The Oil & Gas Technology Centre

Your Innovation Partner

Marine Logistics

Summary of Feasibility Study Findings
Sept 2017 – May 2018
FINAL REPORT – JUNE 2018

1. Executive Summary

Marine logistics, the transportation of equipment by boat, accounts for almost 10% of the £10bn total operating costs. Despite this, data and anecdotal evidence strongly suggested that this area of supply was far from optimised. A recent study showed that in some parts of the UKCS vessel efficiency (i.e. useful time) figures were only 30% (ASCO, 2015). The study showed deck utilisation at around 50% and time utilisation at only 60%. An opportunity exists to significantly reduce the cost of marine logistic operations by increasing this utilisation through the use of digital technology.

The OGTC conducted a feasibility study, partnering with RGU, focussing on support vessel logistics in the North Sea, to see how data can be used to quantify inefficiencies and the size of the prize. Then with Crimson & Co to understand logistics models used in other industries and the key success factors required to move towards new, digitally enabled models.

There were three components to the study: -

- Analysis of publicly available marine traffic data to illuminate historical patterns
- Modelling to ascertain how historical patterns could have been optimised
- Enquiry into other industry logistic models to identify success factors

The RGU analysis of approximately 3,000 marine voyages between Oct 16 and Sept 17 in the Central North Sea area revealed that more than 68% of the trips only visited a single platform whilst sailing past many others en route. Furthermore, more than 87% of the voyages involved only one operator, so less than 13% of the trips involved some form of vessel sharing. Analysis of non-productive time near platforms revealed that on average ships were spending 60% of their time waiting just outside the exclusion zone to come in alongside for unloading operations. There are many reasons for this NPT, some unavoidable but many avoidable. Further work would be required to quantify the efficiency opportunities.

Modelling work demonstrated that, if automated scheduling had been applied to shift the same amount of equipment and bulks supplies in the study area, fewer boats would be used on shorter but more frequent voyages, sailing for less vessel days. It is indicated that theoretically, savings of the order of 20-25% in vessel days could be achieved if there are no operational restrictions. In addition, if vessel sharing is invoked, further savings of 5-10% could be achieved. The modelling indicated that around 50% of the vessel trips would need to be shared between operators. This is significantly higher than the current 13% observed.

These initial investigations using data have wetted the appetite to move on to using data to forward model alternative scenarios rather than continuing to refine a look back approach.

Looking at other industries, key success factors include having clear standards to facilitate the sharing of data, an independent body to facilitate that collaboration and clear protocols in place to ensure commercially sensitive data is protected.

This report recommends that the industry collaborates to develop software that: -

- models the supply of expected demand to illuminate options to optimise delivery
- Models different vessel sharing options so that Operators can make the best choices
- Publishes available deck space to facilitate vessel sharing opportunities
- Models the balance between long term hire commitments versus short term spot hires for various demand scenarios so that it can be optimised.
- Collects and updates anonymised data that Operators can use to judge performance.

2. Introduction

Purpose

This report has been prepared to summarise feasibility studies into Marine Logistics efficiencies coordinated by the Digital Transformation Solution Centre ("DTSC") in The OGTC in conjunction with The Robert Gordon University and Crimson & Co.

Background

A key element of operating on the UKCS is the transportation of people and equipment offshore. Marine logistics, the transportation of equipment by boat, accounts for almost 10% of the £10bn total operating costs. Despite this, data and anecdotal evidence strongly suggested that this area of supply was far from optimised. A recent study showed that in some parts of the UKCS vessel efficiency (i.e. useful time) figures were only 30% (ASCO, 2015). The study showed deck utilisation at around 50% and time utilisation at only 60%. An opportunity exists to significantly reduce the cost of marine logistic operations by increasing this utilisation through the use of digital technology and insights from data.

Given the scale of this opportunity, The Oil and Gas Authority (OGA) had asked The Technology Leadership Board (TLB) to look for potential efficiencies within the marine logistics process. The TLB commissioned an initial landscaping study to further define the problem and the potential size of the prize.

Work completed by the TLB

The TLB commissioned Neil Logan (Chairman of Incremental Group and Chair of The DataLab Innovation Centre) to conduct a landscaping study into the topic.

Initial meeting

An initial meeting was held on the 2nd March 2017 comprising key stakeholders from 12 North Sea operators. It was decided to work with Operators first, as customers and drivers of the activity set. However, it was recognised that at a suitable point the work would need to involved suppliers who are a key part of the equation.

The initial proposal was to create a pilot programme which builds on existing digital solutions and:

- Analyses, evaluates and demonstrates how marine logistics has operated historically
- Sets out how it will operate in the future if we continue as we are
- Identifies and models an alternative future in which marine logistic operations are optimised across the UKCS, and quantifies the potential benefits.

Subsequent follow on workshops were held on the 11th April and the 21st July 2017.

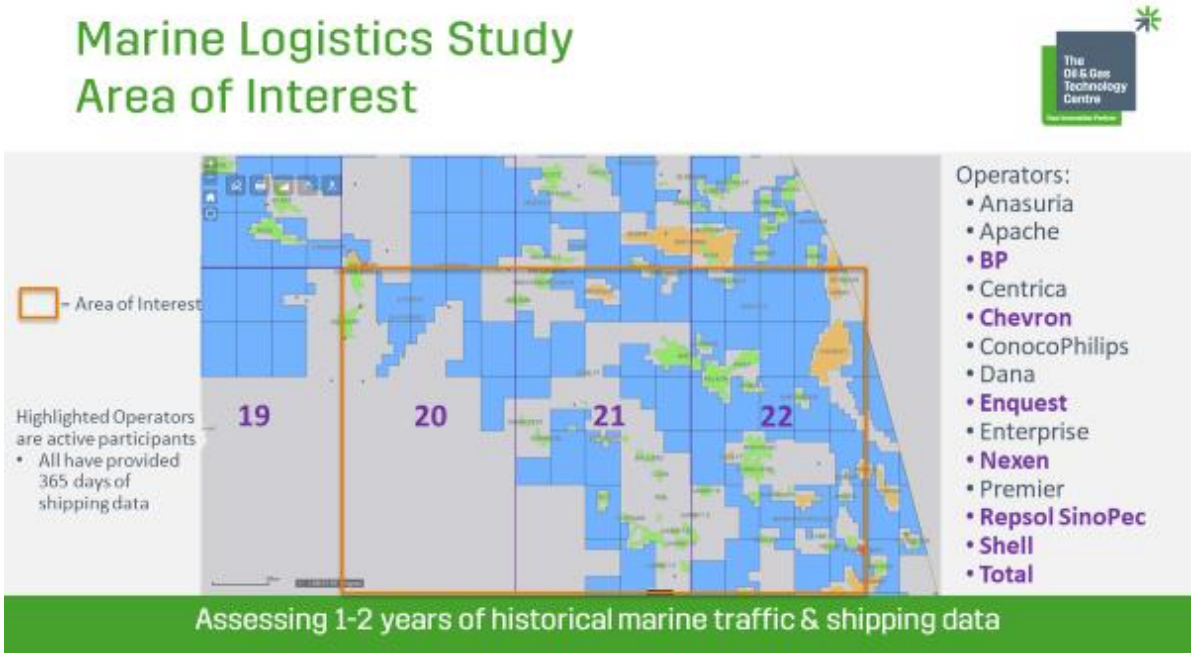
The TLB then transitioned the project to Digital Transformation Solution Centre ("DTSC") within The Oil & Gas Technology Centre (OGTC) so that it could benefit from the matched funding model to help generate resource.

The OGTC received approval to proceed with a feasibity study in September 2017 with in-kind contributions of data from Operators used to create matched funding.

In parallel, Robert Gordon University had received funding from Innovate UK as part of their Game Changer initiative to create a demonstrator capability for Offshore Logistics, Land & Marine and were developing a modelling capability. It was agreed to pool efforts.

3. Area of interest selection

The TLB working group agreed to select a small geographical area of the North Sea, involving a subset of Operators to create a manageable pilot project. The area chosen was Quads 20, 21 and 22 in the Central North Sea and 9 Operators managing 16 platforms within this area were asked to participate.



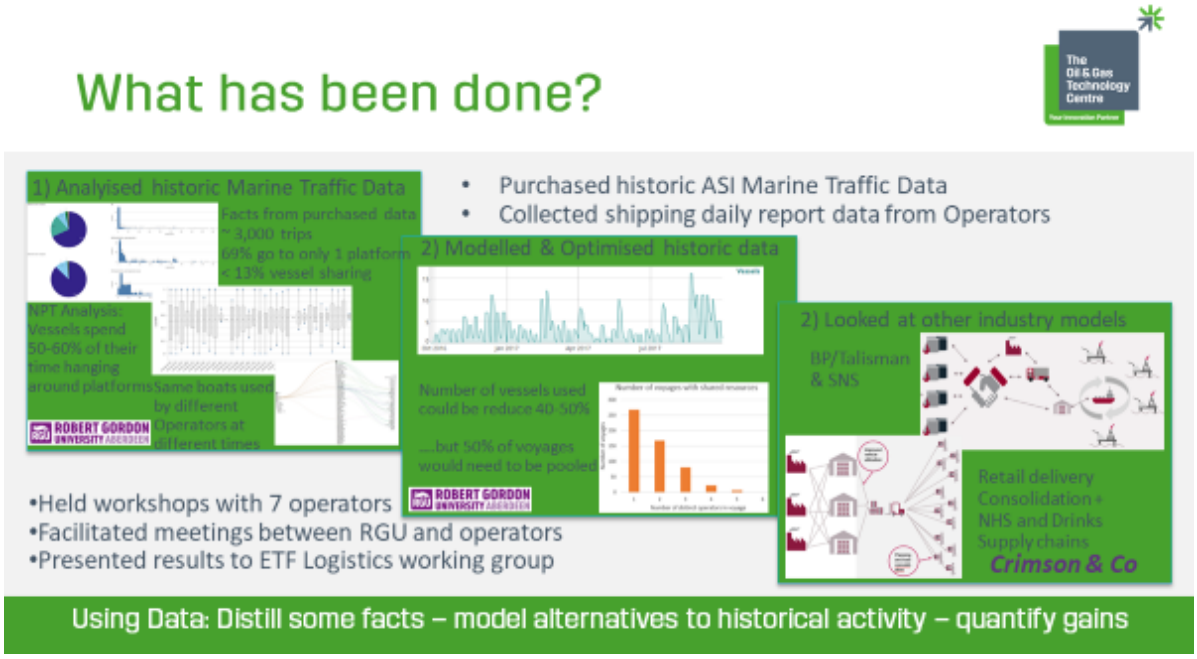
Representatives from BP, Chevron, Enquest, Nexen, Repsol SinoPec, Shell and Total were active participants in all of the workshops and facilitated the provision of data into the study.

4. Elements of the OGTC Study

The OGTC study comprised 4 elements:

- Workshop engagements with Operator Logistics Managers in study area
- Historical analysis of marine traffic data (RGU)
- Modelling alternative scenarios of historical activity (RGU)
- Looking at other industries for key success factors (Crimson & Co)

The diagram below summarises the work done during the study period.



5. Workshop Engagement

Workshops

Workshops held with the pilot Operator group focused on discussing current practices; issues faced; and identification of the soft and hard constraints; with a view to developing a data model that could be used for optimization. These workshops were well supported and there was high energy in the room as the operator representatives shared their working practices and recognized that they had many issues in common. The participants agreed to share data and have honoured this commitment.

Initial data relating to bulk supplies for sustaining life were requested from the participants at the end of the first workshop. These data were received, partially analysed and initial findings shared during the second workshop.

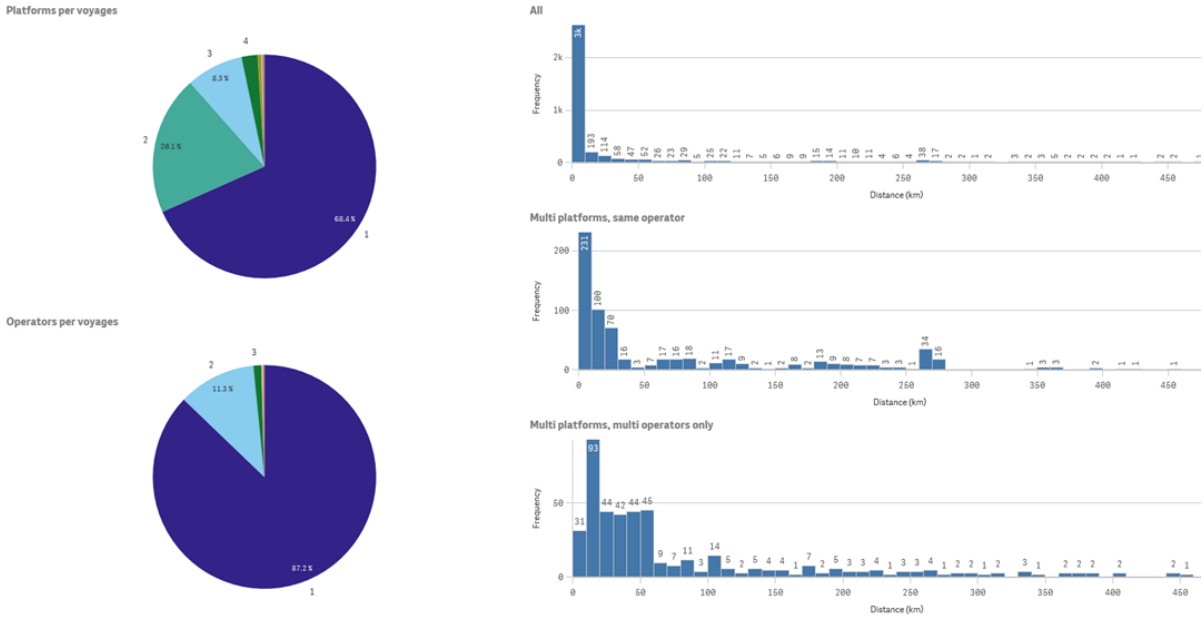
The second workshop continued to develop the data model and focused more on the drivers of the variable equipment requests serviced. The conclusion was that periodic not regular activity drives most of the demand i.e. maintenance, turnaround or drilling campaigns drive a lot of variable demand over and above the base level of supply to keep operations running.

At the end of the workshop participants agreed to supply details of tonnages shipped and vessel sailings in the form of available daily reports. One of the challenges that this data request raises is the ability to take daily reports, all in different formats from the different operators, digest them and extract key data, like length of vessel sailing and utilisation, to enable analysis to be completed. The use of Natural Language Processing technology could help with all of this and could become a part of an ultimate solution to help optimise operations. However, during this limited study it was out of scope. Information was extracted manually from these data to calibrate the RGU modelling work.

6. Historical Analysis of Marine Traffic Data

Voyage Analysis

AIS Marine traffic data for the Central North Sea area was purchased by the OGTC and analysed by RGU to illuminate what the boats actually did during the study period.



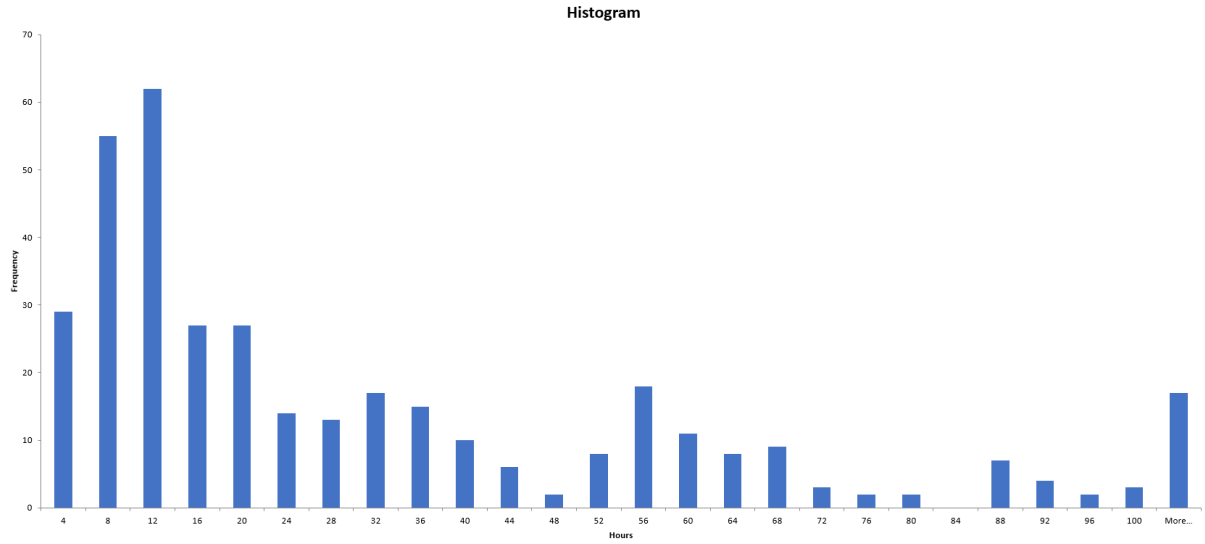
The key observations are that of the approximately 3,000 vessel trips analysed:

- 68% visit only 1 platform. Less than 32% visit more than 1 platform and less than 12% visit more than 2 platforms.
- 87% involve just 1 operator; less than 13% involve more than 1 operator and less than 2% involve more than 2 operators.
- Of the 32% that do visit more than 1 platform, many boats make epic voyages between those platforms

Behaviour in vicinity of platforms

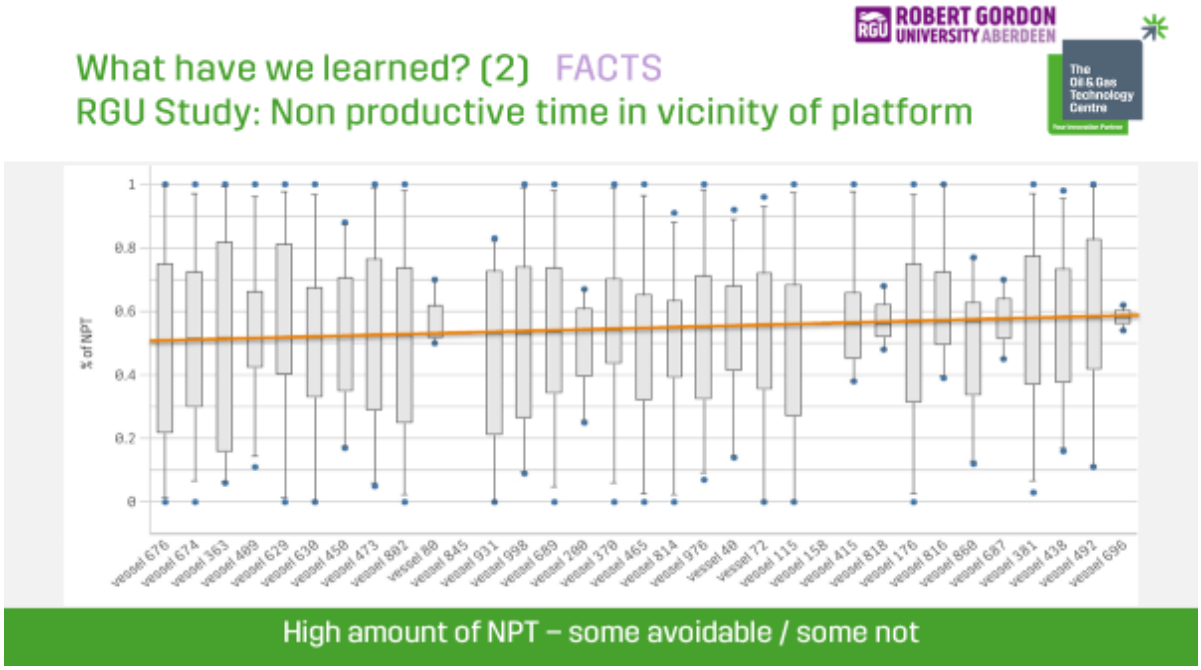
Supply boats spend quite a long time in the vicinity of platforms when delivering supplies. Much of this time is spent waiting outside the exclusion zone for opportunities to dock and unload, for example ‘waiting on the day shift to start operations’. The chart below shows the range of time spent in the vicinity of a platform by number of vessels.

Some vessels were in the vicinity of platforms for more than 72 hours. Only 84 vessels (<25%) spent less than 12 hours at a platform.



Length of Platform Visits

The data analysis revealed that within the sample area, supply boats typically spent on average 65-70% of their time waiting outside the exclusion zone (see chart below). This initial analysis would indicate there is potential for more effective use of time.



When presented to the pilot group several legitimate business reasons for why vessels are often held offshore were provided, making it more difficult to reveal the true level of underlying inefficiency. Further work could be conducted into understanding the split between avoidable and non-avoidable wait times to see which areas might be optimised.

Legitimate reasons for wait time include ‘waiting on weather’, ‘waiting on day shift to start work’, etc. Avoidable wait time could include things like ‘Crane defect’, ‘Cargo not required yet’, ‘vessel undergoing repair’, etc.

7. Alternative scenario modelling by RGU

Aim

The aim of the project was to create a software demonstrator to carry out realistic simulations of supply chain scenarios to determine potential efficiency savings in the North Sea production supply chain.

Project Partners and Contributors

The modelling and optimization research was carried out by RGU with software development carried out by Celerum Ltd., an RGU spin-out. Leading North East road haulier ARR Craib provided onshore logistics data. OGTC provided AIS data and coordinated input and steer from industry. Operational data and iterated feedback on study findings were provided by senior logistics managers from operators BP, Enquest, Nexen, Repsol, Shell, and Total. Further feedback was provided by senior managers of leading logistics suppliers ASCO and Peterson. All of the modelling was focused on production platforms and supply vessels visiting those. Other supply vessel activity, including supply to drilling rigs, was excluded from the study.

Model characteristics and approach

In this phase of the study, software was developed that allows optimization algorithms to explore the most efficient usage of offshore supply vessel fleets to achieve operational goals, as defined by a scenario. The modelling algorithm is optimised towards the reduction of vessels used to convey the cargoes. The model could be optimised on other parameters such as reduction in vessel days, distance sailed, voyages, single platform trips etc.

The following scenarios were compared for the study area:

- **Historical** operations for the period October 2016 – September 2017 as derived from cargo haulage, AIS data and operator input
- **Independent** fleet operations as optimised by algorithms scheduling reduced fleets to deliver a similar level of production supply as that observed in actual operations
- **Pooled** fleet operations as optimised by algorithms scheduling a single fleet, pooled over six operators to deliver a similar level of production supply as that observed in actual operations

In the final phase of the study, interim results were presented to operators through OGTC and feedback was used to rerun scenarios and to provide further analysis of results and their implications.

For the Independent and Pooled scenarios, we additionally explored the effects of 07:00 – 19:00 opening hours versus 24-hour opening. The algorithms found no particular advantage was gained from extended opening hours. In response to feedback from logistics suppliers, further work was conducted to examine the effect of diesel and water delivery constraints on the simulated scenarios. It was established that bulk delivery constraints do not significantly effect the conclusions of the study.

Model Assumptions / biases

The following assumptions were included in the model:-

- The model is biased towards the reduction of the number of vessels used

- The model uses the available fleet of vessels operating in the North Sea and assumes that only 80% of deck space can be used. The model does not assume full utilization on voyages: actual utilization depends on specific cargos allocated to a vessel by the modelling algorithm.
- The demand was simulated by scaling up cargo deliveries provided by ARR Craib for the study period. Estimates were systematically rounded up to ensure that simulated demand was at least equal to actual demand.
- The model selects boats from the available fleet and commissions voyages to deliver the demand pattern of equipment supplies versus bulk supplies. Each vessel in the model was not necessarily fully utilized. Many possible allocations of cargo to vessels are analysed in each modelling run to discover optimal vessel use subject to realistic constraints.
- The model was tested to see if the number of voyages in the two models were sufficient to also deliver the bulk supplies required. In only two cases was there insufficient capacity, so overall the models are robust to that requirement.

Model Insights / conclusions

The study identified that **significant efficiency gains can be made by optimizing supply vessel usage**. In particular, it is possible to identify particular changes to vessel usage patterns that realise significant efficiencies.

The most significant change relates to visiting multiple platforms on a single vessel voyage. This will bring advantage when partial loads for multiple platforms can be combined on a single vessel. The current industry pattern relies heavily on single-platform out-and-back trips. This is observable from AIS voyage data. **Optimised schedules made significant use of multi-platform visits.**

	Historical	Independent	Pooled
Average Platform Visits Per Voyage	1.07	1.27	1.94

Table 1: Average platform visits per voyage for Historical, Independent and Pooled scenarios

The optimized scenarios suggest that significant savings can be made by reducing the number of vessels used for offshore supplies and equipment. An analysis of numbers of supply vessels in use in the study region on a monthly basis was carried out using AIS and compared with the minimised fleets generated in the independent and pooled scenarios.

	Historical	Independent	Pooled
Median number of vessels	25	15	11

Table 2: Median vessel numbers required for Historical, Independent and Pooled scenarios

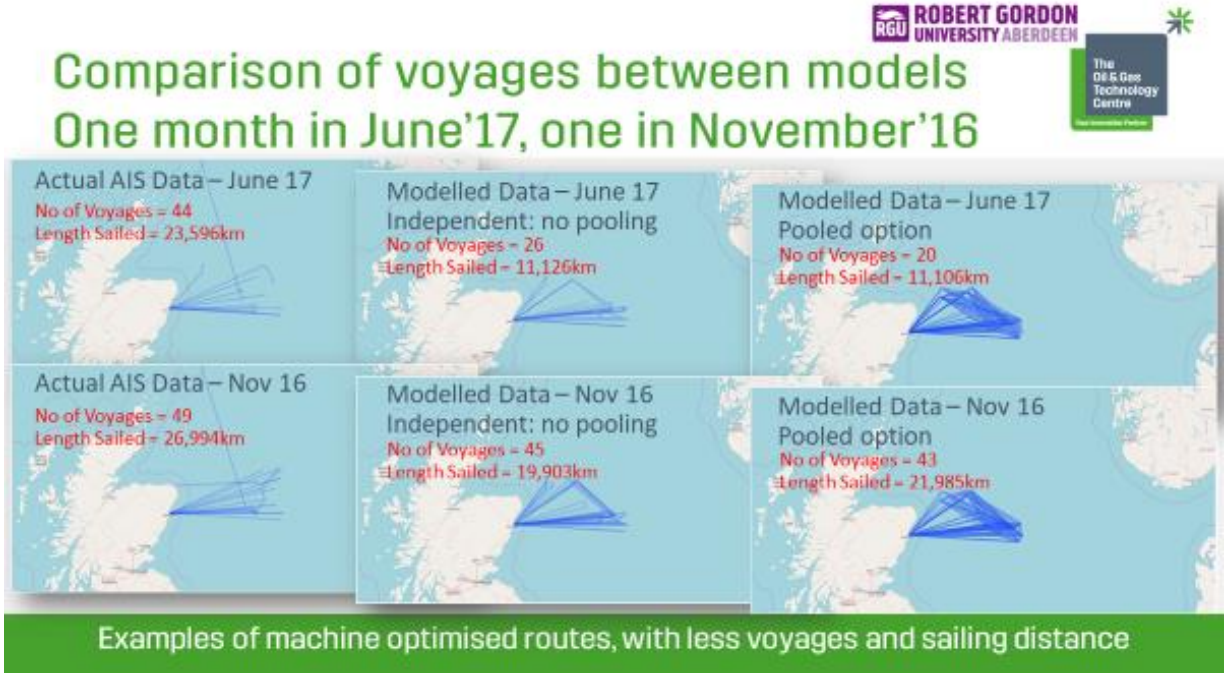
The modelling work has shown that, without any commercial or other operational constraints, if left to a machine, less boats would be used, more voyages would visit multiple platforms and more of the voyages would involve sharing between operators.

More detailed insights

The diagram below illustrates visually and numerically for just two example months of the study period the differences between the historical pattern and the two modelled scenarios.

During the June '17 example the models considerably reduce the number of voyages and sailing length. In the November '16 example these reductions are less but still significant.

Taking these two example months the average reduction in voyages is 24.5% for the Independent model and a further 13.7% for the Pooled option.



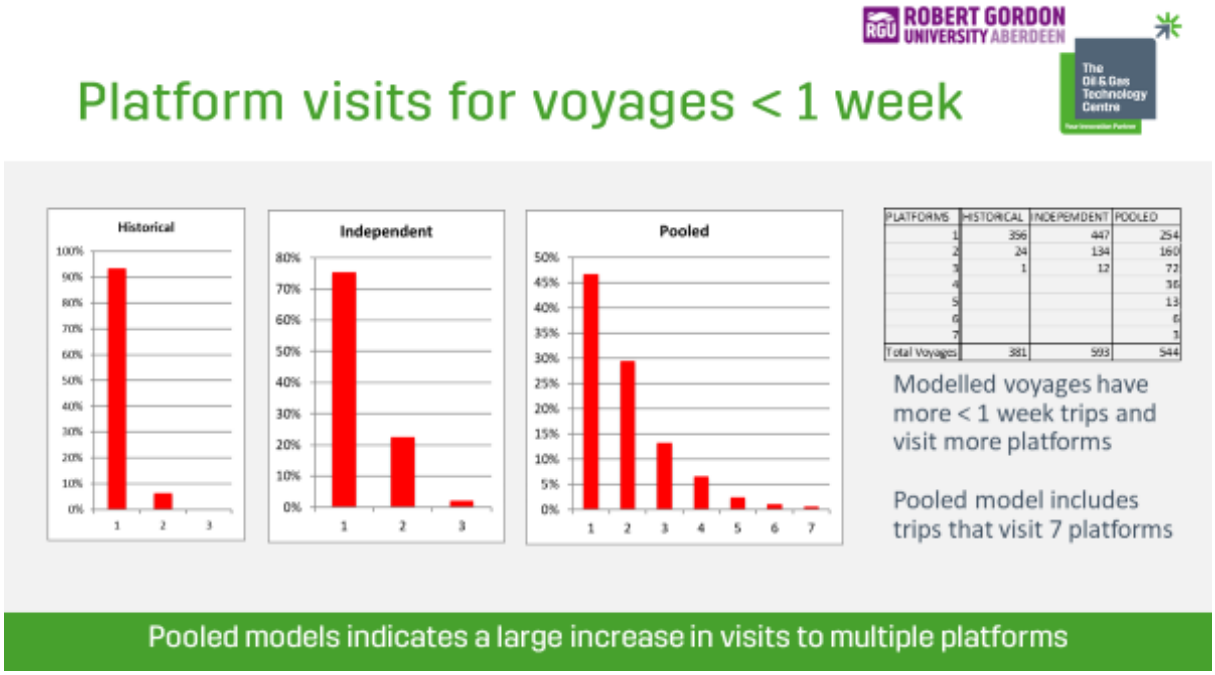
An overall summary of the changes in vessel days, voyages, distance sailed and visits to platforms between the historic and the modelled scenarios for the whole study period is given in the table below.

	Historical AIS		Independent		Pooled	
	All Voyages	< 1 week	All voyages	< 1 week	All voyages	< 1 week
Vessel Days	5934.6	1610.4	1271.1	1271.1	1271.7	1271.7
Voyages	557	381	593	593	544	544
Days per voyage	10.65	4.23	2.14	2.14	2.34	2.34
Distance	276474	168391	246228	246228	252795	252795
Visits	556	407	751	751	1056	1056
Visits per 1000km	2.01	2.42	2.14	2.14	4.18	4.18

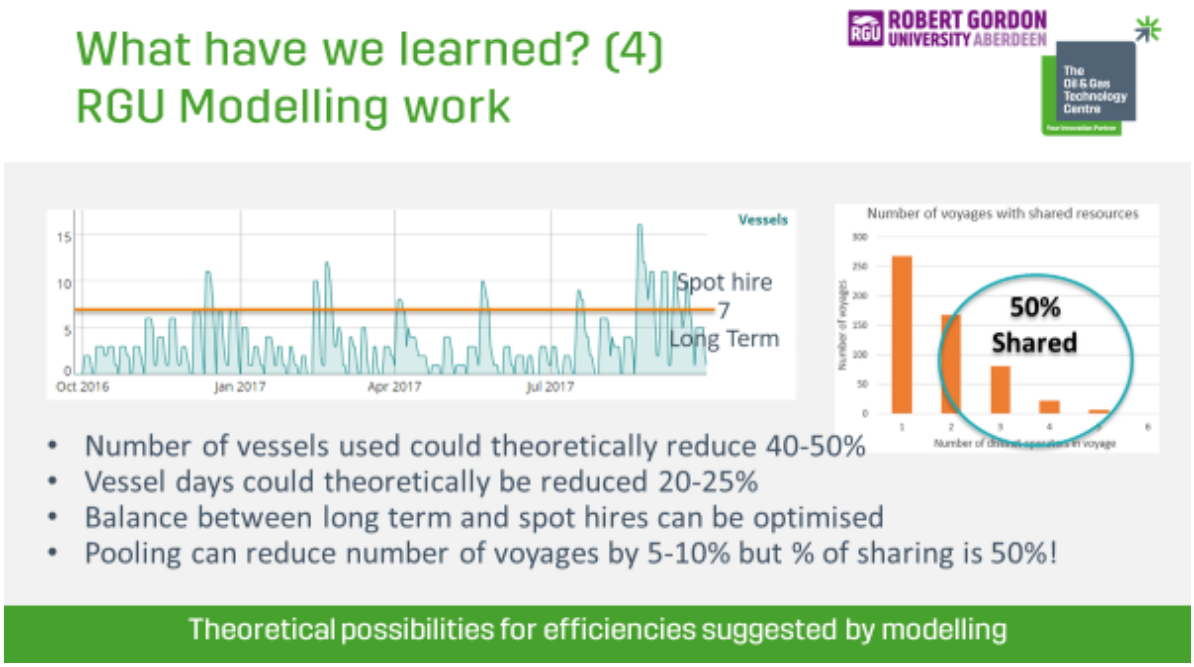
Significant vessel day (and trip length) savings are apparent in the two modelled scenarios compared to the historic actuals. The major reduction between the historic and modelled scenarios is because multi-platform voyages allow multiple co-located platforms to be serviced with only a single out and return leg. The same deliveries carried out using single platform voyages add an out and return leg for each voyage. Current low deck space utilisations suggest that these multi-platform visits are feasible. Some of the reduction is also due to the fact that the models only contain wait times at the platforms when vessels arrive out of hours or together. They do not include the significant wait times in the vicinity of platforms during working hours that are observed in the marine traffic analysis discussed

earlier in the report. The model always includes loading time and back loads at the platform, and loading and unloading at the port, all based on the number of lifts on the vessel. Interestingly, the number of vessel days does not reduce between the Independent and the Pooled models but the number of voyages, and therefore loading efforts, do as the table above shows. However, these efficiencies might be balanced out by the fact that the model prefers more frequent but short trips and so the number of visits to platforms, and therefore unloading efforts, is increased relative to the historic data.

For voyages of less than one week the models demonstrate an increase in the number of platforms visited per voyage, as illustrated in the diagram below. It should be noted that, although the pooled scenario contains voyages that visit platforms belonging to multiple operators, the vast majority of these visits involve only one to three operators. Therefore, most of the benefits of pooling can be obtained without requiring highly complex pooling arrangements.



The modelling outputs also provide insight into the optimum balance between long term vessel contracts and spot hires – see the diagram below:



Summary

In summary, the modelling of alternative scenarios demonstrates that:-

- The number of vessels used could theoretically reduce 40-50% if there are no major operational constraints
- Vessels days could theoretically be reduced 20-25% with savings in fuel and environmental impact
- The balance between long term and spot hires can be optimised
- Pooling could reduce the number of voyages by an additional 5-10% but the percentage of sharing needed would be around 50% of the voyages

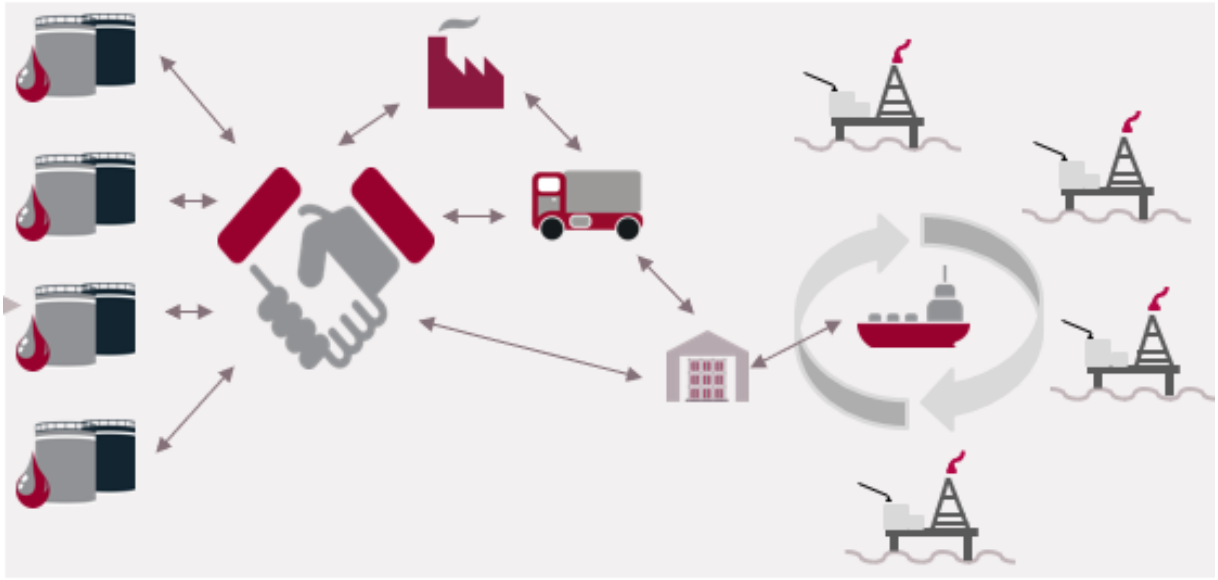
8. Other Industries

Crimson & Co conducted a short study of logistics models in other industries. They looked at the following:-

- Retail
- Drinks
- NHS

And compared models with those in operation in oil & gas. The main conclusions reached are:-

- Collaboration exists in various sectors. The most effective is generally between competitors, not between customers and suppliers
- The main driver to collaboration is generally cost. Either working jointly to meet reduce the costs of stringent service levels, or better utilising excess capacity
- The main areas of successful collaboration are load consolidation; warehouse and inventory management; and procurement
- Key elements of successful collaborations are
    - Use of an independent body to operate it
    - Strong safeguards in place to prevent inadvertent sharing of commercial information
    - All participants must be treated equally in terms of service and how benefits are shared
    - Process standardisation is a pre-requisite to success
- Some real opportunities exist for North Sea collaboration. For example, in the BP Talisman and SNS examples a managed service provider co-ordintes and manages the contracting and planning of all logistics.



The full report and conclusions are attached in Appendix 2

9. Conclusions

The general conclusions are that:

- logistics offshore are driven by a complex set of drivers and constrained by several hard and soft limits.
- There are inefficiencies within current practices that could be optimised as illustrated by an analysis of historical marine traffic data.
- Modelling of historical data indicates that, not withstanding some operational factors, a machine would choose to deliver similar volumes of containers and bulks using less vessels but more frequent trips with visits to multiple platforms and sharing of capacity between operators. **Savings appear to lie in the region of 10-40% which is a significant prize.** However, the higher end of the range is considered more a theoretical maximum**.**
- Modelling also indicates that **there is a further opportunity to optimise by 5-10% through vessel sharing between operators.** However, there remain commercial barriers to sharing options that need to be resolved.
- The modelling work has illustrated that there is a clear opportunity for individual operators with more than one platform to optimise their logistics by reducing the number of voyages that only visit one platform. **This modelling exercise suggests that simply reducing the number of voyages that visit only one platform has the largest impact.**
- Operators would appreciate solutions that help them illuminate options around:
  - ▶ vessel sharing
  - ▶ fleet combinations for base contract hire versus variable spot hire
  - ▶ utilising available deck space
- The characteristics of a suitable collaborative solution(s) would need to include being independent of suppliers and operators but having the ability to interface with existing operator and supplier procurement and supply systems. This will minimize the change management aspects of a project but also preserve the ability of all companies involved to continue to choose their system of choice to optimize their own part of the operation and remain competitive.
- Existing solutions outside the Oil & Gas industry, such as those operated by the airline industry, appear extremely relevant to the UKCS logistics optimisation opportunity and may offer suitable models to adapt and adopt rather than inventing something from scratch.

10. Recommendations

The following recommendations are made based on numerous discussions with industry representatives, the modelling work carried out by RGU and observations from other industries.

1. **Increased Supply Chain Visibility**: Going forward, demand and supply data is more widely shared collaboratively to help the supply chain better anticipate and meet the required demand. Some form of Blockchain solution should be considered to facilitate secure and confidential sharing of required data between the demand and supply aspects of the industry.
2. **Information Standards**: Consideration should be given to establishing data sharing standards that facilitate access to the required information.
3. **Use of Analytics**: Modelling functionality is developed to use this data to model forward looking scenarios that create greater insights for the industry to help with planning.
4. **Industry Ownership**: It is noted that under the **Efficiency Task Force**, a **Logistics Task Finish Group** has been established to develop a forward vision for the industry, publish results of case studies to increase awareness of capability and help coordinate collaborative efforts. This group should be leveraged to define and implement Phase II requirements. Ownership by industry of this opportunity set is vital to ensure progress is made.
5. **Pilot Data Driven Approaches**: Participants should be sought to define, agree and pilot the technical functionality for a new generation of logistics capability that:-
    a. Provides decision support tools informed by data for Operators and suppliers
    b. Publish / illuminate vessel sharing opportunities
    c. Models alternative scenarios and quantifies benefits for all involved
6. **Collaborative Commercial Frameworks**: In parallel with data sharing and modelling technology development, efforts should also be made to evolve commercial arrangements that facilitate the opportunities that the insights from forward data modelling highlight.

Acknowledgements:

The OGTC wishes to acknowledge the contributions of all involved in this feasibility study:

1) The Logistics Managers from BP, Chevron, Enquest, Nexen, Repsol SinoPec, Shell and Total.
2) Professor John McCall and his team at Robert Gordon University, Aberdeen,
3) The staff of Crimson & Co
4) The Members of the Efficiency Task Force's Logistics Working Group