt that support to help businesses to make continual improvements was lacking, stating that, *"when you've cut everything you can think of, you need someone to come in and say: 'you could do A, B and C', but there isn't that sort of secondary help"* (P4_SSE).

4.7.3. Labour: Recruitment, Retention and Automation

Staff recruitment and retention were discussed frequently, with

participants describing it as *"a nationwide problem"* (P8_FEE2), *"a constant challenge"* (P6_MEE), and "*an issue we discuss every day"* (P5_MN). This remains a stubborn and well-documented problem for processing businesses across the UK, particularly following changes to the UK's skilled worker visa and competition from other sectors (Seafish, 2025a). Between 2023 and 2024, the number of full-time equivalent staff dropped from 17,729 to 17,169 reflecting difficulties with recruitment, rather than a reduction in available positions (Seafish, 2025a).

Several seafood businesses relied heavily on EU workers (P6_MEE; P5_MN). Processors cited Brexit and COVID-19 as reasons for the loss of EU staff from the industry. Some recognised that the flight of EU staff pre-dated both periods, attributing the trend partly to the stagnation of living standards in the UK and economic advancement in other EU countries (P4_SSE; P8_FEE2; P10_INES).

Seafood companies reported struggling to recruit UK workers for a range of reasons included seafood processing being *"noisy"* and *"smelly"* (P1_SNES), and not very *"glamorous"* (P7_FEE1), while staff are expected to work *"at night in the cold, wet, damp atmosphere"* (P5_MN). One processor claimed that when UK workers are recruited *"they last three or four days and end up reporting sick and then don't turn up anymore"* (P5_MN).

One company reported the limited success of different recruitment methods, and recounted employing just one member of staff from 140 people invited to interview (P4_SSE). Another found that recruitment through agencies did not attract *"high-calibre or quality"* candidates, while apprenticeships seemed to *"end miserably"*. Students employed over summer usually left to *"go onto bigger and better things"* (P9_FEE3).

Processors were concerned about an increasingly elderly workforce, noting that fewer young people *"aspire to work in factories"* (P6_MEE) and that *"the art of filleting fish is dying out"* (P8_FEE2). To try to inspire a younger generation and with support from an industry forum, one company developed *"promotional videos of fish filleting that will then go into schools [and] colleges"* (P8_FEE2).

One industry expert stated that the UK seafood industry may have to *"automate [its] way out of these issues"* (P10_INES). While several interviewees were currently using automation and open to the idea of expanding its use, few were convinced that it will be a quick fix. One stated that "*There is a lot of machinery in the seafood sector that can be used. But some of it is a bit temperamental"*, and that more development is required, *"but it all costs money"* (P10_INES).

Interviewees were largely in agreement that the technology is not yet advanced enough to employ automation on a wider scale. One company believes that hand-filleting *"provides a greater quality product"* (P7_FEE1), while another reflected that *"a good fishmonger is a craftsman"* (P5_MN). The need for *"passion for fish"* and flexibility was cited, with one participant stating *"My lads can be on salmon for half an hour, and then another order may come in and I'll have to change straight away to plaice … When you look at the diversity of fish we're selling now… that's where your skills lie in your fish filleters. That ability to change. And you don't get that with automation"* (P8_FEE2). Companies believed that the dexterity required for processing shellfish required humans as it is *"fiddly, and it's all done on the very finest margins of yields"* (P4_SSE). One company that was keen to automate as much as possible cited the experience of another company that found their factory less efficient under automation, noting that *"it's the main KPI in our production facility, is the yield they get off the fish"* (P9_FEE3).

4.7.4. Unsupportive Media and Regulatory Environment

Several businesses felt the seafood industry faces harsh and sometimes unwarranted scrutiny including *"downright lies"* from the media (P10_INES). One interviewee commented that seafood companies *"do a lot of [good] things… that never get recognised" such as the "Cod Avoidance Programme in the North Sea… which closes off areas of high catching … [and] huge sectors of the sea during spawning aggregations"* (P10_INES). Some interviewees discussed recent documentary films that painted the seafood industry in a poor light (P5_MN), including one that gave *"fish farming a bit of a battering"* (P9_FEE3). One interviewee saw environmentalism as *"an industry, like every other industry"*, stating that there are *"lots of people employed in that industry, and they're trying to find ways of sustaining their existence"* (P10_INES).

One participant lamented that politicians and the media idealise *"small South coast coastal towns with little boats going out and fishing locally"*, while *"the big guys are frowned upon"*. They argued that *"you need the big guys to compete in the global markets…, even more so since we've left the EU"*, and that larger companies support smaller companies *"through loans and through buying, procuring their catches. We give them a reliable market for their product"* (P1_SNES).

Various issues with legislation and regulation were discussed, from a lack of support for producers to access export licences (P3_SSWE) to insufficient representation for the industry due to its diversity and relatively small size, with even the larger UK seafood companies dwarfed by supermarkets in terms of influence (P5_MN).

Brexit was discussed as an ongoing threat that compromises businesses' ability to export. One business considered it to be *"prohibitively expensive for me to get [product] out of the UK, because of this blooming Brexit carry-on"* (P2_SNS). P1_SNES saw trade with Europe as an additional but necessary expense, while P3_SSWE *"made a conscious decision not to export"*.

One participant noted that their forum had been *"instrumental with regards to the changes in Brexit"* (P8_FEE2), for example by sharing knowledge and experience of navigating new processes. Forums facilitated networking and information exchange, for example between European representatives, industry representatives and other businesses (P8_FEE2; P10_INES).

4.7.5. UK consumption patterns

Several processors discussed lack of UK demand for a variety of seafood. One company noted that for many people in the UK, oysters are deemed *"A) for rich people, and B) something quite disgusting"* (P2_SNS). Another company stated that *"The only thing that we sell in the UK in any volume is langoustine tails for scampi… [which is] typical of the British household, that you take this beautiful delicate meat and you deep fry it in breadcrumbs"* (P1_SNES). One company hoped Brexit would result in an increase in consumption of UK seafood in the UK but noted that other European consumers are willing to pay more for their products (P5_MN).

Some businesses anticipated changes in demand linked to environmental sustainability and animal welfare concerns, with one observing that *"the next generation coming up is much more focused on it, it's very important to them. They want a future"* (P5_MN). One company suggested that due to the emissions from seafood production being relatively low compared with other animal products, *"people are looking for alternatives for that and I think this is where you are going to see the growth in the seafood industry"* (P8_FEE2). Another was more ambivalent, unsure whether salmon will *"grow in popularity over the next few years… or …dwindle as more and more people do go plant-based"* (P9_FEE3).

5. Discussion

To address RQ4 (Which key characteristics of resilience are involved in response to disruption and how can seafood businesses build adaptive capacity?), the discussion section is structured according to three key resilience mechanisms: flexibility, diversity and connectivity. This is followed by a logic model linking firm-level antecedents and outcomes. We then present a series of recommendations for building adaptive capacity in seafood supply chains.

5.1. Flexibility

Responding to the COVID-19 pandemic required flexibility. This is particularly crucial for processors, who are positioned as boundary actors that absorb disruption from both upstream (supply) and downstream (demand) simultaneously.

Proactive management allowed some firms to respond quickly to closed markets, disrupted supplies and new operational restrictions. In keeping with Asche et al. (2022), larger companies were able to use their financial stability as a buffer to survive uncertainty and take advantage of market opportunities, using international connections to target different regions and catches. For example, P6_MEE's financial slack allowed them to take advantage of temporarily lower prices and to expand their processing facilities to respond to the rise in demand for ready meals. While financial stability did allow for flexibility in response, arguably the least profitable company we interviewed (P2_SNS) was very quick to pivot business model almost entirely from online sales to conservation. They put this down to their willingness to engage with external networks that offered new opportunities. This speed of pivot was also potentially helped by the company being in its infancy. So, while financial buffer was not a precursor to their adaptation, network embeddedness within their local area appeared to be important. Taken together, these cases suggest that financial slack enables flexibility but does not guarantee it, and that network embeddedness can substitute for financial buffer in some circumstances.

Smaller businesses were agile enough to pivot their business model at short notice, focus on the local scale, or sell direct to consumers through online platforms, echoing the crisis-induced re-localising observed by (Stoll et al., 2021). Companies with access to existing digital infrastructure (e.g. P9_FEE3 selling via online platforms) were able to demonstrate flexibility when shifting to direct sales, and frozen products allowed for more flexibility due to their longer shelf-life.

In general, we found that firms most able to pivot were those where pre-existing capabilities (e.g. financial slack, digital infrastructure) matched some of the vulnerabilities exposed by COVID-19 (e.g. collapse of service channels, export friction). This extends the work of Pettit et al. (2019) by showing that fit between capability type and disruption type might matter more than aggregate capability levels.

5.2. Diversity

Our findings support existing research (Love et al., 2021; Stoll et al., 2021) demonstrating that companies with a diversity of suppliers, customers and routes to markets were able to shift the balance of their suppliers and outlets based on availability and demand, for example directing a higher proportion of product to retail rather than service. This was perhaps more difficult for shellfish businesses than fish processors, as their product is more dependent on export markets and the service industry. Fish processors had a more mixed customer base that tended to include retail.

Shellfish companies shifted to new products and international markets, offering a temporary solution (for example by increasing the sales of whelk); however, this led to a price crash and potentially unsustainable outcomes for a species that was not well regulated. The ability to swap from one species to another easily is needed for adaptive capacity (Stoll et al., 2017) but high synchronicity (multiple businesses shifting at the same time) is detrimental for resilience (Nomura et al., 2021). This highlights the importance of assessing resilience at the sector level as well as the firm level.

5.3. Connectivity

Collaboration across supply chains and between businesses and policymakers at multiple scales has been shown to improve resilience of seafood businesses (Tolley et al., 2015), and social connectivity and learning have positive implications for adaptive capacity (Pelling et al., 2008; Rubio et al., 2021). Both local and global supplier relationships proved crucial for interview participants. Established global relationships enabled some businesses to maintain supply, although export-dependent businesses were vulnerable when global links severed, while businesses with robust local/domestic customer networks demonstrated resilience.

While fish processors were in established hubs, shellfish processors were more geographically dispersed, limiting opportunities for sharing knowledge and infrastructure. Fish processors benefited from local social capital, where informal networks sustained businesses (e.g. P8_FEE2's local connections to customers and national connections to 'van lads'). Shellfish companies, who tend to have a narrower range of available outlets were more heavily impacted by service industry closure and international trade disruption. For some shellfish processors, connections to international customers were disrupted, and existing connections to local consumers were weak or non-existent. Although there was evidence of a short-term response from shellfish companies (e.g. P4_SSE shifting products to adjust to changing international markets), in the longer term, social connections can support the development of new routes to customers and to distribute produce (Stoll et al., 2021), which might suggest that geographically isolated companies are more vulnerable.

Industry forums provided vital coordination, linking businesses to new markets and facilitating knowledge sharing between companies, policymakers and other industry experts, while online platforms enabled businesses to maintain connections across geographic scales, from local direct-to-consumer sales to maintaining international business relationships remotely.

5.3.1. Linking firm-level antecedents with intermediate adaptations and outcomes

Drawing on patterns observed across interview data, Fig. 6 visualises a logic model that links firm-level antecedents with intermediate adaptations and with outcomes, drawing on supply chain resilience theory (Ali et al., 2017; Pettit et al., 2019). Specifically, we identify three antecedents in our data: (1) financial slack (e.g. cash reserves, access to external funding); (2) digital readiness (e.g. existing online sales infrastructure, remote-working capability); and (3) network embeddedness (e.g. participation in industry forums, established local and international customer relationships, strong communication and leadership within firms). These are linked to intermediate adaptations, such as speed of market reorientation (e.g. service-to-retail pivots), supply diversification (alternative species, alternative suppliers), and operational reconfiguration (e.g. shift patterns, on-site housing, rationalising product lines). The adaptations map onto outcomes, such as continuity of operations, preserving margins, and recovery time.

5.3.2. Recommendations for Building Adaptive Capacity in Seafood Supply Chains

Reliance on Imports.

The UK seafood system's reliance on import and export means that trade and supply is affected by global supply chain disruption. Businesses will need a diverse range of product sources to maintain supply in times of stress.

Heavy reliance on international processing risks weakening resilience if international supply chains are disrupted. Larger companies with more significant cash reserves can withstand shipping delays, particularly if they deal in frozen stock. While processing in East Asia may be cost effective in the short-term, it leaves supply chains vulnerable to shocks. As Stoll et al. (2021) note there is a tendency towards re-localising during times of stress. To pre-empt this trend, the UK must increase its processing capacity.

Consolidation Risks.

The pattern of consolidation of seafood businesses has continued in recent years (Seafish, 2025a), with the number of seafood processing sites in the UK falling from 380 to 336 between 2016 and 2025 (Seafish, 2025b). Consolidation can be exacerbated by periods of disruption, potentially leading to a less robust landscape. More targeted support should be made available for SMEs in the form of grants and subsidies and training support (for example for obtaining export licences), and a standing crisis response fund would help businesses to function during shocks. Government could also increase access to domestic markets

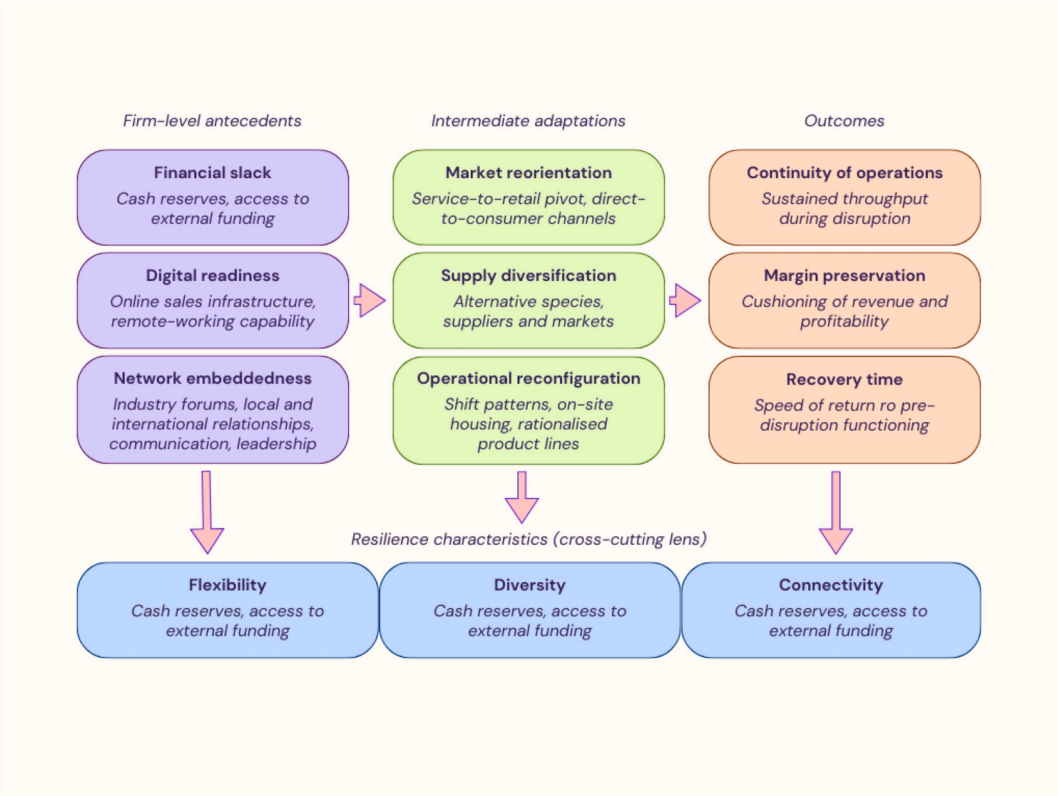

Fig. 6. Logic model linking firm-level antecedents, intermediate adaptations and outcomes.

through changes to procurement policy that specify a minimum share of local public procurement contracts to SMEs who produce local seafood.

Resource Availability.

Resource availability is key to the ability to adapt. Given the uncertainty around continued supply of product (for example: impacts of potential future regulations on salmon aquaculture, migration of stocks, reliance on imports, depletion of stocks), businesses must plan for a variety of outcomes. This planning process should ensure businesses have a diverse product portfolio and are sourcing sustainably. Active participation in governance and decision making is also important for building adaptive capacity (Powell et al., 2022). Businesses should take active steps to support stock monitoring and management schemes and governments and industry bodies should ensure that policy design processes are participatory (Seara et al., 2016).

Environmental Sustainability.

Recent research has sought to link the concepts of resilience and sustainability in the context of seafood systems, by suggesting that principles of resilience can contribute to socio-ecological sustainability (Subramaniam et al., 2023) and by proposing that increasing adherence to the principles of circular economy could increase seafood businesses' capacity to respond to shocks (Fletcher et al., 2021; St. Clair et al., 2023).

UK seafood businesses face tensions between meeting immediate demands, which may mean compromising environmental sustainability, and planning for the longer term. Short-term shocks can cause financial strain, meaning that longer term sustainability measures are put on hold. Our findings presented examples of this tension, including higher energy use to process alternative products, delays to internal sustainability improvements, and stock management engagement and development setbacks. In this sense, environmental sustainability can be viewed as a measure of resilience, a facilitator of adaptability, and a victim of crisis.

To build adaptive capacity, seafood businesses need support with forward looking investment and development, as well as technical support for improving efficiency and lowering emissions and waste.

Labour Issues.

Recruiting and retaining labour for seafood processing in the UK is an ongoing challenge. Recent reliance on EU workers and Brexit exacerbated challenges around employment and retention of staff (Symes and Phillipson, 2019). Some businesses have actively considered ways to address this challenge (e.g. directly engaging the local community); however, employment gaps remain a stubborn problem, partly due to the difficult work environment. For example, working in UK seafood processing sites is associated with health consequences, such as an increased incidence of Occupational Asthma (Mason et al., 2020) and staff often need to withstand cold environments and repetitive work (Cramer et al., 2023).

Businesses recognise the need to futureproof themselves against risks such as lack of labour, rising bills and climate change and some are very active in these areas. Our findings suggest that external support is needed in the development and implementation of automation capable of achieving similar yields to people. Businesses are also seeking stability and reassurance regarding the source of labour as fewer UK citizens are willing to work in processing sites.

The UK Government could consider investment in training programmes with the potential for career progression for local people. Some examples already exist, such as the UK Seafood School and the Step into Seafood project. This would need to be alongside initiatives that strengthen local culture and pride, improve job stability, pay and conditions, and invest in local coastal areas to prevent ‘brain drain’.

Consumption Patterns

Given the dependence on imports, resilience would require demand for and availability of UK seafood. Symes and Phillipson (2019) predicted that seafood businesses would respond to disruption linked to the UK's exit from the European Union by shortening supply chains and relocalising, however the industry remains largely export driven. Deeper integration and collaboration along the supply chain to better link producers to consumers may stimulate an increase in consumer demand for locally produced seafood, which is currently low (Graziano et al.,

2018; Symes and Phillipson, 2019).

6. Conclusion

Our paper has examined UK seafood processing businesses' responses to COVID-19 through a resilience lens, with a particular focus on flexibility, diversity, connectivity and building adaptive capacity. We found that UK processors showed flexibility through proactive management, financial stability and pivoting business models at short notice. Severed international connections presented challenges for companies, but local and digital connectivity and cross-industry collaborations strengthened responses. Businesses with a diversity of products, customers, labour force and suppliers were able to demonstrate resilience.

While this study draws on experiences from COVID-19, which exposed structural weaknesses in the seafood processing sector, the lessons extend beyond the pandemic. Resilience is not static. It requires continuous investment to allow for flexibility, connectivity and diversity. Building adaptive capacity is essential for UK seafood processors to withstand future disruption. As such our recommendations address future threats such as consolidation risks, resource availability, environmental sustainability, labour gaps, and seafood consumption patterns.

6.1. Theoretical and Managerial Implications

When it comes to theoretical implications, our study contributes to supply chain resilience and food systems resilience literature in three ways. First, it provides empirical evidence from the under-researched processing segment of the seafood supply chain (the hidden middle), responding to the need to focus beyond production and retail narratives (Cramer et al., 2023). Second, it refines the conceptualisation of resilience in seafood systems by showing that the usefulness of flexibility, diversity and connectivity depends on fit with the specific vulnerabilities a disruption exposes, extending Pettit et al.'s (2019) capability-vulnerability framing. It also highlights three firm-level antecedents (financial slack, digital readiness and network embeddedness) linked to intermediate adaptations and outcomes. Third, it highlights that diversity is relational, not only firm-level: adaptations that diversify one firm's options can undermine sector resilience when adopted simultaneously (consistent with Nomura et al., 2021).

Our findings point to several priorities for industry when building adaptive capacity: actively participating in industry forums and other networks, which proved decisive in accessing new markets and navigating Brexit; maintaining diversity across suppliers, customers and routes to market, including investment in digital infrastructure to enable direct-to-consumer channels; and, building forward-looking capacity (e.g. financial buffer, sustainability planning, and stock management) so that short-term shocks do not compromise longer-term preparation. For policymakers, supporting processors' resilience means targeted SME support, procurement measures that favour local seafood, investment in domestic processing capacity, and stable, well-funded, accessible training pathways to address labour gaps alongside a renewed focus on retention, working conditions and career progression opportunities.

6.2. Limitations and Future Research

This study provides an in-depth account of business responses to COVID-19, and future threats facing the industry. We add to the literature by focusing on processors which are historically under-researched. The study does however have limitations, such as the sole focus on processors rather than the wider supply chain, and the relatively small sample size, which may limit the transferability of findings to broader contexts. We also acknowledge that the voluntary nature of participation may have skewed our study towards more proactive businesses, perhaps with an interest in environmental sustainability. Future research could include comparative studies across seafood sectors and other food industries, or longitudinal research that investigates businesses' efforts to build adaptive capacity post-COVID.

CRediT authorship contribution statement

Rebecca St. Clair: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Maria Sharmina:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Claude (Anthropic) for language editing to improve readability and polish the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clscn.2026.100353.

Data availability

The data that has been used is confidential.

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