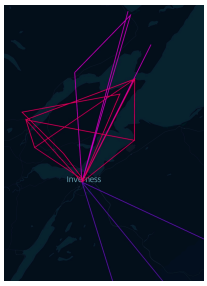

HiPLAN – Highland Food & Drink Open Logistics Platform

March 2021

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2 Acknowledgement

The authors gratefully acknowledge the twenty-four companies who provided their valuable data and insightful comments in support of this study.

2.1 Food and drink producers

Aquascot Ltd	Isle of Skye Fudge Company
Bannerman Seafoods	Isle Of Skye Sea Salt Co Ltd
Black Isle Dairy	Isle of Skye Smokehouse
Bogrow Farm	John M Munro Ltd
Cairngorm Brewery Company Limited	Praban na Linne Ltd.
Highland Crackers	R&B Distillers Limited (Isle of Raasay Distillery)
Highland fine cheeses	Skye Free Range
Isle of Skye Baking Company Ltd	The Tomatin Distillery Co. Ltd
Isle of Skye Distillers LTD	Zepice Ltd

2.2 Logistics services providers

ARR Craib Transport Ltd	Skye & Localash Food Link CIC
Letterfinlay Foods Ltd	Swansons Food Wholesalers
M&H Carriers	Williamson Foodservice

3 Executive Summary

The Highland Food and Drink Open Logistics Platform (HiPlan) pilot project aims to test if a data driven **open logistics platform** can be created to address key logistics-related issues in the Highland Region food and drink supply chain by: boosting order fulfilment, reducing time to market, lowering distribution costs, improved sourcing and maximising load efficiencies, and building supply chain resilience. The pilot project gathers and uses data from businesses to inform the creation of an open logistics platform using adaptations of portal technology, establishing a basis to build and deploy a variety of Web applications designed to meet changing business requirements.

The project took place between November 2020 and February 2021 and was funded by The DataLab and Highlands & Islands Enterprise. The project team comprised Robert Gordon University, Rural Matters LLP and Celerum Ltd. all with relevant and complementary skills in logistics modelling, economic development and the Highland food and drink sector, and software systems.

The creation of an open logistics platform presents a formidable innovation challenge. It is a challenge that has faced businesses in the Highlands and other rural areas for decades. Recent engagement with businesses by Rural Matters LLP as the contractor for the Highland Food & Drink Innovation Network confirmed the importance of the topic as it is raised consistently by many companies across the Network.

Food & Drink is recognised as a key sector for the economy. An open logistics platform could assist in speeding-up economic recovery, increase efficiencies, help companies to explore new markets and operate nimbly post COVID-19. It would also bring benefits to logistics companies, increasing volumes and the ability to identify specialized market opportunities.

The open logistics platform has many wider benefits and will utilise and highlight the value of data in future-proofing economic activity, helping improve resilience in the face of new challenges and transitioning towards a low carbon economy.

The pilot study gathered data from business surveys to build a realistic model of logistics – including typical types of transport fleet used, volumes of goods to be moved/brought in, destinations, distribution locations, and constraints. Artificial Intelligence (AI) was used to try to optimise the goals for all project participants through effective simulation.

The pilot chose two areas to focus on and test the project concept, Inverness/Moray Firth and Isle of Skye. Questionnaires were sent to companies in both areas with 18 food and drink full questionnaires and 6 logistics full questionnaires completed and returned for analysis and modelling. Other companies offered comments and insights which are noted in the report and were broadly confirmed by the data analysis.

The data gathered was used to model the daily demand for outbound and inbound logistics movements, of different sizes and with different

"Logistics can cause a problem and time delays. We are a small business and at present deliver all our product to customers or have them collect from us, this is due to organisational reasons and because there is little available for sending chilled / frozen direct to customers."
Food and drink producer

handling constraints. One year's worth of synthetic data was generated, based on the frequencies of different size goods and handling requirements, giving a set of daily delivery jobs to be done in each of the study areas.

This provided a robust data set incorporating daily and seasonal variation that gives a realistic sample of the logistics needs of the participating producers and enabled simulation information that would be available to an open logistics platform.

The analysis explored the potential for groupage of delivery jobs from a particular local area with the same destination. The optimisation process to group delivery jobs only combined delivery jobs that have the same handling requirement (Normal/Chilled/Frozen).

Analysis shows that with a sufficiently high number of producers, road time savings of up to 18% can be reliably achieved. Analysis of the use of local hubs showed that the optimised truck delivery jobs can take advantage of nearby producers to pick up multiple delivery jobs on the way to the hub. This has the benefit of increasing truck utilisation at the same time as reducing road miles and, hence, emissions. Analysis of delivery jobs using an optimisation algorithm to route trucks to collect goods together and bring them to a local hub for groupage and onward transport showed that utilisation improves significantly. The greater the utilization achieved, the greater the efficiency and emissions benefits achieved.

"We are looking to expand the business products both chilled and frozen, probably requiring more logistics (capacity, options and choice) in future."
Food and drink producer

The results of the HiPlan pilot show that producers and providers can benefit significantly from the use of an open logistics platform. Without coordination, the current situation of poorly utilised trucks, sometimes running empty, and missed opportunities for groupage and low utilisation delivery jobs for logistics suppliers is observed. This is reflected in the current real-world situation where there is a sub-optimal relationship between the delivery requirements of producers and the need for logistics providers to operate profitably.

With increasing coordination and collaboration based on full information, it is possible to meet the delivery requirements and deadlines of food and drink businesses and at the same time organize movements into high-utilisation truckloads that would be profitable to handle.

The measured benefits show that the proposed open logistics platform would generate a wide range of benefits:

- Economic: facilitating sustainable growth and regeneration by increasing competitiveness of local businesses, improving supply chain efficiency, reducing waste and missed trading opportunities, informing future investments in a more cohesive and integrated supply chain infrastructure, and improving competitiveness of the supply network.
- Environmental: the open logistics platform would improve efficiencies of movement and reduce pollution as well as less disruption and congestion, accidents and stress, enhancing the quality of the natural environment and the attractiveness of the area and its provenance.

- Community: sustaining local communities and service provision while improving connectivity and confidence also reducing uncertainty. The open logistics platform would create opportunities for local community cooperation to be formalised and scaled up.

Local analysis shows significant potential for increased truck utilisation using an open logistics platform supported by AI to route and group goods movements. Results show a majority of delivery jobs with over 50% utilisation, with the mode figure around 70%.

The next phase of the project will look to secure support and engagement to expand the scope of modelling across the Highland region, gathering feedback from companies and stakeholders as well as attracting additional partners to the project team, and providing a regional solution, that may well be applicable to other regions also.

"High cost of delivery especially for frozen goods has required us to restrict where we offer our products for sale."
Food and drink producer

4 Introduction

This document is a concluding report on a pilot study into Food and Drink Logistics provision in the Highland region. The document has eight further sections as follows:

- Section 5 provides the background and context for the study, the challenges being addressed. It sets out the project rationale, innovation focus and overall study aim.
- Section 6 describes the participants of the study and methodology for gathering data. Section 7 then describes how the data was modelled to generate realistic food and drink logistics data by taking into account time and volume variations, as well as handling constraints collected from the participants.
- Sections 8 and 9 describe how end-to-end and local delivery jobs were analysed using optimisation algorithms to estimate the possible benefits to be gained by producers and providers from an open logistics platform. Project wider benefits and barriers are then summarised.
- Section 10 contains conclusions, followed by recommendations in Section 11.
- Additional appendices provide a glossary of terms and outline the data analysis method used.

5 Background, Context and Challenges to be addressed

The aims of this pilot project are to prove the concept of a data-driven **open logistics platform** to address key logistics-related issues in the Highlands by: boosting order fulfilment, reducing time to market, lowering distribution costs, improving sourcing and maximising load efficiencies, and building supply chain resilience. The pilot project gathers and uses data from businesses to investigate the potential of an open logistics platform for food producers and logistics providers, creating a basis to build and deploy a variety of Web applications and AI designed to match supply and demand as business requirements change.

The creation of an open logistics platform presents a formidable innovation challenge. Traditional logistics systems rely on fixed routes, with very few or single providers and typically AI is only available to large companies with their own fleets. An open logistics platform will need to adapt vehicle routing and delivery groupage to fit varying demand from producers, coordinating across multiple providers.

Most of the food and drink companies in the Highlands are small and the open logistics platform will need to offer low technical barriers to access. Businesses in the Highlands are looking for improvement and so there is a unique opportunity to develop a world-leading smart open logistics platform. This could have the potential to transform business models and provide new market opportunities for producers and providers alike. It could also have application to a wider area and other territories facing similar challenges.

> *"Biggest logistics challenges / inefficiencies are the spread of local customers, and small volumes being sent. We would like to expand our business and explore how we get our product to customers rather that deliver ourselves."*
>
> *Food and drink producer*

The pilot study focuses on Food & Drink companies. This is recognised as a key sector for the economy where an open logistics platform could assist in speeding-up economic recovery, increase efficiencies, assist companies to explore new markets and operate nimbly post COVID-19. It will also bring benefits to logistics companies, increasing volumes and the ability to identify specialized market opportunities.

The open logistics platform has many wider benefits and will utilise and highlight the value of data in future-proofing economic activity, helping improve resilience in the face of new challenges and transitioning towards a low carbon economy.

This is an innovative dynamic partnership between business and academia. The pilot project partners are: Highlands & Islands Enterprise, The DataLab, Robert Gordon University, Celerum Limited and Rural Matters LLP, who currently operate the Highland Food and Drink Innovation Network. Other stakeholders include companies providing data and business and sector support bodies including Chambers of Commerce.

For the first time in the Highlands, data was gathered from company surveys to build a realistic model of food and drink logistics – including typical types of transport fleet used, volumes of goods to be moved/brought in, destinations, distribution locations, and constraints. AI was used in simlulation to explore how the business goals of all project participants could benefit from information sharing and cooperation. This fused the outcomes in line with partner specific objectives, identifying the benefits in application to a real world setting of recovery from COVID-19.

The project has been innovative in the way that it has progressed as a strong, active partnership with a roadmap for future phases of development where the partners will be

able to track progress and data usage as well as telling the story of outcomes and impact from this data based industry driven collaboration project.

5.1 Challenges

Logistics has been a recurrent topic for food and drink businesses in the Highlands for decades. The geography and spread of businesses, with many small and micro enterprises generating limited volumes often with pronounced seasonality factors, has created a challenging context for logistics and developing a shared view of distribution as a key part of the industry supply chain.

From the launch of the Highland Food and Drink Innovation Network (HFDIN – the Network) in late 2019, various business consultations and workshops with food and drink companies across the Highland region have consistently raised logistics as a key issue in terms of fulfilling orders from customers, achieving goods distribution on time and at a lower cost and, to a lesser extent, in terms of sourcing supplies and raw materials.

The network has also showed good engagement from a number of logistics companies trying to work across a very wide and dispersed geography in terms of deliveries and pick-ups, and a number of local logistics solutions particularly for smaller producers supplying to the food service industry nearby such as Skye Food Link CIC.

This company engagement confirmed logistics as a major factor for business efficiency and growth. Logistics remains one of the main issues for F&D companies, and the pilot project scope aims to be a first step in tackling some of the issues experienced. It also fits with the Network commitment to help the sector and individual food and drink companies in the Highlands achieve greater scale and economic impact; take on new technologies and innovations to improve their productivity; to reach and grow new markets; and, to address the issues constraining the growth of the sector.

Addressing the topic and applying new technological and data led solutions was seen as a way to assist F&D companies to achieve greater scale and economic impact through the adaptation of new technologies and innovations through HFDIN.

The project solution aimed to be of real value to logistics companies. The outputs should be able to demonstrate that better utilisation of logistics loads or jobs would bring about better flexibility and a wider scope of ability amongst logistics and distribution service providers. And therefore, bring about business benefit to the companies, and wider economic benefit to the Highlands.

"Would be great to see Skye Food Link service extend to year round, and extend reach to 2-3-hour radius - and supply to both food service and community points. Ideal if the logistics pilot can help over time to extend the season and provide choices to operate all year round"

Food and drink producer

Greater understanding of mutual industry needs for sustainability and growth will also improve collaboration and uptake of new technological and data driven innovations to assist future business growth for F&D and Logistics companies. In short, the pilot investigated and tested an approach which demonstrates the potential of practical benefits from a smart open logistics platform to both F&D companies and logistic companies.

"Cost for inbound deliveries is often very high. Outbound, sometimes they don't pick up and there is a lack of information on website and customer communication."
Food and drink producer

6 Methodology and Participants

The Highlands covers a vast geographical area with a largely dispersed population across many small settlements, several regional centres and one principal city, Inverness. The pilot chose two areas to focus on and test the project concept. These areas were Inverness and Moray Firth, and Isle of Skye.

The Highland Food and Drink Innovation Network engaged with businesses in each area. Figure 1. shows the companies recuited and their locations.

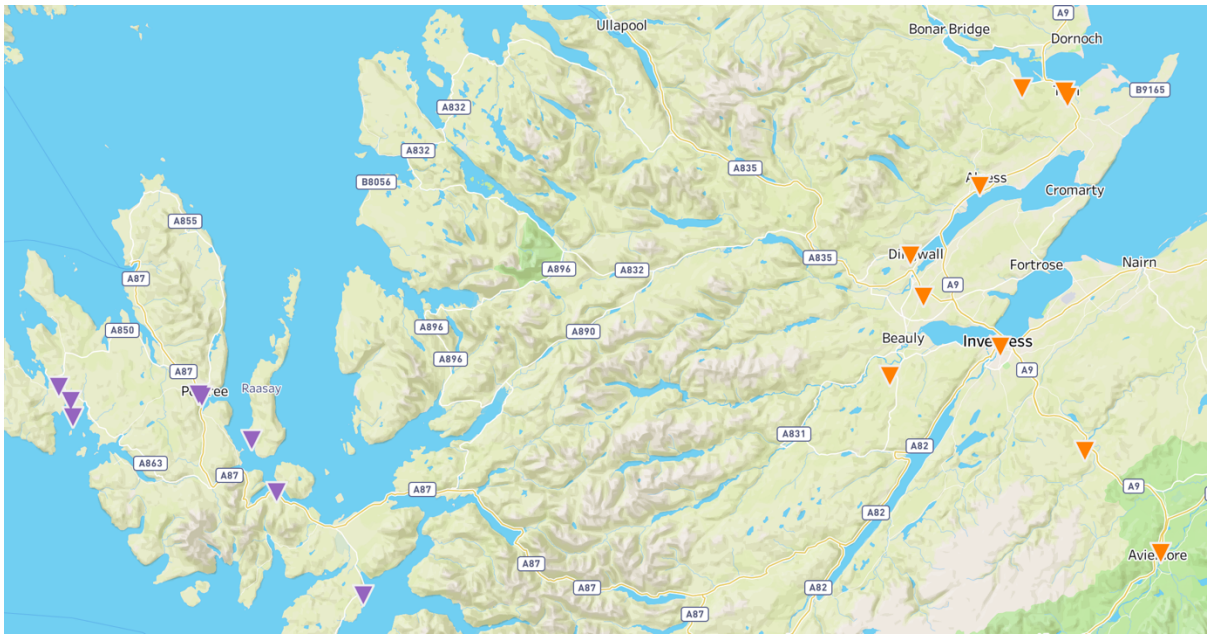


Figure 1. Participating producers and their locations

On the Isle of Skye, sixteen Food and Drink companies were approached for participation in the Pilot and eight companies became involved by completing the survey Questionnaires (50% return). Of the main logistics companies serving Skye regularly, four were approached, and two completed Questionnaires returned (50%).

In the Inverness Moray Firth area, twenty-one Food and Drink companies were approached and ten completed survey responses were received (48% return).
Eight Logistics companies were approached and six completed survey responses were received (75% return). A number of prominent service providers did not respond to multiple approaches and liaison with trade representative bodies including the Road Hauliers Association and Inverness Chamber of Commerce. Other companies provided insightful comments but declined to complete the survey questionnaire.

"Running a business is very challenging in the Highlands, trained staff are expensive and we don't have the 'white van man' sub-contractor culture that exists in other parts of Scotland. The fact that there are 10 or 20 times as many deliveries as there are collections makes the business model very different from elsewhere."

Logistics provider

6.1 Company Insights on Challenges

Some of the F&D companies who did not complete the survey were able to provide comments and insights on their logistics challenges including:

- Companies use a range of parcel service providers including DHL, Royal Mail, Parcelforce and other service providers including Menzies, Skye Express and use of online sites such as Parcel Monkey;
- Growing companies forecast significant additional logistics needs in further years; for example, there are a small number of the Skye companies with aspirations to grow and serve wider Scottish, UK and export markets;
- Delays and high costs are common with inbound supplies such as packaging and breakages are common for outbound, especially bottled products;
- Chilled and Frozen goods delivery services has been a real challenge for a number of smaller businesses;
- Increase in B2C and online sales sees logistics as becoming increasingly important;
- Many customers' pick-up from companies especially in the busy summer months;
- Increase in enquiries about next day delivery which is challenging for companies;
- While many companies are satisfied with the general services overall there is a perception of lack of choice and lack of connection/information from larger logistics companies. This is seen as a barrier to relationship building and having a shared understanding that could improve business for all companies.

Logistics companies also highlighted their challenges and comments:

- January to March is usually quiet with excess capacity - business picks up from April onwards;
- Several companies have been involved in previous initiatives to develop a shared information platform with public sector support but this was not taken forward and Logistics & Distribution is not regarded as a priority sector for support despite being vital to the supply chain and the functioning of businesses in the Highlands;

- Highland companies have invested before and not received the volume and regularity of business to sustain the investment and services on offer to F&D;
- The sector has low barriers to entry and gross margins are low for most companies;
- There is interest in future phases of the project including mapping who does what across the Highlands, where they service, how frequently and the collaborations existing and potential to coordinate business loads, despatch days and delivery options;
- The Highlands has great products and provenance to sell more and reach wider markets. This will require collaboration including by transport and logistics companies looking at co-investment models and ways of sharing knowledge;
- Any system must recognise the costs of servicing the Highlands to reflect the market, volumes, demand levels and distances involved, and identify the real gains for logistics businesses, immediate and long term;
- Forms of sub-contracting and collaboration exist but more sharing of information could improve opportunities if it can be shown not to disrupt existing relationships that work well;
- Collaboration and coordination to create back load opportunities is key as most delivery trucks return empty and there is over capacity for many months of the year;
- Recognise the difficulties for F&D companies and their need for quality handling however customer expectations must be aligned with the cost of service, quality requiring investment in logistics IT, fleet, cross subsidised routes and training of drivers/handling systems;
- Next day delivery has increasingly driven operations and expectations. This has altered the economics for parcel deliveries and with pallet networks being coordinated through a single centre leading to less “groupage” going around.

“At the moment, our needs are met adequately with issues sometimes but an increase in production and company growth would require a better logistics solution.”
Food and drink producer

7 Data Analysis and Modelling

The data gathered was used to model the daily demand for outbound and inbound logistics movements, of different sizes and with different handling constraints. One year’s worth of synthetic data was generated, based on the frequencies of different size goods and handling requirements, giving a set of daily delivery jobs to be done in each of the study areas. The data generation procedure is detailed in Appendix II.

This provided a robust data set incorporating daily and seasonal variation that gives a realistic sample of the logistics needs of the participating producers. While this data is not historical actual data, it has the frequencies, volumes and type of deliveries reported by the participating producers and so provides an acceptable base set of data on which to assess the logistics problem. This simulates information that would be available to an open logistics platform.

"Vans running back empty is a major challenge. There must be opportunities for companies to collaborate and share information on logistics to make everything more efficient and economic."

Logistics provider

Figure 2. shows the distribution of this data over the participating companies[1]. The figure shows a skewed distribution with a small number of companies accounting for around half the delivery jobs along with a large tail of companies with much smaller logistic needs.

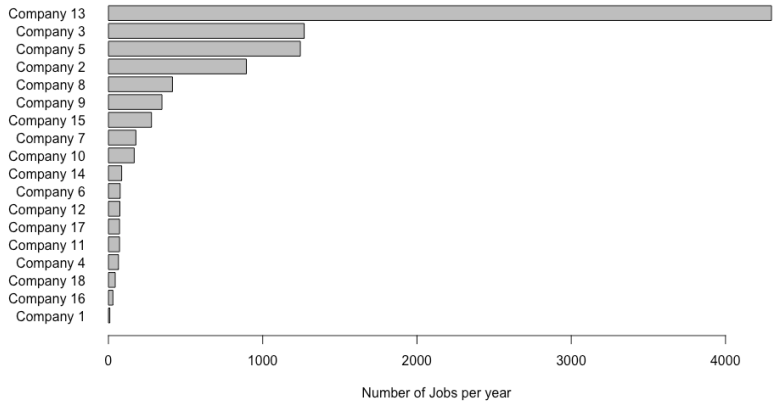


Figure 2. Number of synthetic delivery jobs over a year, distributed by producer.

Figure 3. shows the distribution of the same delivery jobs by handling requirement. The distribution is far less skewed, suggesting that there is scope to combine delivery jobs across multiple companies to maximise utilisation of vehicles. Of particular note is the dominant requirement for chilled or frozen goods transportation, which requires specialized and more expensive vehicles. Availability of refrigerated logistics has been highlighted by the Network members as a significant issue for their businesses.

"Always much more to deliver than to collect for all companies so lots of capacity to go south which gives Highland companies excellent rates to deliver outwith the region. This imbalance makes fleet and resource planning a challenge as deliveries go up and up every year and less B2B deliveries and more B2C deliveries which cost more money to do and take far longer."

Logistics provider

[1] Producers have been anonymized to protect confidentiality

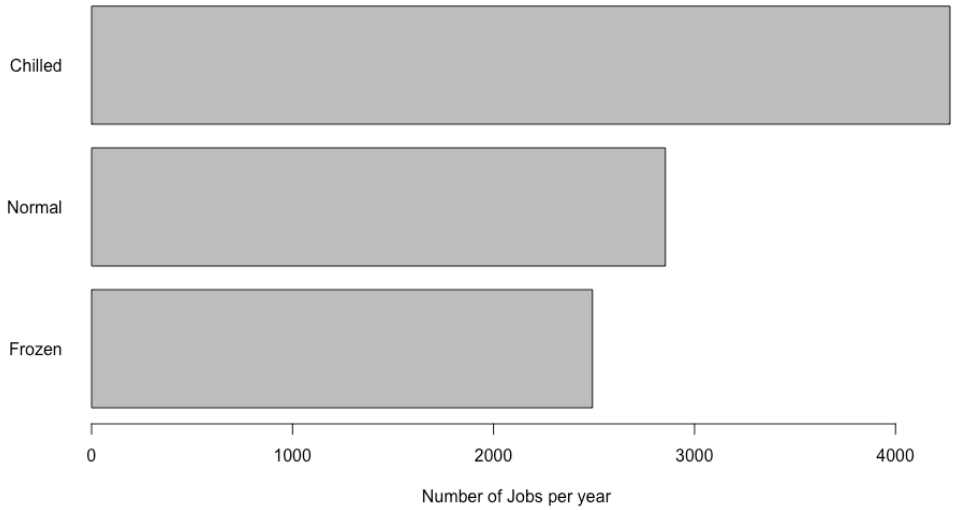


Figure 3. Number of simulated delivery jobs over a year, distributed by handling requirement.

Figure 4. shows how jobs arise during the year, using information on seasonality provided by participating companies. The data show a marked seasonal variation for the dominant categories of chilled and frozen goods with very low numbers of jobs in January and February as well as a lull in November before the Christmas rush. This is consistent with comments from logistics providers who find the low volumes in the early part of the year difficult to service profitably.

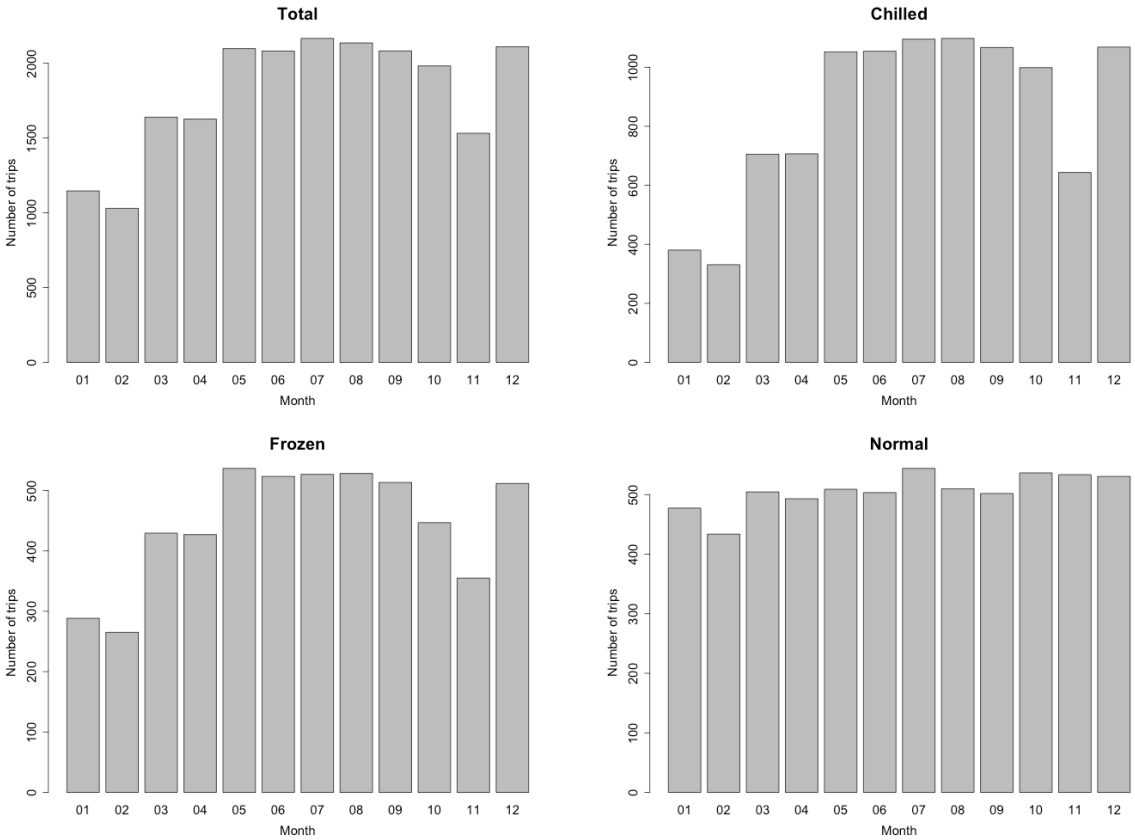


Figure 4. Seasonal variation in delivery jobs over a year, analysed by handling requirement.

As it stands, the dataset is limited to the companies who participated. However, the model was used to synthetically generate further delivery jobs representing additional producers in the Network database. This was achieved by matching size and type of non-participating companies to that of participating companies and then applying the data model to generate synthetic delivery jobs for non-participating companies using the same data. The aim of this was to extrapolate the model sufficiently to obtain a realistic set of delivery jobs with which to explore the potential for efficiency gains. The extrapolated data set contains delivery jobs for thirty-one producers in the Network database, eighteen participants and thirteen non-participants.

> *"One of the biggest challenges is over capacity in the off-season (November – February)."*
> *Logistics provider*

8 End-to-End Delivery job Analysis

The purpose of this analysis is to explore the potential for groupage of delivery jobs from a particular local area with the same destination. A simple optimisation process was applied to group delivery jobs. The optimiser is only allowed to combine delivery jobs that have the same handling requirement (Normal/Chilled/Frozen).

Example: on a given day, the delivery job generator produces the example in Figure 5. Here, six companies wish to move goods to Inverness. The optimiser groups them into 3 different delivery jobs. The first one for instance, starts with a pick up at Company 1 then travels to Company 3, then Company 5, before finally delivering in Inverness. Figure 6. Illustrates the reduction in delivery jobs after the optimiser is used to combine delivery jobs.

Date	Start	End	Job_id
03/01/2020	Company 1	Inverness	1
03/01/2020	Company 2	Inverness	2
03/01/2020	Company 3	Inverness	3
03/01/2020	Company 4	Inverness	4
03/01/2020	Company 5	Inverness	5
03/01/2020	Company 6	Inverness	6

Date	Start	End	Job_id
03/01/2020	Company 1	Company 3	1
03/01/2020	Company 3	Company 5	1
03/01/2020	Company 5	Inverness	1
03/01/2020	Company 2	Inverness	2
03/01/2020	Company 6	Company 4	3
03/01/2020	Company 4	Inverness	3

Figure 5. A list of synthetic delivery jobs generated for 3rd January

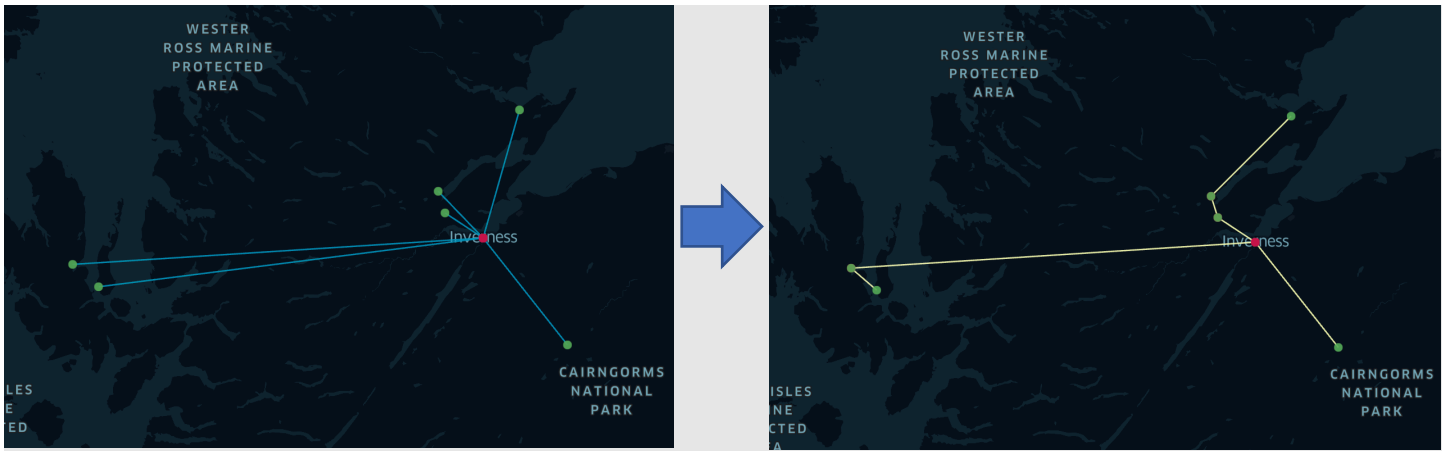


Figure 6. delivery jobs with similar sources are grouped by destination to reduce the number of delivery jobs required.

The road time savings obtainable were modelled in this way across the thirty-one producers considered in the study. In order to explore volume effects, the number of producers was varied from seventeen (the number of participants) up to thirty-one. In this way the relationship between the number of producers pooling their logistics requirements and the the road time savings can be explored. Figure 7. shows the median percentage road time saved by this simple optimisation approach for different numbers of producers in the pool. Each randomised experiment was run 100 times.

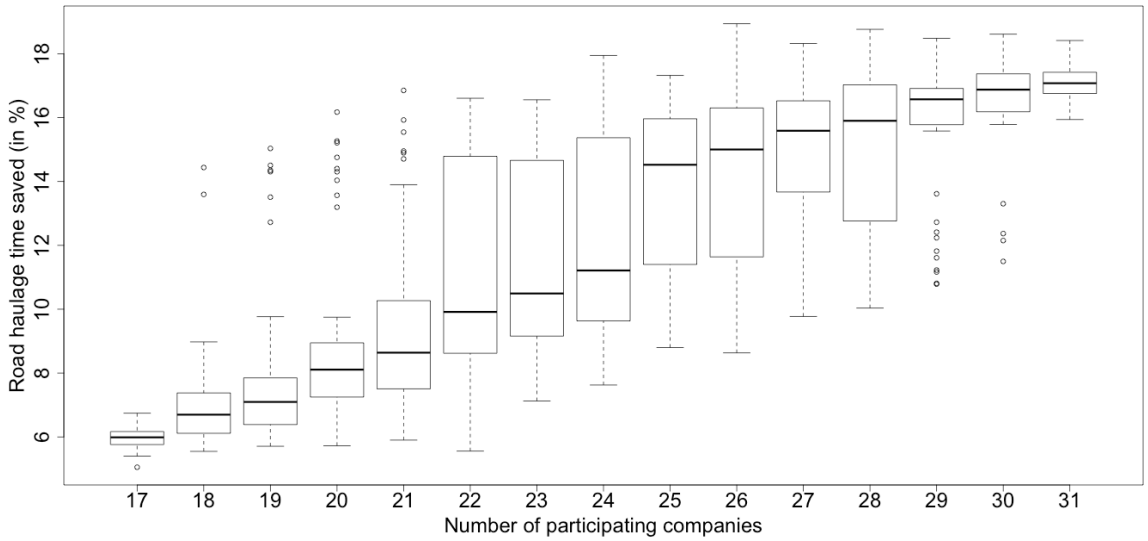


Figure 7. range of road time % saved by number of producers simulated

The experiments show that, when the number of producers is too low, end-to-end road time savings are very modest, at around 6%. However, with a sufficiently high number of producers, road time savings of up to 18% can be reliably achieved. In between these limits, the savings achieved are variable and depend upon which particular producers have goods to be transported on particular days.

The analysis suggests that, with sufficient participating companies, road time savings through groupage of loads from nearby sources can be reliably achieved through pooling of logistics demand. This would result in reduced haulage costs, higher utilisation and reduced environmental impact from freight transport, benefitting producers, providers and the environment.

"We occasionally have return loads, but mostly we deliver goods on set routes and return empty. Chilled fresh carcase meat requires exclusivity; boneless boxed meat does not."
Food and drink producer

9 Local Hub Consolidation Analysis

Using the delivery jobs created from the thirty-one producers, the relationship between local grouping of loads and improved vehicle utilisation for providers, while maintaining the handling and timing requirements of producers, was explored. The data was split into two regions: Skye and Moray Firth. For each region, it is assumed that goods are to be consolidated at a local hub before transport to a final destination. For Skye, the hub is assumed to be at Kyle of Lochalsh. For Moray Firth the hub is assumed to be at Inverness.

An optimisation algorithm was used to efficiently route vehicles to optimise utilisation and ran the optimisation over the year's simulated data for the thirty-one producers. As before, all constraints about handling are observed and truck capacity for parcels, pallets and other is as listed in the appendix. The algorithm used truck types operated by the six logistics service providers who participated in the study. Figure 8 shows a snapshot of the truck delivery jobs planned by the algorithm in Skye for one particular day. Figure 9 shows a snapshot of the truck delivery jobs planned by the algorithm in Moray Firth for one particular day.

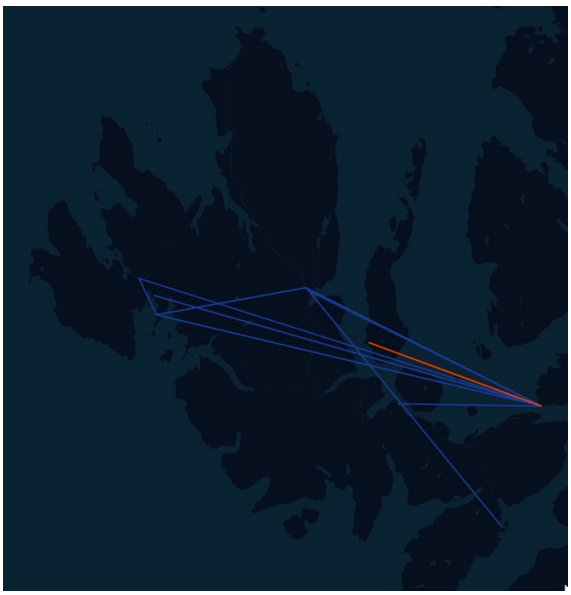


Figure 8. optimised truck delivery jobs on Skye

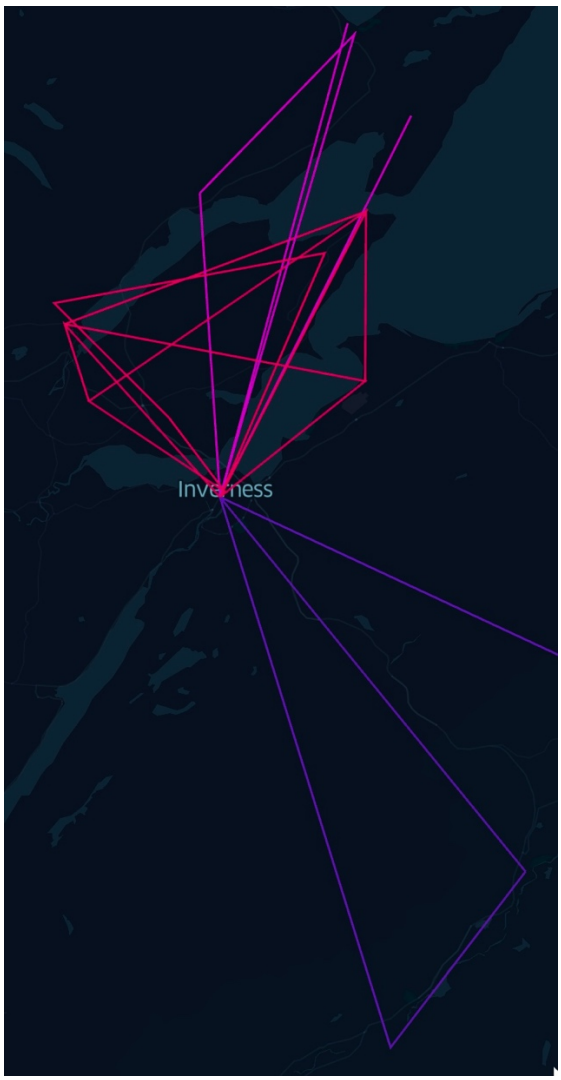


Figure 9. Optimised truck delivery jobs in Moray Firth

The figures show that the optimised truck delivery jobs can take advantage of nearby producers to pick up multiple delivery jobs on the way to the hub. This has the benefits of increasing truck utilisation at the same time as reducing road time and, hence, emissions. Utilisation statistics were aggregated across a whole year to analyse the overall effect of collaboration on utilisation. In the analysis that follows, each chart is derived from the same set of synthetic delivery jobs, but with different levels of coordination and optimisation.

On problems encountered and severity/impact: *"Ideally to get year round local logistics provision, and regionally more next day delivery options. We have plans to develop other packaged products and online over coming year but also ideally would build product offering to food service across the region so better next day delivery options for Highland region including to hotels and restaurants would be important."*

Food and drink producer

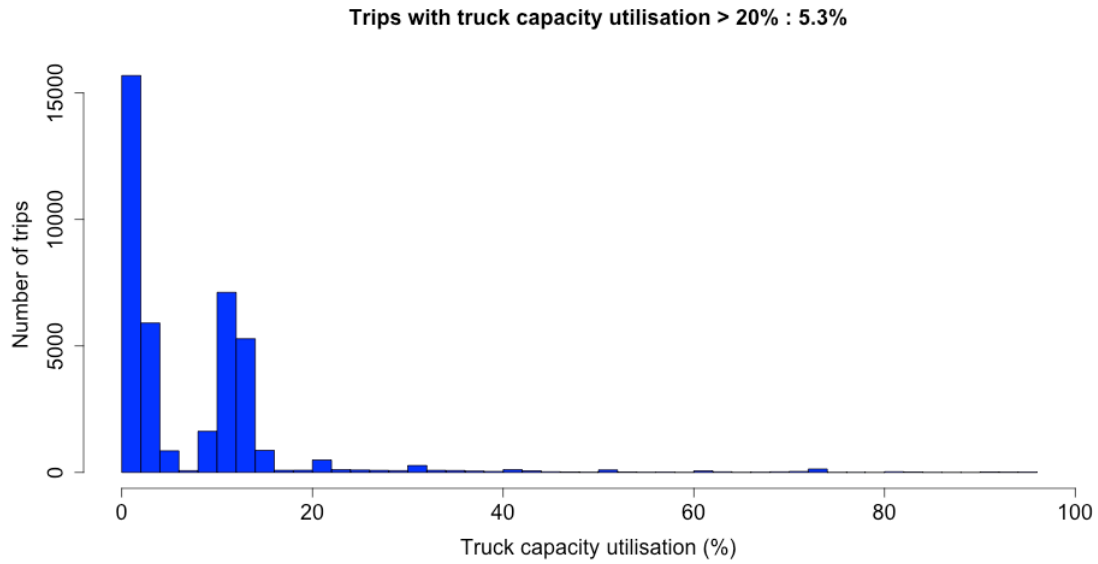


Figure 10: Distribution of % truck utilisation across all delivery jobs without coordination

Figure 10. represents the uncoordinated base case. There are many thousands of small parcels and a large but lesser number of pallets. Very few of these delivery jobs would represent significant utilisation of a truck. Only 5% of the jobs represent over 20% utilization of a truck. Without an open logistics platform capable of matching supply to demand, producers and providers need to communicate pairwise. The onus is on providers to try to group loads from customers they know about. At present, while some level of ad

hoc cooperation exists,producers struggle to get their goods to market and providers struggle to create full trucks, particularly in January and February.

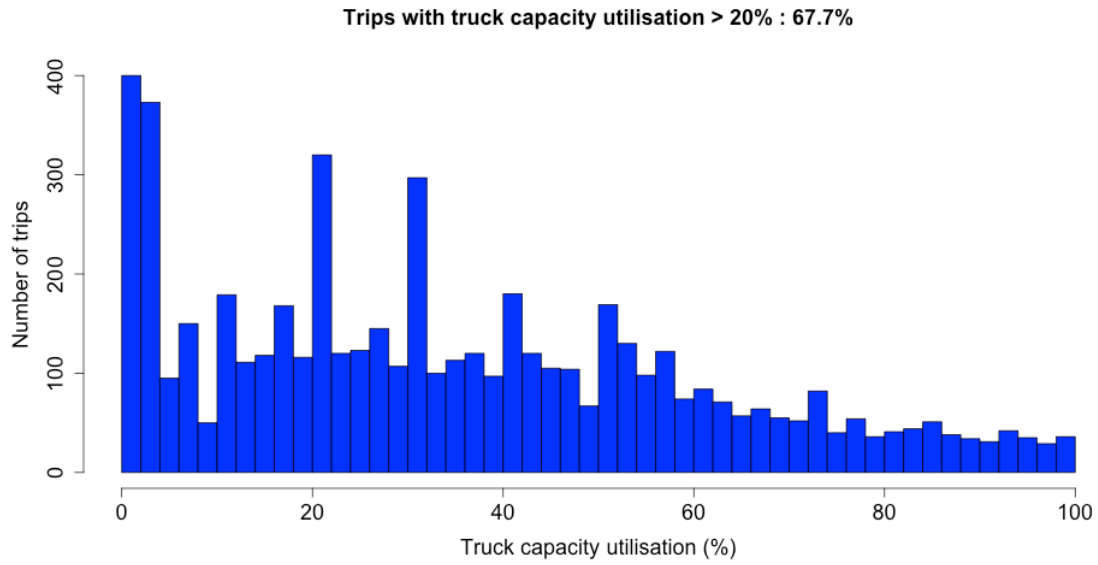


Figure 11: Coordination through an open logistics platform using optimisation algorithms

Figure 11. represents the utilisation achievable for the same set of delivery jobs by using an optimisation algorithm to route trucks to collect goods together and bring them to a local hub for groupage and onward transport. A key assumption is that all producer information is available on an open logistics platform so that optimised delivery jobs can be constructed for providers. To simulate this, synthetic delivery jobs were generated to move loads to local hubs at Inverness and Kyle of Lochalsh. An optimisation algorithm was used to combine loads to increase utilisation, while at the same time respecting constraints about the type of goods that can be moved together. The results show that now 68% of delivery jobs exceed 20% utilisation but there remains a proportion of low-utilisation delivery jobs.

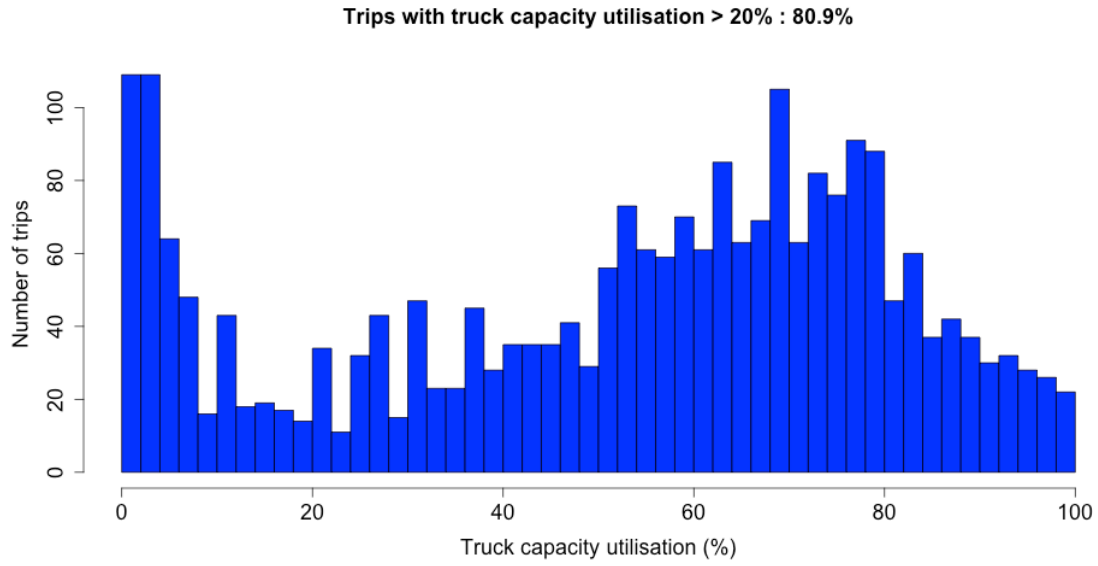


Figure 12. Coordination through an open logistics platform using optimisation algorithms and collaboration on delivery times

Figure 12 shows the same set of delivery jobs, again using optimised local collection but assuming that, through collaboration between producers and logistics providers, delivery jobs can be organised to occur on two days in a week. Delivery jobs generated on Monday or Tuesday are grouped on one day and delivery jobs scheduled on Wednesday to Friday are grouped on another day. This is achievable and results in significantly higher utilisation. Now 81% of delivery jobs exceed 20% utilisation and a clear majority exceed 60% utilisation.

"Our vans return empty. There is so much capacity to do more in the Highlands – if we could find return loads."
Logistics provider

The results show that producers and providers can benefit significantly from the use of an open logistics platform. Without coordination, the current situation of poorly utilised trucks, sometimes running empty, and missed opportunities for groupage resulting in low utilisation delivery jobs for logistics suppliers can be observed. This is reflected in the current real-world situation where there is a high tension between the delivery requirements of producers and the need for providers to operate profitably. With increasing coordination and collaboration based on full information, it is possible to meet the delivery requirements and deadlines of food and drink companies and at the same time organize movements into high-utilisation truckloads that would be profitable to handle.

9.1 Economic, Environmental and Community Benefits

The distribution and delivery needs of businesses and the wider economy are a vital part of everyday life as brought into focus during the pandemic. Improving the efficiency of such services can improve performance and wealth creation as well as contributing a range of other wider benefits such as environmental, quality of life and health and community connections and confidence.

Delivery vehicles continue to provide essential services particularly to the more remote rural areas such as the Highlands. Reducing pollution and inefficiencies of excess road miles often with vehicles returning empty is a major challenge in the transition to a Net Zero carbon agenda that delivers much less environmental, ecological and social disruption yet facilitates Green Growth and sustainability.

The pilot logistics project has demonstrated the value of collaboration and innovation in a real practical way to businesses and communities. In terms of environmental benefits, this could be seen in a number of forms notably with optimisation of delivery jobs to reduce significantly the numbers of goods vehicles travelling on the roads to, from, and within the Highlands, the number of miles they cover, and the resulting impacts in terms of congestion, disruption, and pollution. The means of achieving this are through communication, co-operation and co-ordination between the various companies to ensure that there is a balance and synergy of benefits to businesses, communities, the economy and the environment.

The results are encouraging and show what can be achieved in terms of real benefits and mutual value generation across all parties. This includes re-focusing capacity and informing future investment decision making as well as alignment with major strategic infrastructure investments such as the projects from the Inverness and Highland City-Region Deal.

Examples from other countries in Europe, particularly Germany, show how projects have been set up that are mutually beneficial to all parties in the industry-logistics supply chain and produce benefits that encourage involvement by companies across sectors. The pilot has shown the real benefits that can be produced in the Highlands through a knowledge sharing platform with open communication, co-operation and co-ordination between all parties in the Food & Drink logistics chain. The benefits show that the proposed open logistics platform can assist local sustainable distribution strategies addressing a wide range of issues in terms of:

> *"Limited number of pick up days per week - only Wednesday and Friday but we are delivering fresh stock with key dates to hit."*
>
> *Food and drink producer*

- Economic: facilitating sustainable growth and regeneration by increasing competitiveness of local businesses, improving supply chain efficiency, reducing waste and missed trading opportunities, and informing future investments in a more cohesive and integrated supply chain infrastructure. It can also prompt further innovation and enterprising behaviour, cross sector collaboration and knowledge sharing to create new market opportunities, increased income and profitability potential by unlocking growth, ambition and aspiration. The open logistics platform will improve competitiveness and generate oter positive benefits including partnership working, industry stakeholder engagement, positive profiling of the area and business community emphasising the leadership and new opportunities on provenance and quality. Future phases could also attract funding and investment into the area.
- Environmental: the Highlands is a beautiful area to live in, work and visit, which offers a high quality natural environment. The open logistics platform would enhance this further by improving efficiencies of movement and reducing pollution as well as less disruption and congestion, accidents and stress.
- Community: sustaining local communities and service provision while improving connectivity and confidence. The open logistics platform could also reduce uncertainty, disturbance from vehicles, improve road and driving safety, and enable efficient and timely access to goods and services. The open logistics platform would create opportunities for local community cooperation to be formalised and scaled up within the network and linked with other Highland wide initiatives including, for example, some of the recentHighland Good Food Conversation project proposals.

9.2 Barriers

The range of benefits and potential value add is considerable however there are a number of barriers to be overcome in moving forward. These include:

- Gaining significant and on-going involvement from companies, food producers and logistics providers, to generate the benefits shown;
- The open logistics platform has to be easy to use with minimal investment in technology and training and needs to be transparent in how it operates;
- An operator is required to manage, promote and facilitate use of the open logistics platform;
- The open logistics platform needs to offer the range of clear benefits to producers and providers alike;
- Further research and development work is needed to create the open logistics platform. There is no individual market participant willing or capable of the investment required to support this next phase without funding assistance from other sources.

None of these barriers are insurmountable. The pilot study has shown the value of the proposed open logistics platform and produced evidence to share with others and generate the wider interest and engagement for a future phase of work by the team. Other areas face similar challenges and there is potential to develop the open logistics platform across the Highlands and Islands, other rural areas in Scotland and beyond. This could introduce additional sources of support and scale up the project more quickly.

> *"Moving frozen produce any distance, we have to do it ourselves and end up turning down a lot of potential customers as we can`t get it to them frequently enough or the transport costs are too high."*
> *Food and drink producer*

10 Conclusion

This pilot has shown that an innovative open logistics platform for the Food & Drink supply chain can deliver real tangible economic and wider benefits, increasing the competitiveness, resilience and quality of life in the area without impairing the variety of existing functions and sustainability of the business economy.

By using an open logistics platform to match food and drink logistics supply and demand it is possible to create high-utilisation logistics routes while meeting the full requirements of Highland food and drink companies in both of the sub-regions considered in this pilot project. Moreover, there are opportunities to coordinate long-haul movements to national and international hubs.

Long haul analysis suggests that, with sufficient companies involved, 16% efficiency saving on delivery jobs can be reliably achieved through groupage and optimised routing. Routing optimisations suggest combining Skye and Moray Firth movements at a common Inverness hub, albeit this is based on incomplete and some extrapolated data.

Local analysis shows significant potential for increased truck utilisation using an open logistics platform supported by AI to route and group goods movements. Results show a majority of delivery jobs over 50% utilisation with the largest number around 70%.

The study has been successful in showing how an innovative approach could produce additional benefits and positive impacts for business, the economy and communities.

> *"We had new stock control software installed in the last few years and we are always looking for improvements and possibly upgrades."*
> *Food and drink producer*

11 Recommendations

A series of recommendations are proposed. These are listed below and provide a routemap for maintaining momentum from the pilot and moving forward to the next phase. In moving forward, it will be important to re-engage with study participants as well as reach out to others, especially companies, who did not participate in the pilot.

1. **Disseminate results to pilot project participants for study and feedback**
2. **Disseminate to the wider Highland stakeholder communities**

- Other producers and providers, particularly key producers and providers who did not participate in the pilot stage;
- Trade organisations and representative bodies;
- Relevant agencies and stakeholder organisations including potentially area and community initiatives.

The first two recommendations will involve online meetings with a presentation of findings and facilitated discussion by the project team in the Spring of 2021.

3. **Build a consortium of parties interested in developing the open logistics platform.**

   This is already underway as part of the project team collaboration. The outcome of the pilot study can now be used to continue and extend discussions beyond the existing partners, including potential funders for work of developing the open logistics platform.

4. **Project next steps to define and develop a functioning open logistics platform**

   - Confirm the Scope
     - Highlands (and Islands)
   - Timescale and Budget
     - To be confirmed when activities are fully specified and consortium membership is clear
   - Activities
     - Development of use cases
     - Software platform development
     - Algorithm development
     - Business model development - how the open logistics platform will operate, and the promotion and management
   - Dissemination and recruitment of participants
     - Likely to be continuous through the project and involve significant effort based on pilot-study experience

These recommendations all flow from the study evidence and can be implemented from March 2021 on formal conclusion of this phase 1 pilot project.

"Looking to the future, we can look into different transporters; some have online systems where we can track orders that are shipping. Improvements? Writing better software for pallet/ container builds. Moving stock to a European warehouse could be helpful."

Food and drink producer

12 APPENDIX I: Glossary of Terms

constraint	A rule which must be observed for any delivery job solution. For example, chilled goods cannot be transported in the same vehicle as frozen goods.
data generation	A process that uses a probability model to generate synthetic data, for example a set of delivery jobs in a particular week. Usually this involves a computer algorithm that will use random numbers to generate data items with the required statistical properties.
distribution	The frequencies with which data attributes take certain values, for example the frequency with which delivery jobs involve frozen goods.
groupage	Combination by a provider of delivery jobs from more than one producer on the same vehicle. This increases utilization of the vehicle, allowing more profitable delivery jobs and may reduce costs to individual producers.
open logistics platform	A portal-style web application where participating food and drink producers and logistics service providers can coordinate supply and demand for logistics services through mutually agreed procedures. Artificial Intelligence algorithms will propose groupage and routing solutions to users that promote business, community and enviromnetal benefits.
optimisation process / algorithm	A computational method to select a high quality solution from a set of possible solutions. For example an optimization process finds a way to group delivery jobs that minimizes the number of trucks required to carry out a set of delivery jobs.
skewed distribution	A skewed distribution is where a particular attribute of the data has an overwhelming predominance over the other. For example the distribution of delivery jobs is skewed toward a small number of larger companies.
synthetic data	Data that has been generated from a probability model to have the statistical properties of real data. Used when real data is not available but the probabilities are known or reported. For example a probability of 0.05 (1 in 20) could be used to determine particular days in a year when parcels are sent out from a company. For each day there is a 1 in 20 chance of the data containing such a parcel delivery job. Therefore each day contains the synthetic data of whether a parcel is to be delivered. Similarly destinations are generated using reported probabilities.
utilisation	The percentage of total vehicle capacity taken up by particular delivery jobs. For example, a half-full truck would have 50% utilization. An empty truck would have 0% utilization.

13 APPENDIX II: Data Modelling

Responses from the questionaires by the food and drink companies were used to simulate a typical year of inbound and outbound logistics requirements. In particular, modelling focused on:

- Source and destinations of logistics requirements along with the seasonality information provided.
- Special requirements, i.e. the type of transportation needed (normal, chilled or frozen)
- Volumes.

13.1 Source and destination frequencies

The responses provided have been converted to distributions, as follows.
Frequency inbound and outbound to all given destinations except for "International" and "Rest of the UK". For each company and each destination, based on their response to the frequency at which they send goods to this destination, a probability of job requirement for each specific day is assigned:

- "Daily" = 1
- "Weekly" = .2 (assuming 5 working days)
- "Monthly" = .05 (assuming 4 weeks in a month)
- "Rarely" = 0.005 (assuming once every 200 days)
- "Never", "In Future", and "" = 0

Producer	Destination	Frequency	probas
Company 1	Aberdeen	Monthly	0.05
Company 2	Aberdeen	Monthly	0.05
Company 3	Aberdeen	Weekly	0.2
Company 4	Aberdeen	Rarely	0.005
Company 5	Aberdeen	Rarely	0.005
Company 6	Aberdeen	Rarely	0.005
Company 7	Aberdeen	Weekly	0.2
Company 8	Aberdeen	Rarely	0.005
Company 9	Aberdeen	Rarely	0.005
Company 10	Aberdeen	Daily	1
Company 11	Edinburgh	Monthly	0.05
Company 12	Edinburgh	Weekly	0.2
Company 13	Edinburgh	Weekly	0.2
Company 14	Edinburgh	Rarely	0.005
Company 15	Edinburgh	Monthly	0.05
Company 16	Edinburgh	Monthly	0.05
Company 17	Edinburgh	Monthly	0.05
Company 18	Edinburgh	Rarely	0.005
Company 1	Edinburgh	Monthly	0.05
Company 2	Edinburgh	Rarely	0.005
Company 3	Edinburgh	Daily	1
Company 4	Edinburgh	Rarely	0.005

Figure A-1: Some participant responses

13.2 Special requirements

This work, is focussed only on the type of truck required for transportation, i.e. “Normal” (ambiant) “Chilled” and “Frozen”. The companies were required to inform the frequency for “Chilled” and “Frozen”. The responses were converted into probabilities as follows:

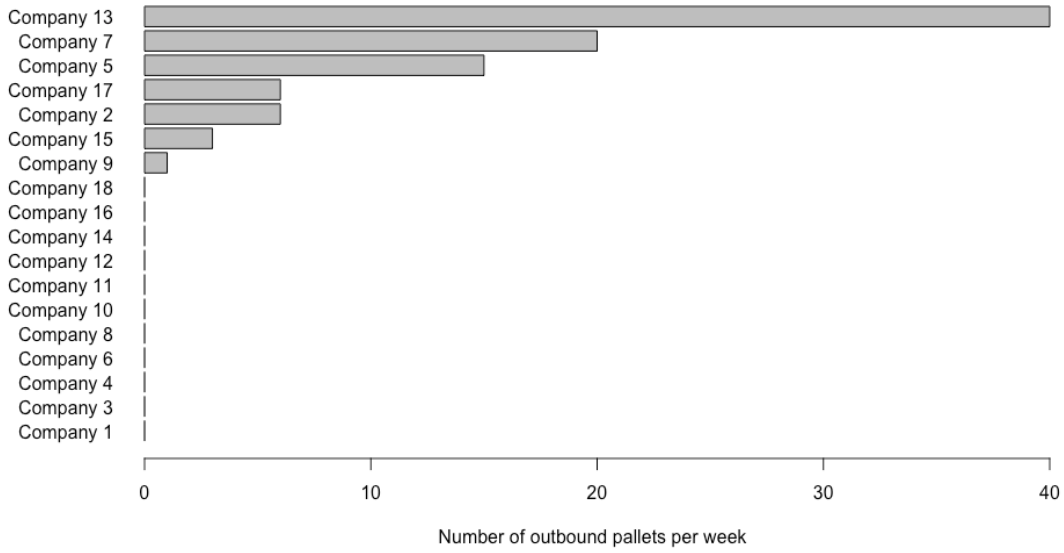
- “Never” : p(Chilled/Frozen) = 0
- “<25%” : p(Chilled/Frozen) = .25
- “25-50%” : p(Chilled/Frozen) = .5
- “51-75%” : p(Chilled/Frozen) = .75
- “76-100%” : p(Chilled/Frozen) = 1

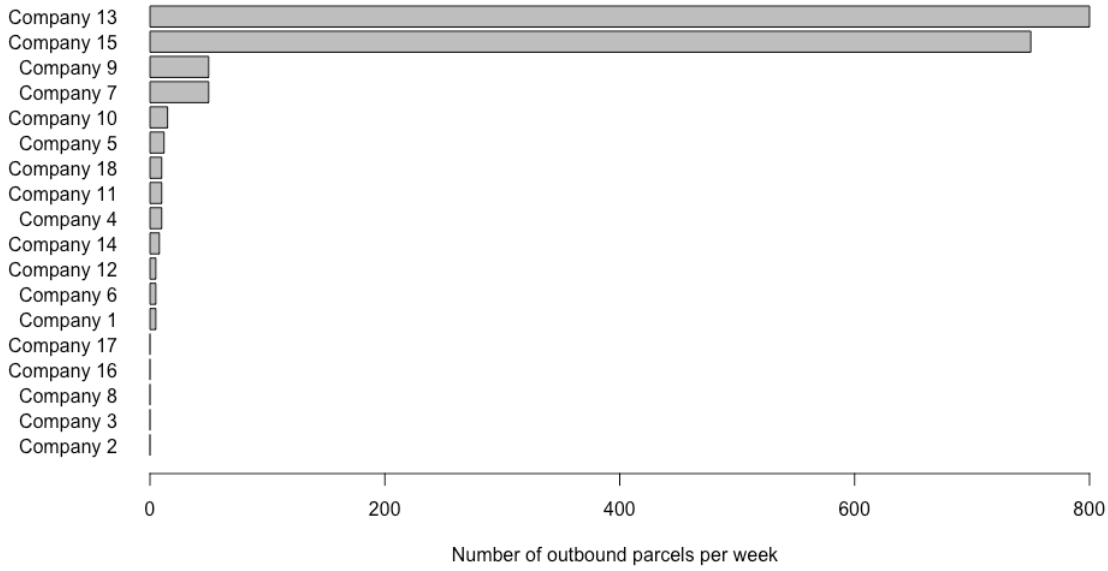
If p(Chilled)+p(Frozen) >1, then normalise the values so that p(Chilled)+p(Frozen) = 1 and p(Normal) = 0

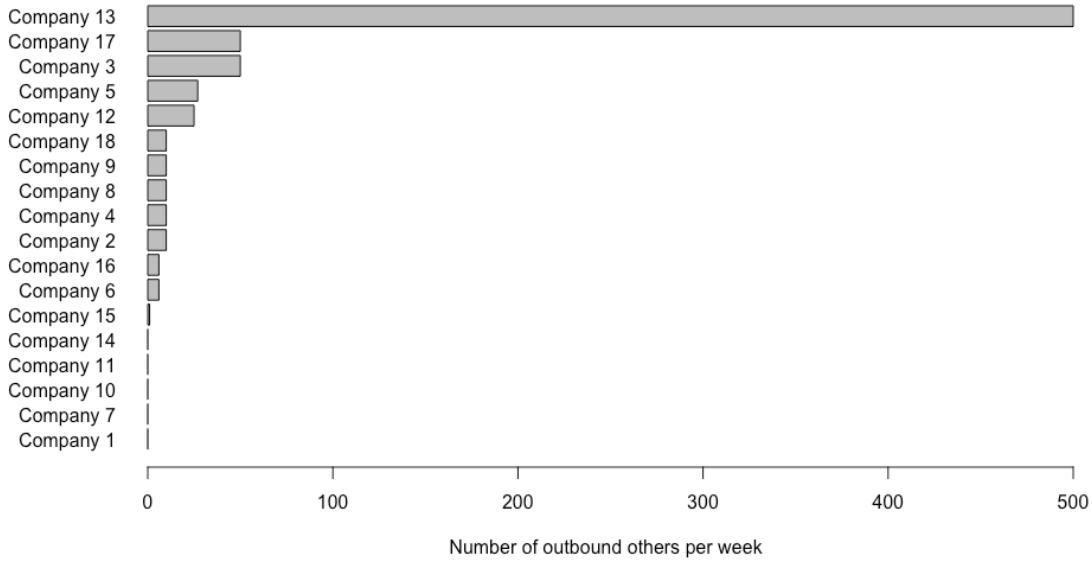
If p(Chilled)+p(Frozen) <1 then p(Normal)= 1-(p(Chilled)+p(Frozen))

13.3 Volume

Volume indications were given by each company in the form of a number of “pallets, “parcels”, “others” per week. To spread the yearly volume sent out or received, those volumes are multiplied by 52 and spread across each job done over a year.




Company 13
Company 15
Company 9
Company 7
Company 10
Company 5
Company 18
Company 11
Company 4
Company 14
Company 12
Company 6
Company 1
Company 17
Company 16
Company 8
Company 3
Company 2
0
200
400
600
800
Number of outbound parcels per week


Company 13
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Company 5
Company 12
Company 18
Company 9
Company 8
Company 4
Company 2
Company 16
Company 6
Company 15
Company 14
Company 11
Company 10
Company 7
Company 1
0
100
200
300
400
500
Number of outbound others per week

13.4 Synthetic Data Generation

This analysis is based on using the previously listed data to simulate logistics requirements for each company over a period of time

1. For each day in time period (one year for this experiment)
    a. For each entry in the frequency table
        i. Generate a job from producer to destination (vice versa for inbound jobs)
        ii. Assign a special requirement (Normal/Chilled/Frozen)
2. For each producer
    a. Assign pallet/parcel/other volumes to each job