Maritime Innovation Networks

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Maritime Innovation Networks

Zoran Perunović
Mads Christoffersen
Sofia Fürstenberg

Need for collaboration for innovation

About the study

Grant
• Danish Maritime Foundation

Team
• DTU Executive School of Business
• Mærsk Maritime Technology

Duration
• Two years

Method
• Exploratory qualitative multiple-case study

Data
• Interviews with more than 100 key informants at 40 maritime organizations
• Analysis of numerous internal company materials, industry reports, publicly available reports about more than 30 innovation networks
• Articles from newspapers and magazines
• Extensive literature review of more than 50 academic journal articles

Turbulent environment for innovation

Market
• Discrepancy between the dynamics of the global trade and the shipping industry
• Trade specialization of ships
• Unpredictable fuel prices
• Efficiency of the existing fleet (Buy or retrofit decision)

Regulations
• Enforcement dates
• Variations in regulations in different regions and countries
• Lack of compliance control

Technology
• Customized solutions for retrofit projects due to the fleet variety
• Myriad of unproven technologies and suppliers
• Contradictory solutions
• Incompatible and uncomplementary technologies
• Scalability of technologies for large capacities
## Stakeholders and innovation

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Role</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulators</td>
<td>Drive innovation</td>
<td>Focused on profit and vessel's liquidity</td>
</tr>
<tr>
<td>Classification societies</td>
<td>Repository of knowledge</td>
<td>Novelty accepted if coming from respectful owner and shipyard with good historical operational record</td>
</tr>
<tr>
<td>Drivers</td>
<td>National could hinder innovation</td>
<td>New instruments to calculate risk of novel technologies</td>
</tr>
<tr>
<td>Financiers</td>
<td>Promote innovation</td>
<td>Promote and finance collaborative innovation activities</td>
</tr>
<tr>
<td>Classification societies</td>
<td>Initiate and moderate innovation networks</td>
<td>Strong influence on innovation in industry</td>
</tr>
<tr>
<td>Classification societies</td>
<td>Help with innovation networks</td>
<td>Present in every innovation network</td>
</tr>
<tr>
<td>Insurers</td>
<td>Service providers embrace process and technological innovations to improve efficiency</td>
<td></td>
</tr>
<tr>
<td>Owners, charterers, and operators</td>
<td>Drive innovation</td>
<td>Port authorities embrace innovation to create attractive conditions for users and service providers</td>
</tr>
<tr>
<td>Classification societies</td>
<td>Large - internal R&amp;D capability</td>
<td>Hinder innovation if do not monitor compliance with environmental regulations</td>
</tr>
<tr>
<td>Owners, charterers, and operators</td>
<td>Small – open for innovation networks</td>
<td></td>
</tr>
<tr>
<td>Owners, charterers, and operators</td>
<td>Other should innovate</td>
<td></td>
</tr>
<tr>
<td>Owners, charterers, and operators</td>
<td>Equipment testing</td>
<td></td>
</tr>
<tr>
<td>Owners, charterers, and operators</td>
<td>First mover concern</td>
<td></td>
</tr>
<tr>
<td>Owners, charterers, and operators</td>
<td>Performance improvement</td>
<td></td>
</tr>
<tr>
<td>Designers</td>
<td>Design to satisfy multiple physical, regulatory, and economical requirements</td>
<td></td>
</tr>
<tr>
<td>Designers</td>
<td>Universities and institutes</td>
<td>Cradle of knowledge and creativity</td>
</tr>
<tr>
<td>Designers</td>
<td>Strong R&amp;D, innovation, and networking capabilities</td>
<td>Strong influence on innovation in industry</td>
</tr>
<tr>
<td>Designers</td>
<td>Industry associations</td>
<td></td>
</tr>
<tr>
<td>Designers</td>
<td>Promote and finance collaborative innovation activities</td>
<td></td>
</tr>
<tr>
<td>Equipment and technology suppliers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipyards</td>
<td>Contemporary model – design, engineer, and build vessels</td>
<td></td>
</tr>
<tr>
<td>Shipyards</td>
<td>Technology push, but opening for networked innovation strategies with early involvement of owners</td>
<td></td>
</tr>
<tr>
<td>Shipyards</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Six innovation networks

- **Centralized**
- **Triad**
- **Horizontal**
- **Designed centralized**
- **Designed decentralized**
- **Emergent**
- **Experts’ forum**
- **Informal**
- **PUBLICLY FUNDED**
**Formation**

**User-driven**
- Owner driven: Fast and affordable access to knowledge and technologies. Formed when needed.
- Engine maker and shipyard driven: Access new knowledge, technologies, and market segments.
- Supplier driven: Test technology, understand user's needs, get sales with large customer.

**Management and organization**
- Centralized:
  - Formal agreements in exploration at engine maker and shipyard driven networks.
  - Informal agreements for scouting and testing.
  - Formal agreements for new builds in exploitation at owner driven network.

**Evolution**
- Strong ties between central organization and individual partners. Little or none formal relationships between the partners (structural holes).
- Ideas and needs shared with partners who are expected to come up with solutions.
- R&D unit/entity is coordinator.
- Engine maker and shipyard protects IPR through patenting. Owner protects IPR by being first on the market.

**Performance**
- Indirect measurement of success.
- Objectives met in most cases.
- Suppliers may delay the process because of lack of resources and uncertain sales.
- Untapped potential of structural holes.
- Networking capabilities not regarded as KPI.

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**Triad**

**Formation**
- Emerge on recognized business opportunity
- Partners chosen on complementarity of competences
- Occasional satellite members
- Clear commercial interest from all partners

**Management and organization**
- Emergent, Formal, Exploit structural holes
- Exploration with fit for exploitation
- Easy to manage
- Governance based on openness, flat structure, and good relationship management
- Trust driven by network size, previous experiences, and personal relations
- Equal distribution of knowledge and information

**Evolution**
- Time limited
- Allow flexibility for partners to establish new triads
- Can initiate new networks to add more competences

**Performance**
- Successful in achieving objectives
- Acknowledge learning as success criteria

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**Centralized**

**Triad**

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### Stakeholders

**Public funds**
- Support development of solutions and industry’s innovation and networking capabilities.
- Top-down and bottom-up generation of topics.
- Relevance of topics depends on individuals.
- Rules for formation in top-down could negatively affect enthusiasm.
- Negative effect of imposed collaboration.

**Access public funding**
- Public funds support development of solutions and industry’s innovation and networking capabilities.
- Relevance of topics depends on individuals.
- Rules for formation in top-down could negatively affect enthusiasm.
- Negative effect of imposed collaboration.

### Management and organization

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Management and organization</th>
<th>Evolution</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access public funding</td>
<td>Decentralized with formal agreements</td>
<td>Designed are time limited</td>
<td>Predominantly incremental improvements or conceptual studies with occasional validation through testing</td>
</tr>
<tr>
<td>Public funds</td>
<td>Simple and flat management structure due to small size</td>
<td>Emergent will continue if positive experience with results and management</td>
<td>Successful commercialization of network results is not captured and disseminated</td>
</tr>
<tr>
<td>Support development of solutions and industry’s innovation and networking capabilities.</td>
<td>Each member involved in project management, participation in projects, and decision making</td>
<td>Partners from work packages may establish new exploitative networks</td>
<td>Universities benefit from academic publications</td>
</tr>
<tr>
<td>Top-down and bottom-up generation of topics.</td>
<td>Top management and work groups jointly make decisions about strategic development of network</td>
<td></td>
<td>No established measures to capture and follow improvement of members’ innovation and networking competences and capabilities and commercialization of solutions</td>
</tr>
<tr>
<td>Relevance of topics depends on individuals.</td>
<td>Efficient knowledge flow due to short distances between the nodes and teams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rules for formation in top-down could negatively affect enthusiasm.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative effect of imposed collaboration.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Evolution

- Designed are time limited
- Emergent will continue if positive experience with results and management
- Partners from work packages may establish new exploitative networks
- Successful commercialization of network results is not captured and disseminated
- Universities benefit from academic publications
- No established measures to capture and follow improvement of members’ innovation and networking competences and capabilities and commercialization of solutions

### Performance

- Predominantly incremental improvements or conceptual studies with occasional validation through testing.
- Successful commercialization of network results is not captured and disseminated.
- Universities benefit from academic publications.
- No established measures to capture and follow improvement of members’ innovation and networking competences and capabilities and commercialization of solutions.

### Formation

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Management and organization</th>
<th>Evolution</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very rare and found in the development phase of innovation process</td>
<td>Decentralized with formal agreements</td>
<td>Designed are time limited</td>
<td>Predominantly incremental improvements or conceptual studies with occasional validation through testing</td>
</tr>
<tr>
<td>Reasons:</td>
<td>Simple and flat management structure due to small size</td>
<td>Emergent will continue if positive experience with results and management</td>
<td>Successful commercialization of network results is not captured and disseminated</td>
</tr>
<tr>
<td>Pulling joint experience, effort, and resources to make business case for everyone, to build networking capability, and inability to develop environmental solutions alone.</td>
<td>Each member involved in project management, participation in projects, and decision making</td>
<td>Partners from work packages may establish new exploitative networks</td>
<td>Universities benefit from academic publications</td>
</tr>
<tr>
<td>Primarily focused on shared learning about operational experience.</td>
<td>Top management and work groups jointly make decisions about strategic development of network</td>
<td></td>
<td>No established measures to capture and follow improvement of members’ innovation and networking competences and capabilities and commercialization of solutions</td>
</tr>
<tr>
<td>Prevention of opportunistic behavior</td>
<td>Efficient knowledge flow due to short distances between the nodes and teams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classification society initiates formation and manages the network.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Members with different market specializations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully committed top management.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Experts’ forum

<table>
<thead>
<tr>
<th>Formation</th>
<th>Management and organization</th>
<th>Evolution</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Founder</td>
<td>Closed, designed, and</td>
<td>Permanent network with temporary groups and members</td>
<td>Advise to regulators</td>
</tr>
<tr>
<td>Expert</td>
<td>Experts are organized within working groups</td>
<td>governing body sets topics</td>
<td>Ideas and initiatives for formation of publicly funded networks</td>
</tr>
<tr>
<td>participation organization</td>
<td>Knowledge sharing intensive within groups. Information sharing in joint meetings. Little or no formal relationships between working groups (structural holes)</td>
<td>Power of single member rooted in technical competency</td>
<td>Influence on formation on innovation projects in industry not captured</td>
</tr>
</tbody>
</table>

### Informal

<table>
<thead>
<tr>
<th>Formation</th>
<th>Management and organization</th>
<th>Evolution</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on initiatives developed from personal relationships</td>
<td>Decentralized</td>
<td>Successful to get to formal collaboration in exploitation</td>
<td>Result in commercial projects</td>
</tr>
<tr>
<td>Partners chosen on technical competence, prestige, expected quality of contribution and added value</td>
<td>Different stakeholders</td>
<td>Light management and strong governance</td>
<td>Deep insight in short time frames</td>
</tr>
<tr>
<td>No contract involved. Trust is guarded and publicly funded behavior prohibited by personal relationships and accepted norms of behavior</td>
<td>Informal because too much bureaucracy can hinder innovation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutual benefit for all members is expected</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Based on initiatives developed from personal relationships**

- Partners chosen on technical competence, prestige, expected quality of contribution and added value
- No contract involved. Trust is guarded and publicly funded behavior prohibited by personal relationships and accepted norms of behavior
- Mutual benefit for all members is expected

**Management and organization**

- Decentralized
- Different stakeholders
- Informal because too much bureaucracy can hinder innovation
- Light management and strong governance

**Evolution**

- Successful to get to formal collaboration in exploitation

**Performance**

- Result in commercial projects
- Deep insight in short time frames
Utilization of maritime innovation networks

Uncertainty

![Graph showing networking activity vs technological uncertainty, market uncertainty, and regulatory uncertainty.]

Innovativeness

<table>
<thead>
<tr>
<th>Incremental</th>
<th>Breakthrough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect for breakthroughs</td>
<td></td>
</tr>
<tr>
<td>Centralized</td>
<td></td>
</tr>
<tr>
<td>Publicly funded</td>
<td></td>
</tr>
<tr>
<td>Pure incremental</td>
<td></td>
</tr>
<tr>
<td>Experts' forum</td>
<td></td>
</tr>
<tr>
<td>Incremental</td>
<td></td>
</tr>
<tr>
<td>Rejuvenate for breakthrough</td>
<td></td>
</tr>
<tr>
<td>Triad</td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
</tr>
<tr>
<td>Informal</td>
<td></td>
</tr>
</tbody>
</table>

NEW Partners

OLD

YES Structural holes

NO
### Utilization of Maritime Innovation Networks

#### Innovation Process

<table>
<thead>
<tr>
<th>Connectivity between different types of maritime innovation networks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CENTRALIZED (Engine maker)</strong></td>
</tr>
<tr>
<td><strong>CENTRALIZED (Shipyard)</strong></td>
</tr>
<tr>
<td><strong>INFORMAL (Trades)</strong></td>
</tr>
<tr>
<td><strong>PUBLICLY FUNDED (Designed)</strong></td>
</tr>
<tr>
<td><strong>HORIZONTAL</strong></td>
</tr>
<tr>
<td><strong>PUBLICLY FUNDED (Emergent)</strong></td>
</tr>
<tr>
<td><strong>TRIAD</strong></td>
</tr>
<tr>
<td><strong>CENTRALIZED (Owner)</strong></td>
</tr>
<tr>
<td><strong>Centralized</strong></td>
</tr>
<tr>
<td><strong>Triad</strong></td>
</tr>
<tr>
<td><strong>Publicly funded</strong></td>
</tr>
<tr>
<td><strong>Horizontal</strong></td>
</tr>
<tr>
<td><strong>Experts’ forum</strong></td>
</tr>
<tr>
<td><strong>Informal</strong></td>
</tr>
</tbody>
</table>

- Closed and controlled environments
- Partner selection relies on existing ties and the social capital’s mechanisms

#### Utilization of Maritime Innovation Networks

#### Stakeholder Participation

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Centralized</th>
<th>Triad</th>
<th>Publicly funded</th>
<th>Horizontal</th>
<th>Experts’ forum</th>
<th>Informal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulators</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Classification society</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Owners, charterers, operators</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Designers</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Equipment and technology suppliers</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Shipyards</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Financers</td>
<td>●</td>
<td>●</td>
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<td>●</td>
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<td>●</td>
</tr>
<tr>
<td>Insurers</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Universities and institutes</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Industry associations</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
Utilization of maritime innovation networks

Result

Innovation networks are relatively new concepts to the industry. Significant innovation-related networking activity despite perceptions about the industry.

Formed predominantly as reaction to regulations.
Pursuit of incremental innovation.
Dominance of closed networks.
Abundance of structural holes in networks and work packages.
Underrepresented stakeholders.
Lack of understanding of values and risks of different types of innovation networks.
Different facets of performance are undermined.
Underdeveloped innovation capability on organizational level.

Utilization of maritime innovation networks

Performance

• Performance = Network dynamics + Member dynamics

• Network dynamics = f[design (social capital, structural holes, knowledge flow) + management (leverage, appropriability, coherence)]

• Member dynamics = f(top management governance, open organizational culture, networking capabilities, innovation capability, absorptive capacity)
Unleashing the potential or maritime innovation networks (1/3)

- Understand benefits and risks of innovation in networks
- Use networks to create standards and influence regulations
  - Create early
  - Use horizontal, experts’ forums, and emergent publicly funded
- More breakthroughs
  - Open and decentralized networks in exploration
  - New partners from maritime and other industries
  - Improved connectivity between members and work packages

Unleashing the potential or maritime innovation networks (2/3)

Enhance holistic and life-cycle approaches
- Activate broad set of stakeholders to capture the needs of the entire value chain
- Involve customers of centralized networks early in the process

New measurement system for capturing value
- At network level (Technology readiness maturation index, Number of patents, Objective achievement, Knowledge receiving/giving ratio, Commercialization probability, Actual commercialization (could be several years after disbanding of network), Number of successor and partnership networks created
- At organizational level (Technology readiness maturation index, Knowledge receiving/giving ratio, New ideas gained/internalized ratio, Number of patents, Commercialization probability, Number of new contacts established (customers, complementary stakeholders, competitors)
Unleashing the potential or maritime innovation networks (3/3)

GOOD INNOVATION NETWORK MANAGEMENT PRACTICE
Respect, learning, trust, transparency, efficient R&D and communications

EACH NETWORK MEMBER

GOVERNANCE
Planning
Power
Policy
Participation
Staffing
Controlling/Managing
Guiding planning and activities

Focus on:
PARTNER SELECTION
ENABLING CONTROL POSITION

NETWORKING COMPETENCIES AND
CAPABILITIES
International within entire organisation

TOP MANAGEMENT
Build innovation and interwinding organisations

OPEN INNOVATION
Attaching resources

OPERATIONAL MANAGEMENT
Innovation
Idea enrichment
Marketing
Transfer of results to marketplace

Focus on:
PERFORMANCE

ACTIVITIES
Innovation processes
Knowledge flows
Network identity

INNOVATION LIFECYCLE

INTEGRATION COORDINATOR

LEAD ORGANISATION