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Continuous Improvement Proposal

Dragon LNG Shipping Delays

Quality and Business Improvement (ACMA4008)

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Introduction

The efficient operation of LNG regasification terminals is crucial for the steady supply of natural gas to global markets. Shipping delays affecting import operations at LNG regasification terminals can be influenced by a variety of factors, including supply chain disruptions, infrastructure limitations, and external market conditions. This report seeks to analyse the root causes, impacts, and potential solutions to these delays.

Cargo delays at Liquefied Natural Gas terminals can have a profound impact on the overall supply chain, affecting not just the availability of natural gas, but also leading to economic repercussions for suppliers, distributors, and end-users. The importance of timely and efficient regasification processes cannot be overstated, given the rising demand for LNG in both industrial and residential applications. (Melas, 2024)

This report will delve into the various factors contributing to these delays, such as port congestion, regulatory hurdles, weather conditions, and logistical inefficiencies. By examining case studies and expert analyses, we aim to provide a comprehensive understanding of the issues and offer actionable recommendations to mitigate future delays. Understanding and addressing the challenges faced by LNG regasification terminals is essential for maintaining the reliability and efficiency of the global natural gas supply chain.

The particular focus of this report is to identify issues and propose solutions in relation to shipping import delays at Dragon LNG regasification terminal, one of three LNG regasification terminals located in the UK. Dragon LNG is a key component in the UK national energy infrastructure. The terminal provides access to the UK National Transmission System for customers Shell and Petronas to import Liquefied Natural Gas from upstream liquefaction supply sources worldwide.

Historical data has been analysed to determine the main causes of delays in relation to shipping imports at Dragon LNG terminal and a continuous improvement plan proposal has been formulated to address current inefficiencies that exist at the regasification facility.

Causes of Shipping Delays in the LNG Industry

LNG shipping delays can be attributed by many factors, when these causes are examined in detail, the results show that often the causes are in fact interconnected. The following section of this report details the fundamental reasons for delays in LNG shipping across the industry.

Global Supply Chain Issues

Supply chain issues can be a major factor in the delay of scheduled LNG imports. The referenced report carried out by The Oxford Institute for Energy Studies, comprehensively examines the impact of restrictions on both the Panama Canal and Suez Canal shipping routes (Sharples, 2024). Findings from the report clearly indicate the effects of diverted shipping routes resulting in longer journey times to the destination port.

Referring to p13-14, 5.5 ‘The Implications of Longer Shipping Distances for Qatari LNG’ (Sharples, 2024) and the data displayed in extract figure 1. The increased round trip journey time of 62 days from 50 days to South Hook upholds the theory of how an interrupted supply chain can directly affect shipping imports with consequential delays.

*South Hook is referenced for basis of this data, as it is Geographically located in the same port (Milford Haven) as Dragon LNG, situated 5.5km to the West.

	Rovigo	Zeebrugge	South Hook	Swinoujscie	Fos Cavaou	Barcelona	Total
2023 Average Days Per One-Way Trip	19.5	21.0	23.5	25.5	18.0	17.0	20.8
Scheduled Number of Days Per One-Way Post-Jan 2024	33.0	29.5	29.5	36.0	33.0	32.0	32.2
Extra Number of Days	13.5	8.5	6.0	10.5	15.0	15.0	11.4
	-	-	-	-	-	-	-
Round Trip via Suez	42.0	45.0	50.0	54.0	39.0	37.0	44.5
Round Trip via Cape	69.0	62.0	62.0	75.0	69.0	67.0	67.3
Round Trips per Year via Suez	8.7	8.1	7.3	6.8	9.4	9.9	8.2
Round Trips per Year via Cape	5.3	5.9	5.9	4.9	5.3	5.4	5.4
	-	-	-	-	-	-	-
Volume delivered in 2023 (MMcm of natural gas)	6,338	4,308	2,389	2,355	2,219	1,219	18,828
Volume delivered in 2024 (MMcm of natural gas)	3,858	3,127	1,927	1,696	1,254	673	12,534
Year-on-Year Decline (MMcm of natural gas)	2,480	1,181	462	659	965	546	6,294

Fig. 1 - Round-trip shipping distances from Ras Laffan to European regasification terminals and the potential reduction in deliveries to those terminals in 2024 (Sharples, 2024)

Weather Restrictions

Adverse or severe weather events can have major implications on shipping routes and LNG cargo transfer operations. Change of course shipping orders can be directly driven by severe weather, meaning an alternative port of destination for an LNG vessel in extreme cases.

On arrival at destination port, LNG vessels can only proceed to commence cargo unloading operations if safe weather limits allow. Safe Marine Pilot onboarding and allowable conditions for the secure berthing of the LNG vessel are pre-requisites. Further operational requirements including ship / shore gangway interfacing and product unloading arm connection are also governed by weather conditions. Vessels entering or departing the Port of Milford Haven will adhere to the Port Entry and Departure Guideline, with specific restrictions relevant to each terminal berth (Milford Haven Port Authority, 2022).

LNG cargo unloads can be delayed until limits are deemed acceptable for the operation of critical equipment, to enable the discharge of LNG into the associated terminal facilities. The associated report provides an example of a delayed commissioning LNG cargo, disrupted due to weather, preventing planned commissioning activities at the FSRU (Staff, 2024).



Fig. 2 – LNG carrier at berth (The Korea Economic Daily, 2023)

Political and Geopolitical Influences

Political indifferences can have a direct impact on energy supplies, in particular LNG market volatilities. Prior to the Russian Ukrainian conflict, data has shown that Europe heavily relied on Russia for Natural gas supplies.

As tensions grew and war materialised, alternative gas supplies throughout Europe were in great demand, correlating with an urgency of LNG shipping imports across the continent. Heightened demand, resulting in inflated gas prices, caused disruptions at terminals and delays in receiving bulk LNG cargoes. (Açık, 2024)

Fig. 3 represents the heightened requirement for LNG cargoes in 2022, coinciding with initial hostilities between Russia and Ukraine, which eventually culminated in physical war.

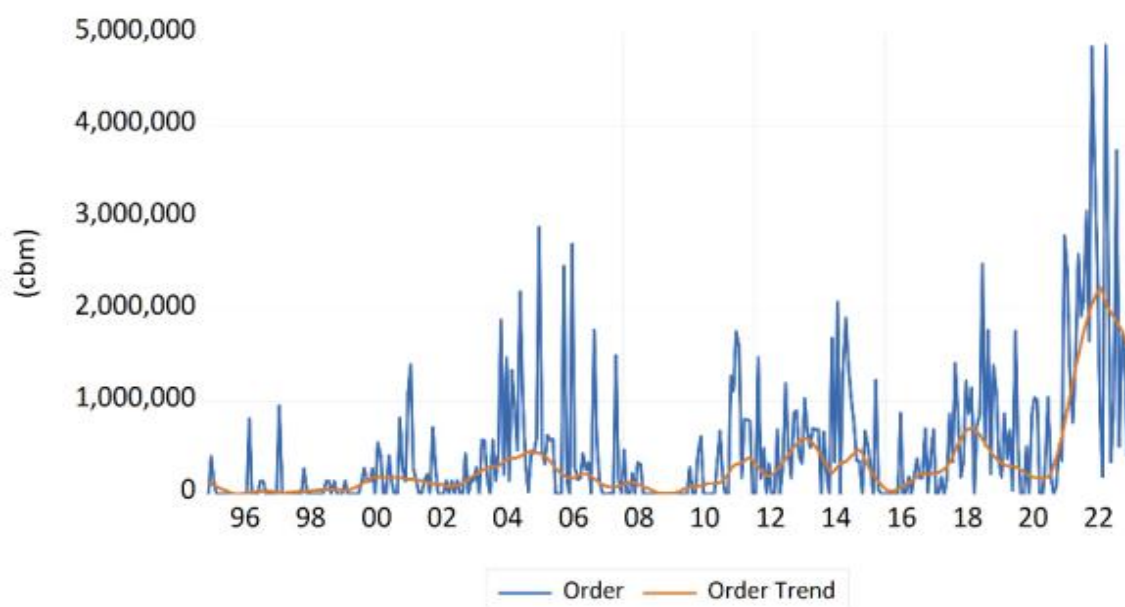


Fig. 3 – LNG ship orders (Açık, 2024)

Operational and Technical Faults

Receiving terminals can be the cause of delayed import of LNG cargoes, due to operational or process failures. The breakdown of critical process equipment has the potential to affect scheduled Liquefied Natural Gas vessels from unloading into the terminal facility. In an instance where an item of terminal process equipment has failed, could potentially result in receiving tank levels being high, providing insufficient ullage to receive a scheduled cargo.

Conversely, an LNG vessel may have technical issues with navigational or process equipment for instance, which may prevent the vessel from entering the port for scheduled unloading of hydrocarbons. The following report evidences the impact of a technical failure on board a vessel destined for Negishi Terminal, Tokyo Bay. (Reuters Staff, 2019)

Port Congestion and Marine Vessel Management

Marine ports are busy hubs where multiple vessels are constantly arriving, loading, and departing. Scheduling the arrival and departure of vessels within a port is a complex task that requires precise coordination to avoid congestion and delays. Contributing factors that lead to delays in LNG shipping imports include but not limited to, tugboat restrictions, pilot availability and port scheduling conflicts and limitations.

Calculated planning is critical to ensuring that delays to LNG shipments to and from receiving LNG terminals are minimised. Figure 4 represents a 'port congestion index', with 2020 illustrating increased congestion within marine ports throughout Europe, coinciding with the Worldwide Covid-19 pandemic. Due to the additional restrictions and documentation required during this period, the strain and complexity on the management of LNG vessel logistics in European ports is clearly displayed.

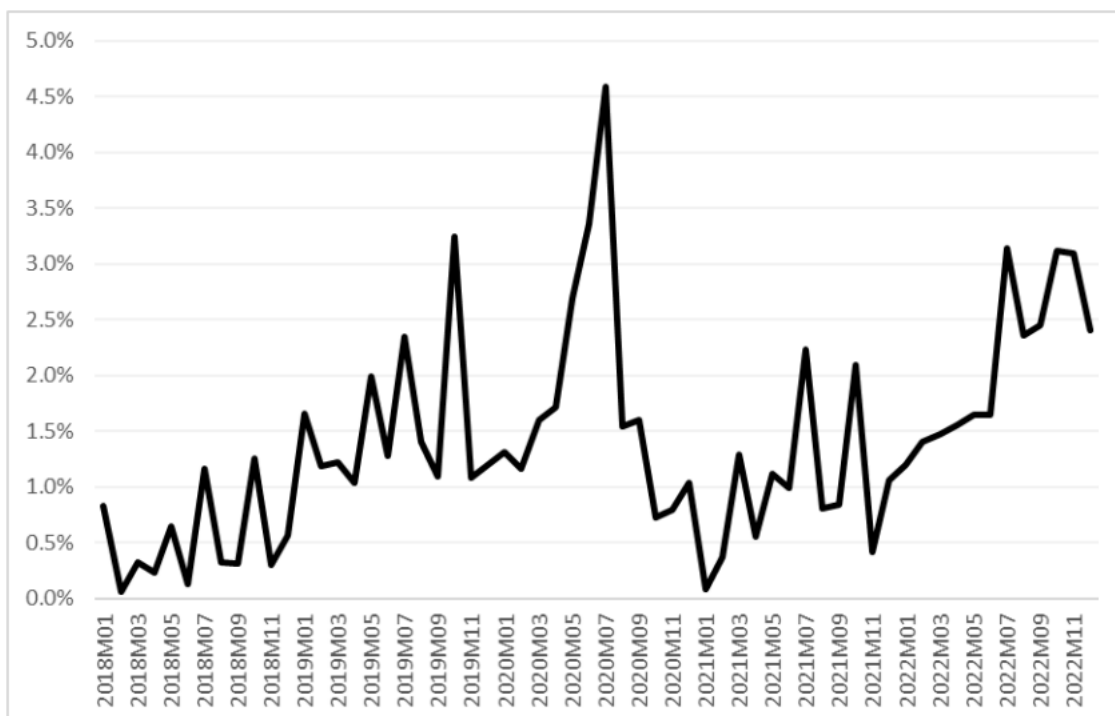


Fig. 4 – The Euro area LNG port congestion index (Melas, 2024)

Root Cause Analysis

Root Cause Analysis (RCA)																
Item: Dragon LNG Shipping Delays		Responsibility: C Robertson		RCA number: 1												
Model: Organisational		Prepared by: C Robertson		Page : 1												
Core Team: Marine and Logistics				FMEA Date (Orig): 19/12/2023 Rev: 1												
Process / Function	Identified Issue	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s)/ Mechanism(s) of Failure	O c c	Current Controls	D e t	R P N	Recommended Action(s)	Responsibility and Target Completion Date	Action Results				
												Actions Taken	S e v	O c c	D e t	R P N
Process / Function	Describe the issue		Rate the severity from 1-10	Ex: Operational Failure	List potential causes of the issue	Rate the occurrence likelihood from 1-10	List current controls in place to detect/prevent the issue	Rate the detection capability from 1-10	Multiply severity, occurrence, and detection	Actions recommended to mitigate the issue	Person responsible and target date for action completion	Results after implementing actions				0
Shipping Logistics	Excessive shipping import delays to Dragon LNG Terminal	Financial implications, interruption to planning schedules, strain on organisational and resource requirements. Threat to future security of terminal if unreliability of shipping schedule continues.	8	Logistics Management	Outdated logistics management and scheduling system, poor communication between key stakeholders, insufficient resources in place.	3	Marine logistics control, proven procedures and policies, skilled resources.	3	72	Implementation of new marine logistics scheduling and management system. Improved quality communications between key stakeholders in the port. Review of critical resources and execution of actionable measures	01/01/2024					

A root cause analysis has been conducted relating to issues in scheduled shipping delays at Dragon LNG Terminal. As described in the RCA, an outdated marine scheduling and management system, lack of proper communication between key stakeholders and insufficient resources have been identified as contributing causes of the delays, resulting in implications for the business.

Analysis of Shipping Delay Data at Dragon LNG Terminal

This section of the report provides analysis of historical shipping delay data at Dragon LNG Terminal. Data has been provided by Milford Haven Port Authority. The aim is to examine and provide graphically transparent representation of the data, to form understanding of the root cause and therefore apply necessary continuous improvement recommendations.

Data overview

Fig. 5 represents data for shipping arrival delays to Dragon LNG terminal during the year 2023. For clarity, a description of each category is defined below:

Svitzer: Tugboat contractor

Own Resource: MHPA resource

Weather: Any delay directly affected by adverse weather conditions

Environmental: Tidal constraints

Terminal Operations: Restriction due to terminal operations

Vessel: LNG carrier

Incident and Emergency: Emergency response in the port

Delay Category	Delay Duration (Days)	Number of Delays
Svitzer	19.1	52
Own Resource	10.0	50
Weather	33.5	27
Environmental	2.8	12
Terminal Operations	9.2	6
Vessel	5.4	6
Incident and Emergency	0.1	2

Fig. 5 – 2023 shipping arrival delays at Dragon LNG terminal

Fig. 5 represents the raw delay data at high level and initial examination of the table doesn't clearly indicate a specific area for improvement. However, what the table does clearly indicate, is the highest number of delays have been attributed to by **Svitzer**, closely followed by **Own Resource** (MHPA).

Preliminary data representation doesn't provide immediate clarity of correlation relationship between the number of delays and delay duration. Fig. 6 replicates the data; however, delay duration data is organised in descending order.

Delay Category	Delay Duration (Days)	Number of Delays
Weather	33.5	27
Svitzer	19.1	52
Terminal Operations	9.2	6
Own Resource	10.0	50
Vessel	5.4	6
Environmental	2.8	12
Incident and Emergency	0.1	2

Fig. 6 – Dragon LNG shipping arrival delays duration

Quantitative analysis of data

Further analysis displayed in fig. 7, includes an important metric, ratio. The ratio defines the average delay duration per delay. The highest offending category based entirely on the ratio metric is **Terminal Operations**. However, taking number of delays and delay duration into consideration, early observation of the data indicates that **weather** is a serious cause.

Delay Category	Delay Duration (Days)	Number of Delays	Ratio (Days per Delay)
Svitzer	19.1	52	0.37
Own Resource	10.0	50	0.20
Weather	33.5	27	1.24
Environmental	2.8	12	0.23
Terminal Operations	9.2	6	1.53
Vessel	5.4	6	0.90
Incident and Emergency	0.1	2	0.05

Fig. 7

Scatter diagram

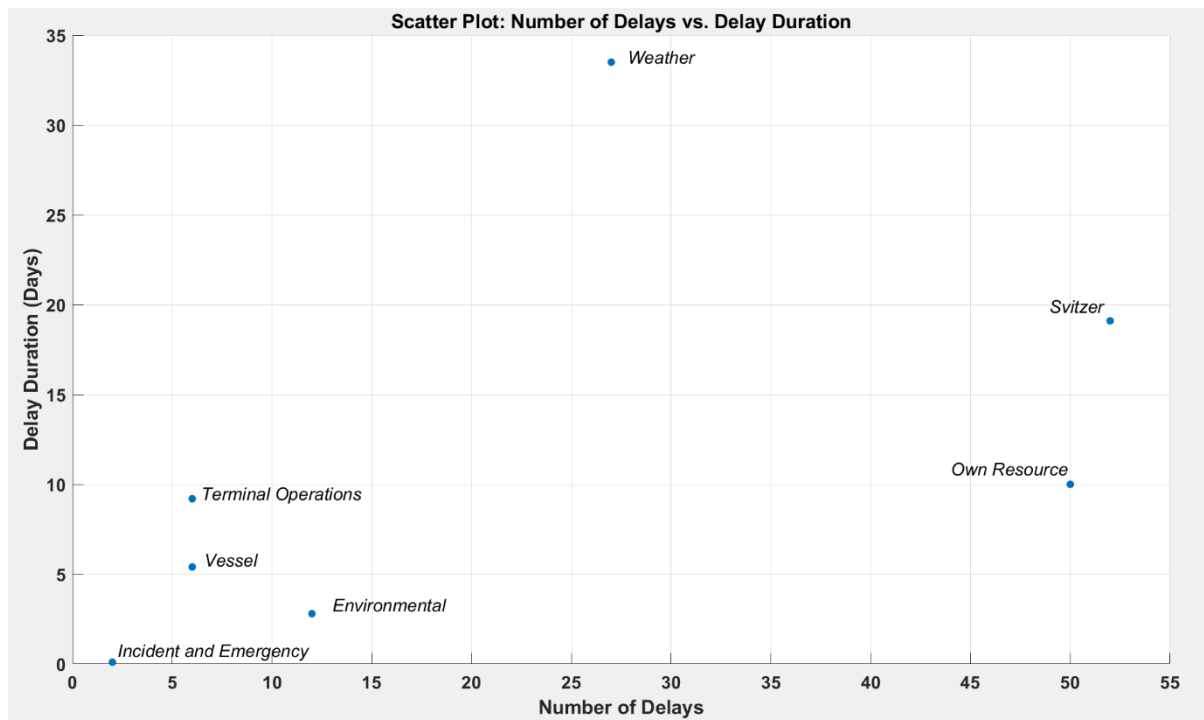


Fig. 8

The scatter diagram in *fig. 8* provides supplementary depiction of the data derived from *fig. 7*. Each delay category located on the diagram influenced by duration and number of delays. The position of each category corresponds to its ratio.

Histogram

Illustrated in *fig. 9*, data from *fig. 7* is graphically represented. The red line plotted in relation to the blue bins, portraying the ratio for each category.

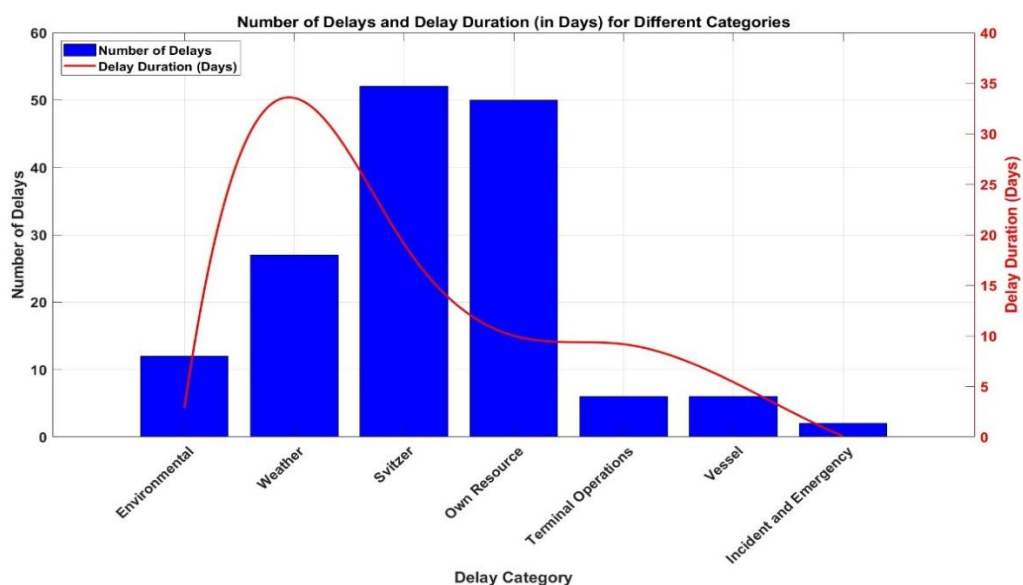


Fig. 9

Continued analysis of the data further indicates varied correlation between cumulative number of delays and total duration of delay, per delay category. Although, the data provides clarity, as illustrated by *fig. 8*, in displaying main causes in relation to number of delays and delay duration in isolation.

Initial analysis has provided valuable information but has not enabled a definitive strategy in terms of addressing the required delay categories. Supplementary data appraisal utilising pareto analysis is required to formulate conclusive evidence, to ensure that the appropriate delay categories are identified to assist in structuring a comprehensive improvement proposal.

Pareto Analysis

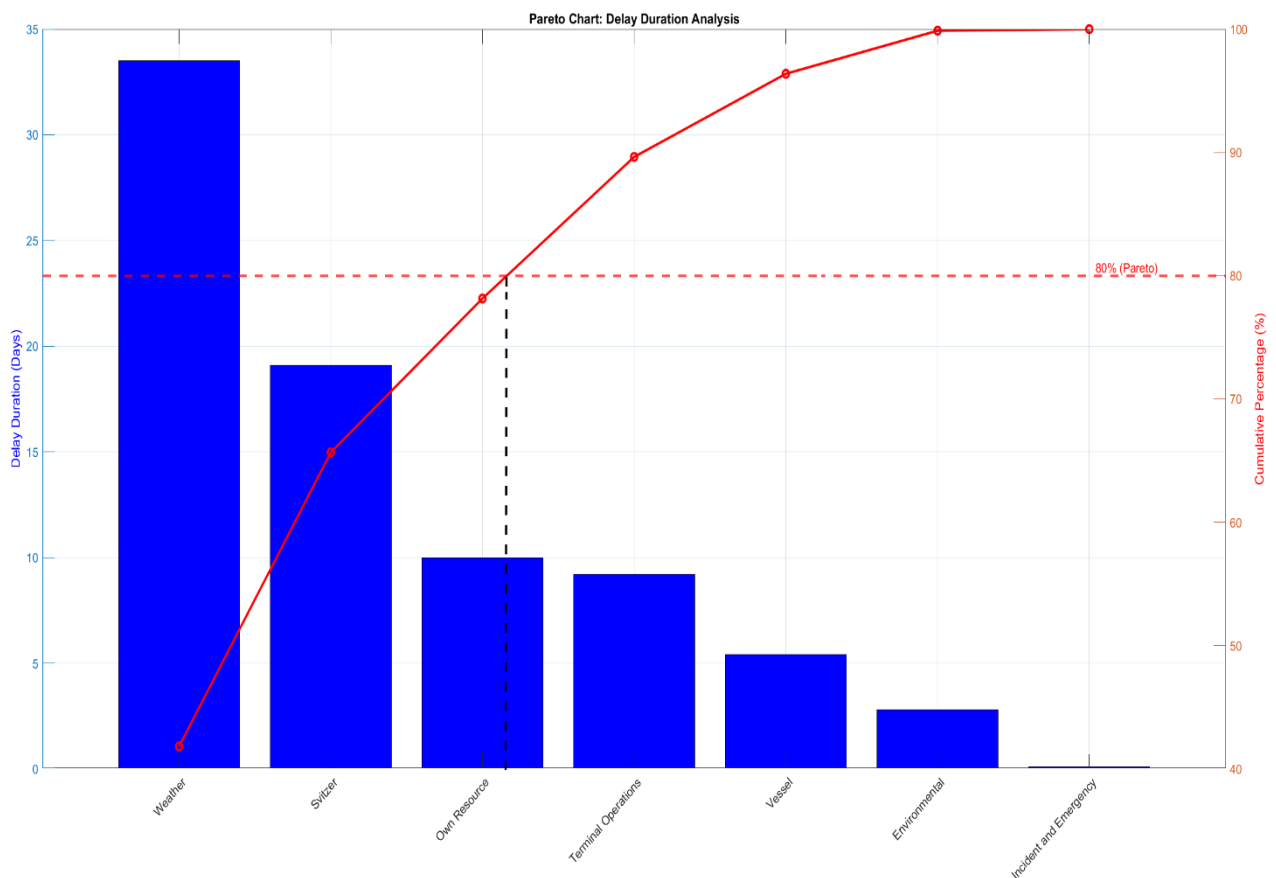


Fig 10

The application of pareto analysis is deemed necessary to ensure comprehensive investigation has been undertaken, to obtain essential information as a pre-requisite to preparation of a continuous improvement plan.

The analysis, as shown in *fig. 10* has been utilised to provide enhanced data interpretation and provides indicative guidance on which categories of delays are causing the biggest impact on delays. In this case the pareto analysis identifies that the ‘vital few’ categories are those of **Weather, Svitzer and Own resource.**

The decision was made to carry out the pareto analysis on the delay duration metric. The reasoning behind the selection, was due to the duration of delays metric having the greatest impact on organisational performance.

Continuous Improvement Proposal

Examination of analysed data has produced key information to enable the formulation of a robust continuous improvement proposal. The proposal focuses on the categories which have been identified during the pareto analysis (**Weather**, **Svitzer** and **Own resource**), although due to the interconnected nature of delays within shipping logistics, it is expected that the following proposal will also positively affect 'the trivial many' indirectly.

Key recommendations

1. Implementation of new marine logistics scheduling and management system
2. Improved quality communications between key stakeholders in the port
3. Review of critical resources and execution of actionable measures

The proposal outlines the implementation of an upgraded marine logistic scheduling and management system. The basis of the newly proposed shipping management system will provide greater efficiencies of logistics in and out of Milford Haven Port. The system will utilise AI to provide improved forecasting of shipping slots, achieved by optimum integration of key variables such as weather forecasting, tidal restrictions, pilot / tugboat resources and terminal shipping prioritisation requirements.

The second recommendation identifies that an improvement in quality communications between key stakeholders within Milford Haven Port will have a strong influence on reducing shipping delays into Dragon LNG Terminal. Effective planning of regular communications meetings, involving all relevant stakeholders is advised as a fundamental element in positively impacting delay issues.

The final aspect of the continuous improvement proposal is a thorough review of critical resources that directly affect shipping logistics within Milford Haven Port. Marine Pilot, Tugboat support and marine logistics control will form the basis of this part of the proposal. Addition or refinement of resources will be actioned where appropriate.

The objective of the proposal is to reduce delays, post implementation of the key recommendations. As previously stated, the target areas for increased efficiency are **Weather**, **Svitzer** and **Own resource**. The expectation is that successful implementation of each element of the proposal will achieve greater streamlining of marine logistics, resulting in reduced delays.

With the proposal fully implemented, it is not expected that the key improvements will enable the eradication of any one of the delay categories (causes), in its entirety. The plan is focused on reduction of target categories and due to the interconnected nature of the marine logistics industry, the assumption is that with optimised management, scheduling and communication a direct impact will be evident across various delay categories.

Understandably, external influences cannot be fully controlled and implementation of this proposed plan, cannot account for instances such as conflict or worldwide pandemics. However, proper execution of the proposal will integrate enhanced control, if external influences do arise.

Anticipation is that factors including **Terminal Operations** and **Incident and Emergency** cannot be directly affected by integration of the recommended actions. Delays caused by these factors, will be absorbed and offset by a reduction in the delay categories, which this proposal intends to target.

In terms of feasibility, the recommended upgrade to the marine logistics scheduling and management system will incur the greatest cost implication. However, the proposed system has the potential have the greatest impact on delay issues at Dragon LNG Terminal, whilst providing a return on investment within a short timeframe. If budget constraints prevent the implementation of the data driven system, recommendations 2 and 3 offer financially viable solutions, whilst ensuring improvement practices are executed.

Post implementation, a twelve-month period during 2024 will be utilised to monitor and record delay data. This data will provide vital information to enable analysis and data interpretation to be performed, essentially indicating the effectiveness of the proposal.

Post implementation results

Throughout the year 2024, shipping import delay data to Dragon LNG Terminal has been recorded to enable quantification and validation post implementation of continuous improvement proposal. The data has been analysed and graphically illustrated to display the results and the effectiveness of the embedded proposal.

Post implementation quantitative analysis

Fig. 11 and fig.12 represent a successful reduction in delays throughout 2024. The grand totals for delay duration and number of delays have decreased significantly from the previous year, with totals of 31.2 and 101 respectively.

Delay Category	Delay Duration (Days)	Number of Delays	Ratio (Days per Delay)
Own Resource	5.6	35	0.16
Svitzer	10.8	35	0.31
Weather	12.1	14	0.86
Environmental	1.8	9	0.20
Vessel	0.9	5	0.18
Incident and Emergency	0.1	2	0.05
Terminal Operations	0.0	1	0.00

Fig. 11

If we analyse the comparable data in more detail, the reduction in number of delays post implementation is 54 in total or 35.8% increase in efficiency. Furthermore, evaluation of the delay duration effectiveness indicates that there has been a reduction in total delay duration of 48.9 days or 61.1%. Additionally, each delay category ratio has been reduced, indicating the implementation of the proposal has affected the severity of each delay.

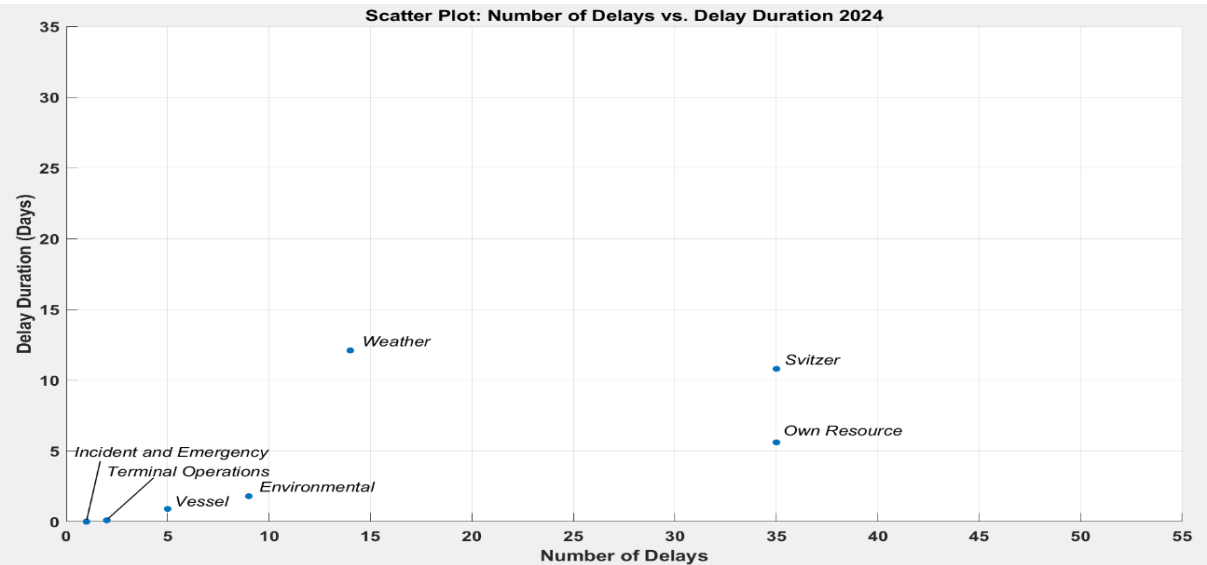


Fig. 12

The post implementation scatter diagram in *fig. 12* further represents the impact of the continuous improvement recommendations. The scale has remained constant, to aid visual impact of the proposal implementation against *fig. 8*.

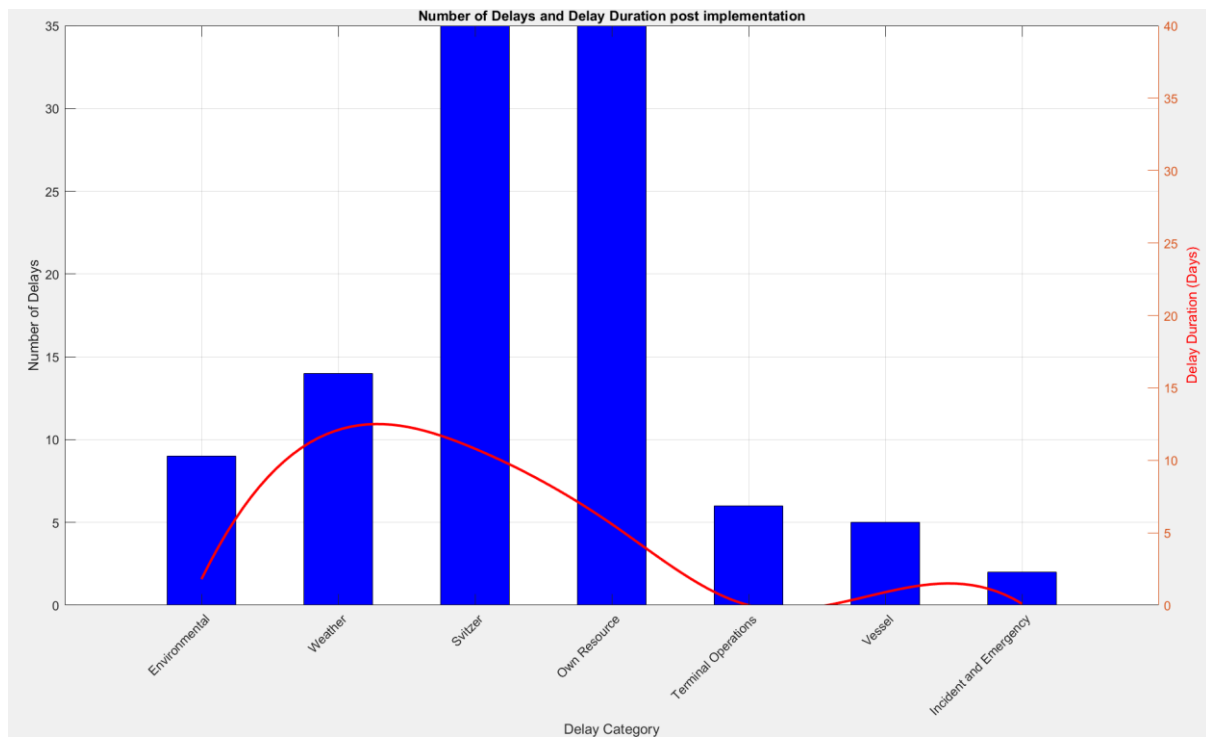


Fig. 13

A post implementation histogram illustrates the impact of continuous improvement strategy. Most noticeably the red plotted line doesn't exceed the total value of each category, implying that the severity (ratio) of each delay has been dampened.

RCA Results

Root Cause Analysis (RCA)																
Item:	Dragon LNG Shipping Delays			Responsibility:	C Robertson			RCA number:		1						
Model:	Organisational			Prepared by:	C Robertson			Page :		1						
Core Team:	Marine and Logistics								FMEA Date (Orig):		19/12/2023		Rev: 1			
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Fig. 14

RCA post implementation analysis detailed in *fig. 14*. Results are reinforced by the data in this report

Conclusion

The analysis of shipping delays at Dragon LNG Terminal has provided valuable insights into the primary causes of delays, particularly **Svitzer**, **Own Resource**, and Weather. Through various graphical representations and Pareto analysis, key delay categories were identified, forming the basis for a continuous improvement proposal.

The proposal, which focused on upgrading the marine logistics scheduling system, enhancing communication between stakeholders, and reviewing critical resources, was successfully implemented in 2024. This led to a 35.8% reduction in the number of delays and a 61.1% decrease in total delay duration, confirming the effectiveness of the recommendations.

While some external factors remain uncontrollable, the improvements have greatly reduced operational delays, enhancing terminal efficiency. The results suggest the proposed actions were successful, and ongoing monitoring will ensure continuous improvement. Further efforts should aim to maintain and refine these gains, ensuring long-term success and adaptability in the face of emerging challenges.

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