A multi-index assignment problem

Optimization of
Fleet wide
Long term
Crew assignment

Orisma(c)

A maritime challenge: Reinforce the human factor
Crew assignment optimization

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The approach

Taking the whole picture and looking forward in time
We create innovative solutions

The whole is greater than the sum of parts
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Particularities of marine profession

- Time contracted employment
- Multi-national
- Multi – culture environment
- without borders
- Polar position continuously changing

Working Address: Ship name
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The conventional approach

Disembarkation list
- Vessel
- Rank
- Nationality
- Sign off date (ESO)

Stand by list
- Seafarer
- Rank
- Nationality
- Availability date (AF)
- Grade

Crew assignment
Crew assignment optimization

Reinforcing the human factor

AD

ESO

IS ENOUGH?
Reinforcing the human factor

**Living conditions**
- Resting hours, Leisure & Entertainment
  - Internet access
  - Satellite TV
  - Audio, video libraries
  - Private email & phone calls
  - Briefing

**Accommodation, victualling**

**Working conditions**: Safety, Security, Leadership
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Attractiveness of seafarer application

Satisfaction factor
Assignment to a vessel type according to the seafarer preference
Promotion policy, potentiality to work at shore

Teamwork factor
Seafarers should be satisfied from the crew synthesis on the vessel to be embarked

Suitability factor
Seafarer assignment to a vessel should be best fitted to his skills and experience

Working availability trustiness
It is highly important for the seafarer to feel confident that he will find employment when he will be available in a suitable vessel

Lesson learnt from aviation
Shipping companies should have the appropriate decision support tools to optimize their crew repository depth, the long term assignment, the seafarers satisfaction level, the retention factor, the rejoin bonus, and the travelling expenses.
Best Business Practices

- Officers’ pool size optimization
- Officers’ satisfaction level improvement
- Embarkation duration refinement
- Retention Factor improvement
- Alternative scenarios comparison
- Stand by monetary cost minimization
- HRM strategic decision support
- Risk management, corrective actions and treatment plan support

What if and why analysis
A simple problem

Solution: 167

The suitability penalty of each of three masters
To each of three vessels is presented in the next table
Assign the masters to the vessels so the total penalty
To be minimum

<table>
<thead>
<tr>
<th>Vessels/Masters</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td></td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td></td>
<td>54</td>
<td></td>
</tr>
</tbody>
</table>

The number of alternatives is: 6

If we have 5 Vessels and masters
The number of alternatives will be 120

For n vessels?

n!
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The officer performance evaluation

- Technical competence
- HS&E awareness
- Commitment and responsibility
- Conduct, skills and communication
- Productivity
- Problem solving & decision making
- Leadership & teamwork
- Planning & organization
- etc

OPI: Officer performance index
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The officer vessel suitability

Availability penalty index

Licences
Nationality
Availability
  ESO: estimated sign on date
  AD: availability date
Experience in the same vessel
Experience in sister vessels
etc

OVI: Officer vessel suitability index
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The teamwork efficiency index

OOI: The officer officer index: \( i=1\Sigma^{n+1}(P_i d_i)/(ed_1+f - ed_0) \)

Each Seafarer is evaluated on a trimester basis. The outcome of this evaluation could be a color (green, yellow, red), which is the indicator that is used to find the correlation penalty with the other officers.
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The teamwork efficiency

Teamwork penalties based on master (M), Chief Engineer (C), Chief officer (O) and second engineer (Ss) grades

<table>
<thead>
<tr>
<th>Penalties matrices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
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</table>
The teamwork efficiency

<table>
<thead>
<tr>
<th>days</th>
<th>1/10</th>
<th>2/13</th>
<th>3/20</th>
<th>4/20</th>
<th>6/21</th>
<th>7/22</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>s</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>mc</td>
<td>100</td>
<td>70</td>
<td>10</td>
<td>10</td>
<td>10</td>
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</tr>
<tr>
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<td>55</td>
<td>40</td>
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<tr>
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<td>40</td>
<td>29</td>
<td>6</td>
<td>18</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

\[ p_{ij} = mc(g(m),g(c)) + mo(g(m),g(o)) + cs(g(c),g(e)) \]
\[ ed_0 = \text{current date: } ed_{n+1} = ed_1 + f \]
\[ f: \text{embarkation period : } n=4 \]
For i:1 to n+1: \[ d_i = ed_i - ed_{i-1} \]

OOI: The officer officer index: \[ i=1 \Sigma^{n+1}(P_i \cdot d_i) / (ed_1 + f - ed_0) \]
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Functionali specifications

An officer may be assigned to only one vessel
An officer is not necessary to be assigned in a vessel
Solution should be provided even the team is not completed
Model should be used for whole or partial fleet even for one vessel
Alternative solutions for a vessel should be presented in order
Decision maker may alter the schedule
Weight factors of the assignment index would be adjusted
Performance, retention, cost indexes should be presented

Human service interactivity: minimum response time is required
## Model in numbers

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of vessels</td>
<td>58</td>
</tr>
<tr>
<td>Variables : Number of quadruplets</td>
<td>37329</td>
</tr>
<tr>
<td>Number of constraints</td>
<td>276</td>
</tr>
<tr>
<td>Model generation time</td>
<td>1 sec</td>
</tr>
<tr>
<td>Model solution time</td>
<td>2 secs</td>
</tr>
<tr>
<td>Lp rule</td>
<td>Branch and bound</td>
</tr>
</tbody>
</table>
Crew assignment optimization

Fleet assignment presentation per vessel

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Rank</th>
<th>Nationality</th>
<th>Vessel Group</th>
<th>Vessel Family</th>
<th>Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYUNDAI BRIDGE</td>
<td>150</td>
<td>1000</td>
<td>107</td>
<td>O/E</td>
<td>1150</td>
</tr>
</tbody>
</table>

Presentation per vessel or per rank

SEAHORSE
Fleet assignment objective function

\[ \min \sum_{i=1}^{v} \sum_{j=1}^{q(i)} p_{ij} x_{ij} + \sum_{i=1}^{v} h x_{i0} \]

\[ \sum_{j=1}^{q(i)} x_{ij} + \sum_{l=1}^{v} x_{i0} = 1 \quad \forall i = 1: v \]

- \( q(i) \): number of feasible q’s for vessel i
- \( h \): high value penalty
- \( p_{ij} \): assignment penalty of quadruplet j to vessel l
- \( x_{i0} \): dummy variable for vessel i
- \( v \): number of vessels
- \( o_r \): officer r

Coordinates extension:
from one vessel to fleet from few days to several months
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### Benefits

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>To: Avg Idle time saving per officer</td>
<td>10 days/year</td>
</tr>
<tr>
<td>Tf: Idle time saving per fleet</td>
<td>4*#vessels*To=2400 days/year</td>
</tr>
<tr>
<td>Cf: Idle time cost saving</td>
<td>1.600.000 $/year</td>
</tr>
<tr>
<td>Crew Retention Factor</td>
<td>10% increment: from 88 to 96%</td>
</tr>
<tr>
<td>Satisfaction factor</td>
<td>8% increment</td>
</tr>
<tr>
<td>Appraisal schema calibration</td>
<td>92%</td>
</tr>
</tbody>
</table>

**Realized!**
Crew assignment optimization

Assign the right officer to right vessel in the right time
Challenges in The Maritime Industry
Systemic model of safety
Crew assignment optimization

Aviation best business practices

A lesson learnt from Aviation

Safety culture

- Safety case structured document
- Mandatory safety reports
- Just culture
- Flight data monitoring system
- Preflight planning dispatch checklist

Being a safe crew – System Model of safety

SeaHorse
Challenges in the Maritime Industry

Being a safe crew
A lesson learnt from aviation
Systemic model of safety

Me too to be better than you
Systemic model of Safety in Aviation industry

The model is related to:
- Safety culture maturity
- SMS in place

Indicators corresponding to «behavior» characteristics:
- Job satisfaction
- Mutual expectation & encouragement
- etc

At organizational level monitoring of:
- Personnel selection
- Personnel training
- Competence & skills checking

Me too to be better than you
To be OR not to be

To be OR

To be better

EU FUNDED MARITIME PROJECT IN PROGRESS
DANAOS AUDITORIUM
5TH DECEMBER 2014