



Predictive Modeling of Mechanical Failures at Sea



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Industry Partner

Fleet Management Limited is a commercial shipping management company. They staff and manage logistics for over 500 vessels, from car carriers to chemical tankers.

Available Data

Two datasets of ship records:

- **Near Misses:** **almost** a problematic outcome (i.e. mooring rope left on deck that was spotted and cleared)
- **Incidents:** **actually** resulted in more than \$10,000 of damage or other severe consequence (i.e. life lost, disease outbreak)

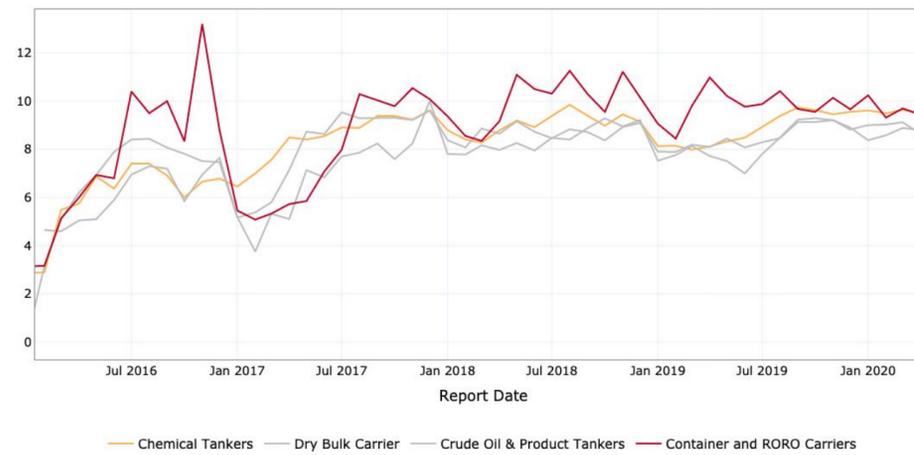
One observation per report, included metadata on ship type, date, location on ship, and more

Computing Environment

The data was provided to the team in Parquet files stored on various Amazon S3 buckets. These files were transformed to Python-readable CSV files that were manipulated and studied in Jupyter Notebooks within the Amazon SageMaker platform to adhere to data security policies.

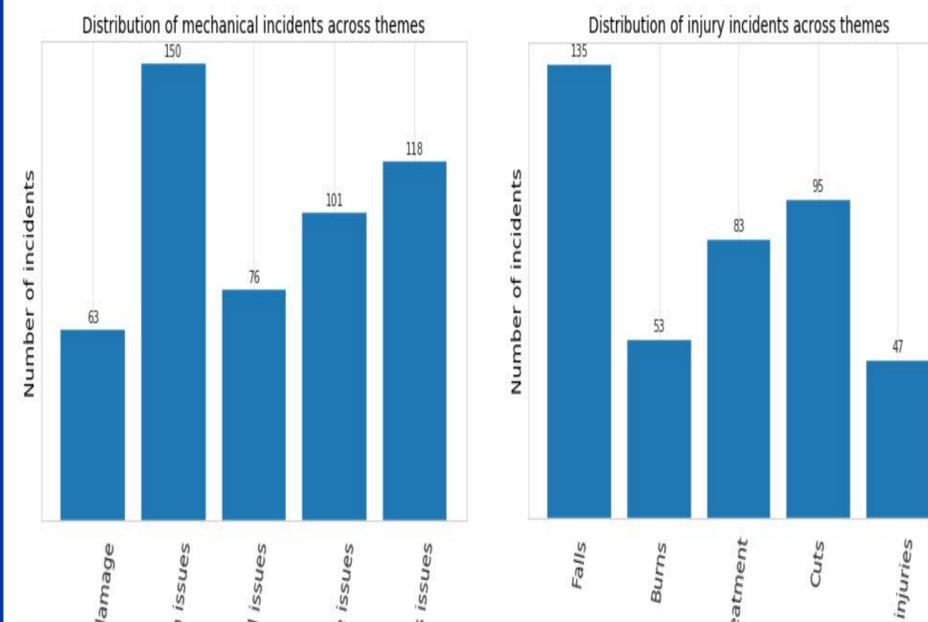
Time-Series Analysis

Near Misses Per Month Per Active Ship Across Ship Type



Near misses by vessel type were similar each month except for fluctuations around late 2016. The data had a clear transition from adoption to stability.

Topic Modeling

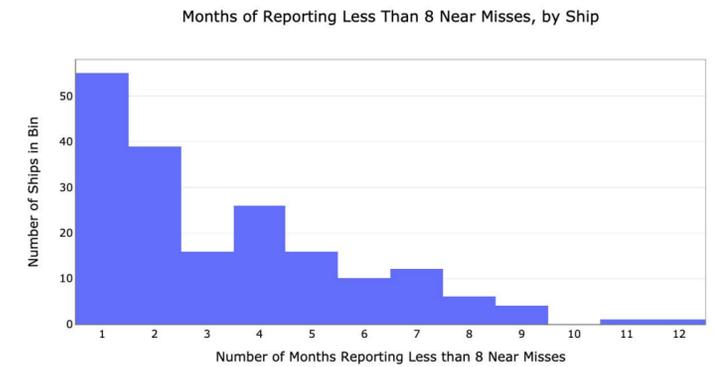


Most common incident types:

- Mechanical: mostly engine/pollution issues
- Injury-related: mostly falls

Finding Policy Violations

One of the client's official policies is that ships must report 8 near misses per-month:



Adherence to the policy is generally good. Few ships showed a consistent pattern of underreporting: 472 had 0 months under 8.

Metrics	Score Mean	Score Median	Score Min	Score Max	Soft Cut-Off (%)	Hard Cut-Off (%)
Mean	0.082	0.053	0.0	1.0	8.32%	5.45%
Median	0.079	0.060	0.0	1.0	7.42%	4.24%
Min	0.029	0.0	0.0	1.0	0.39%	0.31%
Max	0.205	0.160	0.0	1.0	44.48%	34.18%

After performing a word vector-based analysis on the similarity of the description fields, it seemed that aside from a few outlier vessels, most vessels were not reporting identical events.

Conclusions:

The work of this team has been critical in providing a first-look into the wealth of data available and potentially providing inspiration for policy changes or more focused analyses by the company in the future.



Predictive Modeling of Mechanical Failures at Sea



Project Team: Niko Hobart, Jackson Kennedy, Srishti Saha and Ahana Sen; PM: Anil Ganti

Client Partner

Fleet Management Limited is a commercial shipping management company. They staff and manage logistics for over 500+ unique vessels, ranging from car carriers to chemical tankers. They are headquartered in Hong Kong

Available Data

The data came in the form of records of activities occurring on ships that violated company guidelines or policy. This data was provided in two datasets:

- Near Misses: Occurrences that almost resulted in a problematic outcome (i.e. mooring rope left on deck that was spotted and cleared)
- Incidents: Occurrences that resulted in more than \$10,000 of damage or other severe consequence (i.e. life lost, disease outbreak)

For each dataset, one observation represented one report for an occurrence and included fields like description, category, type of vessel, date/time, etc.

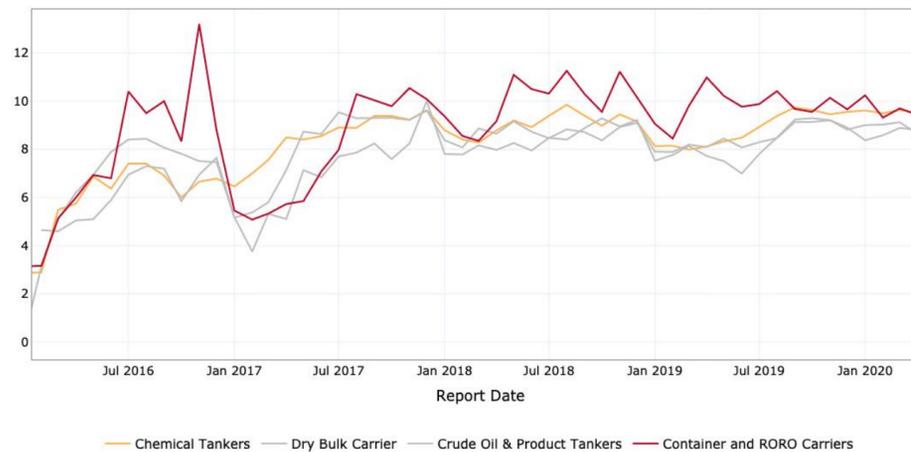
Preliminary Goals

Although the team originally planned to be working with sensor data to do predictive modeling, we adapted our goals to the data:

1. Analyze time-series and cross-sectional trends in near-misses and incidents in a manner accessible to business executives
2. Perform textual analysis on the descriptions of near misses or incidents to prepare a classification model

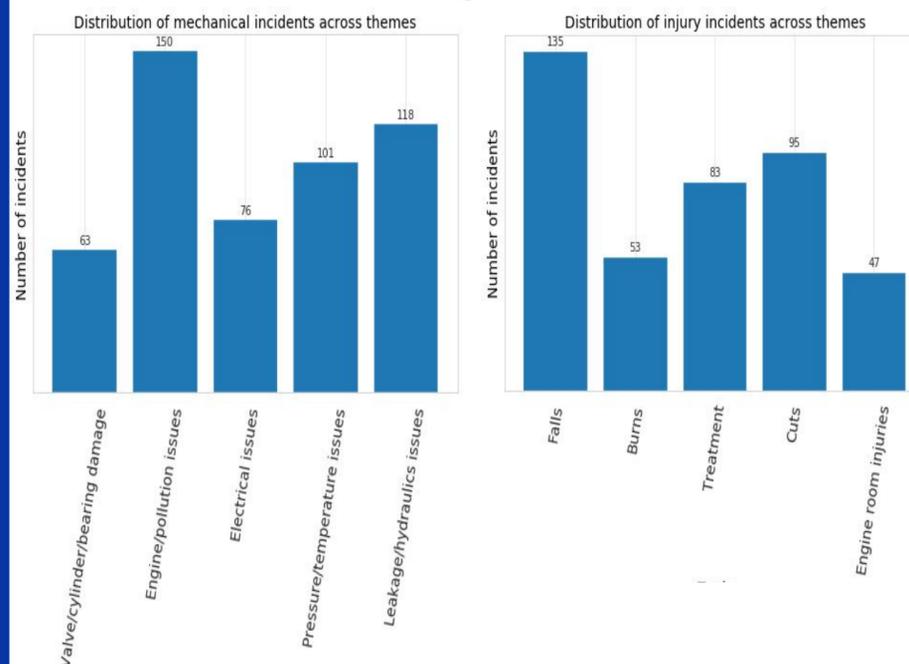
Time-Series Analysis

Near Misses Per Month Per Active Ship Across Ship Type



This graph reveals the nature of the quantities of near misses per ship over the time period captured in the data (2016-2020), in the 4 broad categories of vessels. It highlights, except for the early 2017 period, a stability in near misses across all vessel-types

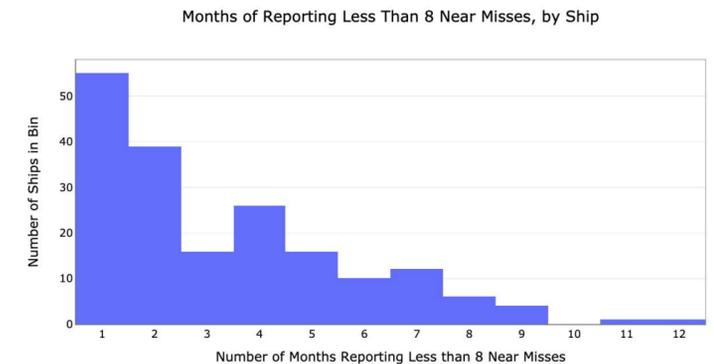
Topic Modeling



- Injury-related

Finding Policy Violations

One of the client's official policies is that ships must report 8 near misses per-month. The team was asked to look into trends surrounding the violation of this policy:



The initial analysis showed that adherence to the policy was generally high, especially when looking at ships that reported less than 7 near misses, where there was a lower number of repeat offenders.

Metrics	Score Mean	Score Median	Score Min	Score Max	Soft Cut-Off (%)	Hard Cut-Off (%)
Mean	0.082	0.053	0.0	1.0	8.32%	5.45%
Median	0.079	0.060	0.0	1.0	7.42%	4.24%
Min	0.029	0.0	0.0	1.0	0.39%	0.31%
Max	0.205	0.160	0.0	1.0	44.48%	34.18%

The team was also asked to look into ships reporting identical near-misses in order to meet their quota. After performing a word vector-based analysis on the similarity of the description fields, it seemed that aside from a few outlier vessels, most vessels were not reporting identical events.

Conclusions:

Additionally, although Fleet Management has collected a wealth of data, most of it has not been utilized to improve the performance of the company's systems thus far. The work of this team has been critical in providing a first-look into the scope and powers of the data available and potentially providing inspiration for policy changes or more focused analyses by the company in the future.