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Maritime Innovation Networks

Perunovic, Zoran; Christoffersen, Mads; Fürstenberg, Sofia

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

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

## Six innovation networks

- **Centralized**: Designed centralized
- **Triad**: Designed decentralized
- **Horizontal**: Emergent
- **PUBLICLY FUNDED**: Experts’ forum
- **Informal**: Informal
Formation | Management and organization | Evolution | Performance
--- | --- | --- | ---
**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
Suppliers: Test technology, understand user's needs, get sales with large customer
---
Formal agreements in exploration at engine maker and shipyard networks
Informal agreements for scouting and testing and formal agreements for new builds in exploitation at owner driven network
Strong ties between central organization and individual partner. 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
**Engine maker and shipyard driven**
Long term
Growing in number of partners
Owner
Time limited
Disband into dyads
**Licensee**
Strong ties between central organization and individual partner. Little or none formal relationships between the partners (structural holes)
Ideas and needs shared with partners who are expected to come up with solutions
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Engine maker and shipyard protects IPR through patenting. Owner protects IPR by being first on the market
---
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

---
**Formation**
Emergent, Formal, Exploit structural holes
Partners chosen on complementarity of competences
Occasional satellite members
Clear commercial interest from all partners
---
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
---
Time limited
Allow flexibility for partners to establish new triads
Can initiate new networks to add more competences
---
Successful in achieving objectives
Acknowledge learning as success criteria

---
**Triad**

---
**Formation**
Emergent, Formal, Exploit structural holes
Partners chosen on complementarity of competences
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Successful in achieving objectives
Acknowledge learning as success criteria
<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>Stakeholder-oriented, designed decentralized, and emergent</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>Designed types for exploration, Emergent types for development (more open)</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>Work-package driven</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>Complex and bureaucratic organization hinders innovation. Heavy management apparatus</td>
<td>Natural stability is very sensitive to quality of governance and operational management</td>
<td>Three variants</td>
</tr>
<tr>
<td>Relevance of topics depends on individuals</td>
<td></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>

**Publicly funded**

<table>
<thead>
<tr>
<th>Formation</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>Positive experience spurs new projects and admission of new members. Small improvements</td>
<td>Main achievement is that competitors learn to work with each other</td>
</tr>
<tr>
<td>Reasons: Pulling joint experience, effort, and resources to make business case for everyone, to build networking capability, and inability to develop environmental solutions alone. Primarily focused on shared learning about operational experience. Prevention of opportunistic behavior</td>
<td>Simple and flat management structure due to small size Each member involved in project management, participation in projects, and decision making</td>
<td>Small incremental steps increase trust and improve networking capabilities</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Classification society initiates formation and manages the network Members with different market specializations</td>
<td>Top management and work groups jointly make decisions about strategic development of network Efficient knowledge flow due to short distances between the nodes and teams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully committed top management</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**

- **Horizontal**
- **Vertical**

- **Publicly funded**
## 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>Seek for expert opinion and advice about regulation</td>
<td>Experts are organized within working groups</td>
<td>Advise to regulators</td>
</tr>
<tr>
<td>Expert</td>
<td>Recognition of personal achievements</td>
<td>Governing body sets topics</td>
<td>Ideas and initiatives for formation of publicly funded networks</td>
</tr>
<tr>
<td>Participating organization</td>
<td>Access to knowledge and influence on regulators</td>
<td>Knowledge sharing intensive within groups. Information sharing in joint meetings. Little or no formal relationships between working groups (structural holes)</td>
<td>Influence on formation on innovation projects in industry not captured</td>
</tr>
<tr>
<td>Power of single member rooted in technical competency</td>
<td>Permanent network with temporary groups and members</td>
<td></td>
<td></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 competences, prestige, expected quality of contribution and added value</td>
<td>Different stakeholders</td>
<td></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>Light management and strong governance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Closed, designed, and decentralized**

**Decentralized**

**Different stakeholders**

**Informal because too much bureaucracy can hinder innovation**

**Light management and strong governance**

**Successful to get to formal collaboration in exploitation**

**Result in commercial projects**

**Deep insight in short time frames**

**Permanent network with temporary groups and members**

**Advise to regulators**

**Ideas and initiatives for formation of publicly funded networks**

**Influence on formation on innovation projects in industry not captured**

**Mutual benefit for all members is expected**

**Deep insight in short time frames**
Utilization of maritime innovation networks

Uncertainty

Networking activity

<table>
<thead>
<tr>
<th>Low</th>
<th>TECHNOLOGICAL UNCERTAINTY</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>MARKET UNCERTAINTY</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>REGULATORY UNCERTAINTY</td>
<td>Low</td>
</tr>
</tbody>
</table>

Utilization of maritime innovation networks

Innovativeness

<table>
<thead>
<tr>
<th>NEW Partners</th>
<th>Incremental Connect for breakthroughs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centralized</td>
</tr>
<tr>
<td></td>
<td>Publicly funded</td>
</tr>
<tr>
<td>OLD Experts’ forum</td>
<td>Incremental Rejuvenate for breakthrough</td>
</tr>
<tr>
<td></td>
<td>Triad</td>
</tr>
<tr>
<td></td>
<td>Horizontal</td>
</tr>
<tr>
<td></td>
<td>Informal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YES</th>
<th>Structural holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>
Utilization of maritime innovation networks

Innovation process

Connectivity between different types of maritime innovation networks

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

Advanced collaborative and final-user driven forms emerge to qualify promising technology

Advanced collaborative networks disband
Industry closes up again

Utilization of maritime innovation networks

Stakeholder participation

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Centralized</th>
<th>Triad</th>
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<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>
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<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>Financiers</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Insurers</td>
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<tr>
<td>Ports</td>
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<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 innovation networks
Different facets of performance of are undermined
Underdeveloped innovation capability on organizational level

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)

Each network member
- Governance:
  - Strategy
  - Planning
  - Funding
  - Controlling/evaluation
- Networking competencies and capabilities
- Operational management:
  - Knowledge management
  - Value creation
  - Marketing
  - Transfer of results to mainstream processes

Focus on:
- Partner selection: enabling control position
- Top management: builds innovation and networking capacities, opens up for innovation
- Open innovation: attaches value to flow of innovation

Activities:
- Innovation: increases knowledge flows, network identity, appropriativeness

Innovation ecosystem
- Lead organisation: integration/coordination