SAFER: Sensemaking Analytics For maritime Event Recognition
About MPA

The Maritime and Port Authority of Singapore (MPA) was established on 2 February 1996, with the mission to develop Singapore as a premier global hub port and international maritime centre (IMC).

MISSION

To develop and promote Singapore as a premier global hub port and an international maritime centre, and to advance and safeguard Singapore’s strategic maritime interests.

VISION

A leading maritime agency driving Singapore’s global maritime aspirations.

VALUES

Forward thinking
Integrity
Respect
Service Excellence
Teamwork

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MPA’s 3 Key Mission Objectives

Premier Global Hub Port
Port Authority
Port Regulator
Port Planner

International Maritime Centre
IMC Promoter
IMC Developer

Advance & Safeguard Singapore’s Maritime Interests
National Maritime Representative at IMO and other regional / international organisations / fora

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The port of Singapore comprises a number of facilities and terminals that handle a wide range of cargo transported in different forms, including containers as well as conventional and bulk cargo. The Maritime and Port Authority of Singapore (MPA) is responsible for the overall development and growth of the port of Singapore, which includes terminal operators, such as PSA Corporation and Jurong Port Pte Ltd.
Maritime Singapore

- **Contributes 7% to our nation’s GDP**
- **Over 170,000 employees**
- **More than 5,000 maritime establishments**
- **World’s busiest container transhipment hub**
- **Approximately 1,000 ships in the port of Singapore at any one time**
- **In 2017, vessel arrival tonnage reached 2.8 billion GT**
- **33.7 million TEUs of container throughput in 2017**
- **World’s top bunkering port with 50.6 million tonnes of bunker supplied in 2017**
- **The Singapore Registry of Ships (SRS) is amongst the world’s top 5 largest ship registries**

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The Next Generation Port 2030 was initiated to meet the increasing demands for international shipping and reliable port services as we move from the city terminals to the Mega Port at Tuas.

With the expected increase in maritime vessel traffic and capacity, MPA is working to ensure that the Port of Singapore is safe, secure, efficient and sustainable.
SAFER:
Sensemaking Analytics For maritime Event Recognition

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Project SAFER is a collaborative between MPA and IBM research to develop and test innovative analytics-based technologies aimed at improving maritime and port operations to cater to increasing growth in Singapore’s vessel traffic.

The SAFER system is capable of automating and increasing the accuracy of critical tasks that previously relied on human observation, reporting. Very High Frequency (VHF) communication and data entry.

Pilot Boarding Detection
Enables MPA to automatically detect pilot boarding time. This provides an efficient way of monitoring and validating pilotage service levels, reduces staff workload and speeds up dispute resolution.

Utilisation Prediction
Provides advanced information on traffic density in high-utilisation areas to help MPA officers be proactive in ensuring port water safety.

Automated Movement Detection
Through cognitive analytics and advanced filtering, vessel movement is automatically identified, the risk of the workload of MPA officers while simultaneously improving the accuracy of the movement locations and timing.

Illegal Bunkering Detection
Using advanced machine learning-based vessel models, illegal bunkering activities are automatically detected and reported. Typically, MPA’s Bunkering Surveyor is派 to assess all suspicious activities. Further enhancing MPA’s regulatory role.

Prediction of Vessel Arrival Time
Through accurate prediction of vessel arrivals, time which is updated continually, just-in-time services are facilitated, improving the productivity and efficiency of terminal operators and maritime service providers.

Infringement Analytics
Employs a targeted approach for detecting suspicious or abnormal vessel behaviour through machine learning-based vessel models, this improving the efficiency of a Port Inspector’s daily routine.

Detection of Vessel Entering Prohibited Areas
Aids MPA in enforcing safety and security by creating a virtual fence in port waters to identify and localise unauthorised entry into prohibited areas.

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SAFER Building Blocks

Data Analytics Layer

- **Predictive Analytics**
  - Utilisation prediction
  - Movement prediction
  - Collision Prediction
  - ETA prediction

- **Sense-Making Analytics**
  - Pilot Boarding Detection
  - Vessel Profiling
  - Operating without permit
  - Speeding
  - Prohibited area entry
  - Illegal bunkering
  - Off Transponder

Sense-making Framework - Data Validation Layer

- **Entity Resolution**
  - Improve data quality by analysing vessel data to uniquely identify vessels based on multiple identities assigned to a single vessel

- **Vessel Modelling**
  - Model the typical spatiotemporal movements of different categories of vessels to flag out deviations from typical behavior

Data Capture Layer

- **MPA Systems, Sensors and Databases**
  - Port Infringement
  - Port Clearance
  - Pilot Vessel
  - Ship Permit
  - Radar/AIS
  - Vessel particulars
  - Vessel movement
  - Pre-arrival notification
  - Port location
  - Electronic chart

Data Visualisation Layer

- **Unified Dashboard**
  - Provide a unified web-based SAFER dashboard

- **Reports**
  - Provide daily/weekly anomalies reports for follow up investigations and actions

- **System Integration**
  - Integrates with Port Traffic Management System (PTMS) for automated movement capturing

- **Mobility**
  - Accessible via mobile devices for enforcement officers

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Background

MPA Port Operations Control Centre (POCC)

- Nerve centre of MPA’s port operations
- Manage port traffic and provide advice to ship passing through Singapore Straits to ensure safety of navigation
- Handles > 1000 ship arrivals daily
- > 4000 intra port vessel movements reported over VHF and captured in Port Traffic Management System (PTMS) daily. Leads to:
  - Significant time spent in data entry
  - Inconsistent reporting times
  - Prone to human error

Automated Movement Detection

Data Ingestion → Data/Vessel Models → Analyse & Detect in real time → Vessel Movement start/end time & location → Auto update → Port Traffic Management System (PTMS)

Vessel Traffic Information System (VTIS) Data

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Automated Movement Detection

**Results achieved**

- **> 1000**
  - Live vessel tracks validated

- **95 %**
  - Of vessel tracks validated are within 15 minutes accuracy

- **90 %**
  - Of location accuracy achieved

- **100 %**
  - Feedback from user is positive

**Benefits / Impact**

- **34%**
  - Time savings

- **Reduce**
  - Work load and VHF communication

- **Eliminate**
  - Manual entry and input errors

- **100%**
  - Consistency in movement reporting times

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Background

MPA Port Inspectors conducts round the clock patrols and inspections to enforce regulations within our waters.
- Harbour craft are usually caught flouting regulations.
- Common infringements include:
  - Operating in port waters without valid permits
  - Speeding
  - Automatic Identification System (AIS) transponder related issues
  - Harbour craft licensing issues
- While effective, there is a limit to how many harbour craft the Port Inspector (PI) can inspect per shift.

Infringement Analytics

**MPA Port Enforcement**

Infringement Analytics

**VTIS, Licensing and Permit Systems Data**

**Data Ingestion**

**Data Models & Algorithms**

**Data analysis, Sense make & Detect in real time**

**Display as an alert on the PI’s iPad**

**Investigate**

**Conduct Inspection**

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Infringement Analytics

Results achieved

- **> 10** Infringements raised during trial
- **80 %** Accuracy in terms of alerts generated
- **70 %** Feedback from user is positive

Benefits / Impact

- **Targeted** approach in conducting inspections
- **Effective** resource planning
- **Improve** enforcement of navigational safety
- **Clear** signal to harbour craft community

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Illegal Bunkering Detection

**Background**

- Singapore is the top bunkering port in the world
- > 50.6 million tonnes of bunker supplied in 2017
- Ensure bunker operations are open and transparent and in accordance with regulations
- To maintain Singapore’s position as a top bunkering port

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**Top Bunker Port**

**Illegal Bunkering Detection**

- VTIS, Licensing and Permit Systems Data
- Data Ingestion
- Data/Vessel Models & Algorithms
- Data analysis, Sense make & Detect
- Display a report on SAFER system
- Investigate
- Conduct investigation

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Illegal Bunkering Detection

Results achieved

- 2 cases of wrong declaration detected
- 85% accuracy in terms of results generated
- 90% feedback from user is positive

Benefits / Impact

- Improve detection of non-declaration of bunker activities
- Uncover complex and suspicious activities
- Maintain position as top bunkering port
- Open and Transparent
Pilot Boarding Detection

Automatically detects pilot boarding time to enable efficient monitoring of pilotage service levels

Benefits / Impact
- A more efficient way of monitoring and validating pilotage service level
- Reduce the workload of officers and eliminate the need for random audit
- Aid in dispute resolution between PSAM and vessel agent
- Dispute resolution from 2 weeks to 3 days

Detection of Vessel Entering Prohibited Areas

Employs geo-fencing technology to identify and localise unauthorized entries into prohibited areas

Benefits / Impact
- Enforcement of security at prohibited areas as it ensures that only authorized vessels and personnel are allowed to enter these areas

Utilisation Prediction

Provides advance information on traffic density in high utilisation areas to support maritime safety

Benefits / Impact
- Enable VTM officers to have advance information on the traffic condition ahead of time
- Aid VTM officers in providing advisory to moving vessels of impending traffic condition at sensitive areas
- Aid VTM officers in exercising due diligence and care in monitoring the port waters when the traffic density is high

Prediction of Vessel Arrival Time

Accurately predicts vessel arrival time to facilitate Just-In-Time services and improve productivity of terminal operators and marine service providers

Benefits / Impact
- Facilitates the provision of just-in-time services by terminal operators and maritime service providers
- Enable the service providers to better manage their resources, thus improving the productivity and efficiency
Well Recognised Internationally and Locally

Project SAFER team at INFORMS IAAA held at Baltimore, USA on April 15 - 17, 2018.

Minister's Innovation Award 2017
Distinguished Award

EXCEL Innovation Project Award on 4 Jul 2018
Project SAFER was featured at the Public Sector Transformation Exhibition 2018 that was held at Resorts World Convention Centre on 3 and 4 Jul 2018.

Achievements

Moving Forward – SAFER 2.0

New Products & Services for the Maritime Industry

Co-Innovation & Co-Development
Create an enabling environment for maritime innovation, co-development and test-bedding of innovative solutions

Application Programming Interface (API)

Microservices

Singapore Maritime Data Hub

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