The Application of Big Data for Ship Operational Efficiency

11th June 2015

Hideyuki Ando, MTI (NYK group)
Outline

1. Introduction of MTI
2. Fleet operation and operational efficiency
3. Big data and ship performance model
4. Big data applications
5. Summary
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3. Big data in shipping
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MTI (Monohakobi Technology Institute)

Company profile

<table>
<thead>
<tr>
<th>Company name</th>
<th>Monohakobi Technology Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Established</td>
<td>April 1, 2004</td>
</tr>
<tr>
<td>Number of employees</td>
<td>63 (as of April 1, 2015)</td>
</tr>
<tr>
<td>Head office</td>
<td>7th floor, Yusen Building, Chiyoda-ku, Tokyo</td>
</tr>
<tr>
<td>Branch office</td>
<td>Singapore</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Yokohama</td>
</tr>
<tr>
<td>Stockholder</td>
<td>NYK (100%)</td>
</tr>
</tbody>
</table>

R&D

- Maritime Technology Division
  - Maritime Information Group
  - Maritime Technology Group
  - Singapore Branch
- Logistics Technology Group
  - Logistics Group

Sales

- Maritime technology
- Logistics technology
- Sales Group
- Yokohama Lab.

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# NYK fleet (as of the end of March 2014)

<table>
<thead>
<tr>
<th>Type</th>
<th>Vessels</th>
<th>DWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containerships (including semi-containerships and others)</td>
<td>101vessels</td>
<td>5,572,991 DWT</td>
</tr>
<tr>
<td>Bulk Carriers (Capesize)</td>
<td>129 vessels</td>
<td>24,576,302 DWT</td>
</tr>
<tr>
<td>Bulk Carriers (Panamax &amp; Handysize)</td>
<td>286vessels</td>
<td>17,597,420 DWT</td>
</tr>
<tr>
<td>Wood-chip Carriers</td>
<td>49 vessels</td>
<td>2,580,879 DWT</td>
</tr>
<tr>
<td>Cruise Ships</td>
<td>3 Vessels</td>
<td>21,577 DWT</td>
</tr>
<tr>
<td>Car Carriers</td>
<td>125 vessels</td>
<td>2,230,958 DWT</td>
</tr>
<tr>
<td>Tankers</td>
<td>77 vessels</td>
<td>12,056,781 DWT</td>
</tr>
<tr>
<td>LNG Carriers</td>
<td>29 vessels</td>
<td>2,172,415 DWT</td>
</tr>
<tr>
<td>Others</td>
<td>26 vessels</td>
<td>318,002 DWT</td>
</tr>
</tbody>
</table>

877 vessels
68,036,568Kt (DWT)
Fleet operation

- Fleet operation pursue best performance in terms of safety, economy and environment
  - Minimize cargo damage and downtime
  - Schedule integrity
  - Cost saving
  - Environment conservation
Operational efficiency – ship operator’s view

Customer/Society

Quality Assurance

Ship Operator

Quality Management

Ship Owner

Ship

Ship

Ship

Ship

Ship Operator’s Fleet

Quality Shipping
• Safety
• Environment
• Schedule
• Cost
Operational efficiency – ship owner’s view

Quality Shipping
- Safety
- Environment
- Schedule
- Cost

Ship Operator

Customer/Society

Quality Assurance

Ship Owner

Ship Operator’s Fleet

Ship Owner

Ship

Ship

Ship

Ship

Ship Owner

Ship

Ship

Ship

Ship Owner

Ship
Performance management

Performance management is an organizational improvement process by using performance monitoring.

- Share objective among related parties
- Continuous improvement and learning cycle with performance monitoring
- Pursue target by Information sharing and collaboration
Operational efficiency project with NYK

NYK IBIS Project (2012-)

IBIS – Innovative Bunker and Idle time Saving

Fuel Efficiency Helped NYK Line Succeed in 2013

Tuesday January 7, 2014

Efficiency improvements, particularly reductions in fuel consumption, helped Japan’s Nippon Yusen Kaisha Line (NYK Line) succeed in 2013, despite a difficult market and high bunker prices, President Yasumi Kudo said in his New Year statement.

Kudo said the shipping company reduced "muda," or wasted activity, through initiatives including its "Innovative Bunker and Idle-time Saving" (IBIS) project, which shares real-time information between land and ships to economise ship movements, and an air-lubrication system adopted on the vessel Soyo to increase fuel efficiency.

NYK Line President Yasumi Kudo said the company faced difficult conditions in 2013

Article from Ship and Bunker

Fuel cost saving by IBIS $40 million in 2013
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Big data in shipping

The followings are examples of Big data, by which MTI try to create values

**Voyage data**
- Automatically collected data
- Noon report

**AIS data**
- Satellite AIS / shore AIS

**Weather data**
- Forecast / past statistics

**Business data**
- Container transport data

**Trouble data**
- Engine trouble data
Big data processing flow

Provide information to right people at right time for assisting their situation awareness for right decision and action
Our data collection platform
**SIMS (Ship Information Management System)**

- **SIMS Data Collection System Onboard**
  - Inmarsat-FBB / VSAT
  - GPS
  - Doppler log
  - Anemometer
  - Gyro Compass
  - VDR / ECDIS
  - Data Acquisition and Processing
  - Viewer

- **SIMS unit**
  - Motion sensor

- **<Navigation Bridge>**
  - Voyage Analysis Report
    - Break down analysis of fuel consumption for each voyage
  - Technical Analysis (MTI)
    - Trend monitoring of speed, M/E RPM, fuel consumption and other conditions per hour
    - Engine monitoring

- **<Engine Room>**
  - Main Engine
  - FO flow meter
  - Torque meter
  - Engine Data Logger

- **Data Center**
  - SIMS auto logging data (per hour) & SPAS electronic abstract logbook data (per day)

- **SIMS Monitoring & Analysis System at Shore**
  - Operation Center
    - Singapore, ....

- **Weather routing service provider**
  - Feedback to captains
  - Communications via Technical Management
  - Report
  - SIMS Viewer

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SIMS as open platform
Open platform = interface to 3rd party applications

SIMS is a computer system to collect onboard equipment data and share it with 3rd parties' onboard and shore applications

Candidate 3rd party applications include

- Weather routing
- Vessel performance analysis
- Engine condition monitoring
- Remote maintenance
Shore dashboard for ship operator

Ship operator can easily check current situation of the vessel and voyage records.

Map:
- ship position
- ship speed
- Beaufort scale
- wind direction

Trend graph:
- departure time
- arrival time
- ship speed
- RPM
- fuel consumption
Shore dashboard for ship technical manager

Ship technical manager can check engine plant condition of each vessel

Trend graph group: (diesel engine ship)
- M/E Exh. Gas & Scav. Air & JCFW
- M/E T/C & A/C
- M/E FO & LO
- M/E Torque Rich
- M/E Exh. Gas x M/E Load
- M/E SFOC
- M/E Cylinder Oil Consumption
- D/G & S/G & T/G
- Boiler & EGE
- M/E Performance

Steam turbine vessel version will be released in July 2015
Ship performance – key technology for analysis

6500TEU Container Ship
Wave height 5.5m, Wind speed 20m/s
BF scale 8, Head sea

@ engine rev. 55rpm
<Calm sea performance>
speed: 14 knot
FOC: 45 ton/day

<Performance in the rough sea (BF8)>
speed: 8 knot
FOC: 60 ton/day

Effecting factors
1. Weather (wind, wave and current), 2. Ship design (hull, propeller, engine), 3. Ship condition (draft, trim, cleanliness of hull and propeller, aging effect)
Ship performance in all weather

<Target vessel>
6500TEU Container
Draft 12m even

Sea condition
Beaufort scale

<table>
<thead>
<tr>
<th>Beaufort</th>
<th>Wind speed (m/s)</th>
<th>Wave height (m)</th>
<th>Wave period (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>BF3</td>
<td>4.5</td>
<td>0.6</td>
<td>3.0</td>
</tr>
<tr>
<td>BF4</td>
<td>6.8</td>
<td>1.0</td>
<td>3.9</td>
</tr>
<tr>
<td>BF5</td>
<td>9.4</td>
<td>2.0</td>
<td>5.5</td>
</tr>
<tr>
<td>BF6</td>
<td>12.4</td>
<td>3.0</td>
<td>6.7</td>
</tr>
<tr>
<td>BF7</td>
<td>15.6</td>
<td>4.0</td>
<td>7.7</td>
</tr>
<tr>
<td>BF8</td>
<td>19.0</td>
<td>5.5</td>
<td>9.1</td>
</tr>
<tr>
<td>BF9</td>
<td>22.7</td>
<td>7.0</td>
<td>10.2</td>
</tr>
</tbody>
</table>

0deg (wind, wave) – head sea

Wind and wave effect
Base line performance
Performance model correction by measurement data

Measurement data

Performance model correction
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# Big data application areas

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<thead>
<tr>
<th>Role</th>
<th>Function</th>
<th>Example of Big data application</th>
</tr>
</thead>
</table>
| **Ship operator** | **Operation**     | • Energy saving operation  
• Safe operation  
• Schedule management |
|               | **Fleet planning**| • Fleet allocation  
• Service planning  
• Chartering           |
| **Ship owner**  | **Technical management** | • Safe operation  
• Hull & propeller cleaning  
• Condition monitoring and maintenance  
• Environmental regulation compliance  
• Energy saving retrofit |
|               | **New building**  | • Design optimization                                                   |
Optimum weather routing with performance monitoring

Weather Routing (PLAN)

- Voyage plan
  + course, speed, RPM, FOC, weather
  + ship performance model

Monitoring (CHECK)

- Voyage actual
  + actual speed – RPM, RPM - FOC
  + actual weather

Ship model and weather forecast are inherently include errors.
But feedback loop by monitoring can make this system work better.
Service optimization

Service route

Ship performance model

Hindcast weather data

Estimation of
- Sea Margin
- Sailing time
- Average Speed
- Total FOC
Fouling risk assessment

Fouling risk assessment will be conducted by using the following information:

- Operation profile
- Long term performance analysis
- Lay-by days/area/season

To recommend underwater inspection and hull/propeller cleaning.
Energy saving hull modification

Operation profile
- Speed, RPM, Power
- Draft, trim, displacement
- Weather
- Sea margin
- etc

Energy saving modification
- Bulbous bow modification
- Install energy saving device (MT-FAST)
- etc

23 % CO2 reduction was confirmed
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Summary

• Big data has a big potential to improve operational efficiency in shipping. Reliable ship – shore network and data collection platform is necessary.

• One of the key technology to utilize big data is accurate ship performance model

• We need to understand two different perspectives of ship owner and ship operator for making Big data applications

• Several Big data applications are introduced
Thank you for your attention