Challenges, Potentials and Perspectives of Information Management in Ship Management

Tanker Operator Conference, Hamburg, 17.09.2013

Ole John, Fraunhofer CML
Agenda

1. Introduction
2. Challenges
3. Potentials and Perspectives
Agenda

1. Introduction
2. Challenges
3. Potentials and Perspectives
Fraunhofer-Gesellschaft

- Largest organization for applied research in Europe
- Contract research for direct benefit of business and in the interest of the society
  - 2/3 of research revenue is derived from contracts with industry and from publicly financed research
  - 1/3 is contributed by German federal and state governments in the form of institutional funding
- 80+ research institutions
- 22,000 employees
- 1.9 billion Euro (2012) research budget
Fraunhofer Center for Maritime Logistics and Services
Logistics innovations within the maritime industry

Challenges
- Productivity
- Ecology
- Safety & Security

Field of research
Maritime logistics chain
- Hinterland
- Port & Terminal
- Vessel
- Port & Terminal
- Hinterland

Research topics
Processes
- Process design and control
  - Coordination
  - Synchronization
  - Information Techn.

Planning
- System planning and optimization
  - Tools
  - Integration
  - Participation

Forecasts
- Forecasting and market research
  - Technologies
  - Markets
  - Strategies

Material flow
Information flow
Services
Systems and Technologies
Decision making requires information

“Shipping is complex business. Scheduling, network operations, intermodal transit, equipment availability, customs, ancient maritime laws, labyrinthine documentation, hurricanes, earthquakes, piracy, war, fluctuating oil prices, insurance premiums, canal tolls…”

Eivind Kolding, Maersk Line CEO
Maersk’s Need for Change Manifesto, June 2011
The underlying challenge of decision making is the acquisition of information

"Information management is the economic planning, purchasing, converting, distribution and allocation of information as resource for preparation and support of decisions as well as the design of the necessary framework requirements (Voß 2011)."
The alignment of information needs and provided information is already challenging for one sub-area in ship management.
Agenda

1. Einführung
2. Challenges
3. Potentials and Perspectives
Challenge 1: Diversity of Tasks

- Data management
- Transparency
- Decision support
- Technical Management
- Quality & Safety Management
- Procurement
- Crewing
- Financial Management
- Compliance aspects
- Data migration
- Crew welfare
- Training
- Regulations
Challenge 2: Market challenges

Market pressure increases the willingness to embrace change

Increase of total shipping operating costs (%)

Are you actively changing your organizational processes or approaches to master the current market?

- Yes: 50%
- Partly: 27%
- No: 12%
- Not involved: 12%

Drewry, Ship Operating Costs 2010-2011
Study Best Practice Ship Management 2013
Study – Best Practice Ship Management 2013 (BSPM 2013)

- Objectives:

- Tasks:
  - Analysis of status quo by interviewing decision makers on a global scale
  - Interviews have been backed up by the expertise of GL and CML

- Outcome:
  - Best practice ideas and best practice examples of ship managers worldwide.
BPSM 2013 – Main Challenges and Reasons

Main Challenges

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Crewing</td>
<td>88%</td>
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<td>Technical</td>
<td>62%</td>
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<td>Management</td>
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<tr>
<td>Financial</td>
<td>50%</td>
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<tr>
<td>Management</td>
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<tr>
<td>Quality &amp; Safety</td>
<td>27%</td>
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<tr>
<td>Procurement</td>
<td>12%</td>
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</tbody>
</table>

Reasons

Cost pressure: 62%
New regulations: 58%
Compliance demands: 54%
Competitive situation: 50%
Environmental requirements: 38%
Availabilities of new technologies: 23%
Other: 19%

Examples

By looking at other companies: 65%
By external advice: 38%
Others: 31%
BPSM 2013 - Expectations regarding the role of ICT in implementing best practice

Role of ICT today

Main Challenges

- Usability
- Management of master data
- Document management
- Data migration
- Administration / support cost
- Security

Role of ICT in future

Main Opportunities

- Seamless information flow
- Better decision support
- Integration of ERP/BI solutions
Challenge 3: Variety of systems

Rapidly growing number of media and types of information systems

Core Modules of Fleet Management Systems

- Planned maintenance
- Safety & Quality and Risk
- Financial Management
- Procurement
- Voyage & Operation
- Charter Management
- Supplementary functions of FMS

- SATCOM
- Vessel Client
- AIS
- Weather routing
- Mobile Applications
- LRIT
Study - Fleet management systems 2013

- Objectives:
  - Provide an overview about fleet management systems and their functions

- Tasks:
  - Enhance transparency and collect information about producers, systems and their functions
  - Identification of software systems and modules

- Outcome:
  - Extensive product overview
  - Market trends

Agenda

1. Introduction
2. Challenges
3. Potentials and Perspectives
Potentials and Perspectives

Future oriented Ship Management

Efficient operation of ships

Cooperation

Information management
Potential 1: Efficient operation of ships

- Procedural: Condition Based Monitoring (CBM) Lifecycle Management (LCM)
- Operativ: Slow Steaming Weather Routing
- Technical: Ship Design
Potential 2: Cooperation

- E-Commerce (E-Marketplace)
- Standards (Data Formats)
- Single Window
Potential 3: Information management

- Use of various information systems
- Control of global information tide
- Using of relevant information for decision support
Decision support through relevant Information

1. Reactive Preparation
   - Target-oriented records
   - Meaningful analyses of past data

2. Active support
   - Supply of planning functions and
   - Prediction models
Decision support: (1) crew requirement planning
Major goal of crew requirement planning is to align crew demand generated by the (future) fleet with crew supply

**DEMAND**
How many seafarers needed to fulfill safe operations 24h / 365d?

- number of ships
- ship classes / ship types
- safe manning certificates
- leave time allowances
- sick leave
- process / planning inefficiencies
- ...

**SUPPLY**
How many seafarers will be available on the company roster?

- current seafarer base
- promotions
- fluctuations
- ...

Future Demand

Future Supply

(e.g. measured in FTE for a full year in two years from today)
CMLs analytical approach based on demand analysis and supply projection

EXAMPLE: Master, Eastern-European Tariff, Tanker, Class XY

Analysis of different scenarios possible (e.g. variation of number of ships)

Analytically derived demand addition factors

Supply Projection Factors

Base Demand

Demand Future

Supply t+1

Supply prev. year
Crew Requirement Planning Cube used to allow analysis and planning on any granularity level

Dimension Ship
- Ship
- Ship Class
- Ship Typ
- Ship Management Pool

Dimension Position
- Position

Dimension Person
- Nationality/Wage Scale
- Permanent/Non permanent contract
- Rank
- Ship Class

Dimension Period
- Days
- Months
- Quarter
- Year
Analytical approach can disclose efficiency potentials already in the analysis phase

Activity Analysis of existing seafarers

<table>
<thead>
<tr>
<th>Share of time spent with activity [%]</th>
<th>average duration per activity [days]</th>
</tr>
</thead>
<tbody>
<tr>
<td>sea service</td>
<td>58%</td>
</tr>
<tr>
<td>paid vacation</td>
<td>31%</td>
</tr>
<tr>
<td>unpaid leave</td>
<td>3%</td>
</tr>
<tr>
<td>waiting</td>
<td>3%</td>
</tr>
<tr>
<td>travel</td>
<td>2%</td>
</tr>
<tr>
<td>sick leave</td>
<td>2%</td>
</tr>
<tr>
<td>training</td>
<td>1%</td>
</tr>
</tbody>
</table>

- Process inefficiencies could be discovered through data analysis
- Decomposing activities allows for benchmarking (int./ext.) to quantify potential
Decision support: (2) crew scheduling planning
Project EIS – Excellence Initiative Ship Management

- Goal: Development of an industry solution for ship management
- Funding: EFRE (EU, Hamburg)
- Period: 2/2012 – 8/2014 (30 Monate)
Output of crew scheduling in ship management

→ For every position on every ship: Assignment of seafarers for a specific time period

Example: Cap Roberta

<table>
<thead>
<tr>
<th>Master</th>
<th>D. Vaclev</th>
<th>J. Below</th>
<th>I. Jacek</th>
<th>M. Smirnow</th>
<th>A. Popow</th>
<th>A. Titow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chief Officer</td>
<td>I. Nikitin</td>
<td>A. Iljin</td>
<td>J. Baranow</td>
<td>A. Lasarew</td>
<td>P. Kusmin</td>
<td>…</td>
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<tr>
<td>2nd Officer</td>
<td>…</td>
<td>P. Estrada</td>
<td>S. Pelaez</td>
<td>T. Ramos</td>
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<tr>
<td>3rd Officer</td>
<td>T. Aquino</td>
<td>F. Villa</td>
<td>M. Quezon</td>
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<tr>
<td>Chief Engineer</td>
<td>U. Lopez</td>
<td>F. Roxas</td>
<td>Z. Tolentino</td>
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<tr>
<td>2nd Engineer</td>
<td>J. Binay</td>
<td>W. Aguinaldo</td>
<td>C. Romulo</td>
<td>I. Remonde</td>
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<tr>
<td>3rd Engineer</td>
<td>…</td>
<td>Y. Nowikow</td>
<td>P. Petrow</td>
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<tr>
<td>4th Engineer</td>
<td>A. Kusmin</td>
<td>J. Gussew</td>
<td>B. Sorrokin</td>
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</tbody>
</table>

Month: 0 1 2 3 4 5 6 7 8 9 10 11 12
Challenges of crew scheduling in ship management

- Various requirements
- Large problem sizes
  - Large ship managers have hundreds of ships and thousands of seafarers
- Long term planning
  - It is done mostly for short term
- Less reliability of seafarers
- Feasibility check to manage new ships
  - It is done mostly through a rough estimation
Sequential approach

1. Construct the contract periods on the ships (contract period construction problem)

2. Assignment of the seafarers to the constructed contract periods (crew assignment problem)
## Sequential Approach – Contract Period Construction

1. **contract period construction**
2. **crew assignment**

<table>
<thead>
<tr>
<th>Role</th>
<th>Months Covered</th>
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<tr>
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<tr>
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<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</td>
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<tr>
<td>2nd Officer</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</td>
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<td>3rd Officer</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</td>
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<td>Chief Engineer</td>
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<td>4th Engineer</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</td>
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</table>
### Sequential Approach – Crew assignment

1. **Contract Period Construction**

2. **Crew Assignment**

<table>
<thead>
<tr>
<th>Month</th>
<th>Master</th>
<th>Chief Officer</th>
<th>2nd Officer</th>
<th>3rd Officer</th>
<th>Chief Engineer</th>
<th>2nd Engineer</th>
<th>3rd Engineer</th>
<th>4th Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>D. Vaclev</td>
<td>I. Nikitin</td>
<td>...</td>
<td>T. Aquino</td>
<td>U. Lopez</td>
<td>J. Binay</td>
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<td>A. Kusmin</td>
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<tr>
<td>1</td>
<td>J. Below</td>
<td>A. Iljin</td>
<td>P. Estrada</td>
<td>F. Villa</td>
<td>F. Roxas</td>
<td>W. Aguinaldo</td>
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<td>J. Gussew</td>
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Constraint 1: A Crew Change can only be conducted in a port
Constraint 2: Minimum time interval between some crew changes

<table>
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<tr>
<th>Month</th>
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</table>
Constraint 3: Maximum deviation from a fixed contract duration

Maximum deviation: x days

- 0-5 days deviation
- 5-10 days deviation
- 10-20 days deviation
- 20-30 days deviation

<table>
<thead>
<tr>
<th>Month</th>
<th>Master</th>
<th>Chief Officer</th>
<th>2nd Officer</th>
<th>3rd Officer</th>
<th>Chief Engineer</th>
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</table>
Contract Period Construction Problem

Further possible constraints:

- The number of position changes in the same port has to be less than a maximum value.
- The number of crew changes for one ship has to be less than a maximum value.

Possible objective values:

- Minimize the number of crew changes (crew change fix costs)
- Minimize the deviation from the fixed contract durations
## Crew assignment - Constraints

**Constraint 1**: Extended overlap for new seafarers in rank or in the company

- **1 day overlap**
- **5 days overlap**

<table>
<thead>
<tr>
<th>Position</th>
<th>Month</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Master</strong></td>
<td>4</td>
<td>A. Popow</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>M. Smirnow</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>A. Titow</td>
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<tr>
<td></td>
<td>7</td>
<td>J. Below</td>
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<tr>
<td></td>
<td>8</td>
<td>D. Vaclev</td>
</tr>
<tr>
<td><strong>Chief Officer</strong></td>
<td>9</td>
<td>P. Kusmin</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>A. Lasarew</td>
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<tr>
<td></td>
<td>11</td>
<td>J. Baranow</td>
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<tr>
<td></td>
<td>12</td>
<td>A. Iljin</td>
</tr>
<tr>
<td><strong>2nd Officer</strong></td>
<td>1</td>
<td>T. Aquino</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>F. Villa</td>
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<tr>
<td></td>
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<td>M. Quezon</td>
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<tr>
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<td><strong>Chief Engineer</strong></td>
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<tr>
<td></td>
<td>12</td>
<td>J. Gussew</td>
</tr>
</tbody>
</table>
Constraint 2: Minimum experience times for specific rank combinations

- Master: D. Vaclev, J. Below, I. Jacek, M. Smirnow, A. Popow, A. Titow
- Chief Officer: I. Nikitin, A. Iljin, J. Baranow, A. Lasarew, P. Kusmin, ...
- 2nd Officer: ..., P. Estrada, S. Pelaez, T. Ramos
- 3rd Officer: T. Aquino, F. Villa, M. Quezon, ...
- Chief Engineer: U. Lopez, F. Roxas, Z. Tolentino
- 2nd Engineer: J. Binay, W. Aguinaldo, C. Romulo, I. Remonde
- 3rd Engineer: ..., Y. Nowikow, P. Petrow
- 4th Engineer: A. Kusmin, J. Gussew, B. Sorrokin
Crew assignment - Constraints

**Constraint 3:** Consideration of minimum and maximum leave times

Minimum leave *

Maximum leave *

Optimal leave *

View of a seafarer

<table>
<thead>
<tr>
<th>Player</th>
<th>Contract 0</th>
<th>Contract 1</th>
<th>Contract 2</th>
<th>Contract 3</th>
<th>Contract 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Vaclev</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>I. Jacek</td>
<td></td>
<td>Contract 1</td>
<td>Contract 2</td>
<td>Contract 3</td>
<td>Contract 4</td>
</tr>
<tr>
<td>Y. Nowikow</td>
<td>Contract 1</td>
<td></td>
<td>Contract 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* depends on the contract duration
Crew Assignment Problem

Further possible constraints:
- Every seafarer could be assigned only to a specific ship type (container, bulker ...)
- Earliest contract start dates of the seafarer have to be considered
- Preferred assignment of permanently employed seafarers

Possible objective values:
- Minimize the deviation of seafarer experience times among the ships
- Minimize the deviation of real leave times from optimal leave times
Benefits of mathematical optimization for crew scheduling

- Optimized crew scheduling for the whole fleet of ships
- Possibility to create a reliable long term plan (e.g. one year)
- Increase the reliability of the seafarers through a reliable crew schedule and vice versa
- Possibility to conduct strategic capacity planning
“The future is already here - it's just not very evenly distributed.”

William Gibson, 1993
Thank you very much for your attention!