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# OPEN INNOVATION IN MARITIME INDUSTRY

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**Abstract.** In this paper we propose to consider open innovation from the point of view of causation and effectuation approaches (Sarasvathy, 2008) and a social networking perspective. Our empirical evidence consists of a case study of an ongoing open innovation project aimed to create a hybrid ship which uses liquid natural gas (LNG) and hydrogen as power sources. The results show that the effectuation approach is preferable to open innovation when the initiator of open innovation aims to keep sensitive information inside the closed group, has established an effective team of representatives from other firms from earlier innovation projects, and participants are situated closely geographically.

**Keywords:** open innovation; partner selection; Norway; effectuation; causation

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## Introduction

Open innovation (Chesbrough, 2003) is a popular approach within innovation studies and innovation in practice. A significant amount of research has been devoted to different aspects of innovation partnerships, such as motives for and impacts of collaboration. However, the important aspect of partner selection for open innovation has received limited attention from scholars (Borch and Solesvik, 2014; 2016; Li et al., 2008). At the same time, selection of the right partner is probably the most crucial aspect of open innovation success (Solesvik and Westhead, 2010). To better understand partner selection issues, additional research is warranted to explore which mode of partner selection leads to more effective open innovation process.

Research and development (R&D) cooperation is one of the forms of open innovation (Herzog, 2008). The bulk of R&D cooperation research uses causation logic as a given. For example, a firm sets a goal to develop a new innovative product. If the firm's management subsequently decides that it is better to cooperate with others to achieve this goal, managers screen the environment for possible partners. The next step is to select one of them and normally to write a formal/contractual R&D agreement. This will specify obligations in time, ownership, deadlines, milestones and possibly other aspects. Cooperation either successfully continues or terminates after the goals are achieved.

However, observations of R&D partnerships show that some entrepreneurial firms follow another path, so called effectuation which has a more ad-hoc and bottom-up character (Sarasvathy, 2008). Entrepreneurial firms screen their networks of customers, suppliers, and other actors to find reliable partners (i.e., ask the question 'Whom do we know?'), they are engaged in existing relations, and decide underway what several partners can do together.

This paper focuses on partner selection issues for open innovation in maritime sector of Norway. There are many public support programs in Norway that directly or indirectly build upon an open innovation approach. Firms may get tax credits for collaboration with universities and research institutes, they can get direct support for joint R&D with other firms or public R&D units, and various public agencies organize and facilitate clusters and networks at regional and sectoral levels. Hence, firms are continually encouraged to enter into new partnerships and to strengthen and redefine existing ones. The research questions of this study are: (1) Do firms follow causation or effectuation logic when they form open innovation partnerships? (2) How do firms select partners for open innovation?

The study aims to make several contributions to the existing knowledge base. First, the paper offers fresh insights to the literature on partner selection in open innovation. Second, the forming of R&D partnerships in open innovation will be considered through the lens of

effectuation and causation theory which is a novel approach to explore R&D alliance formation. The paper is constructed as follows. First, we present the context of maritime industry. Then we outline the theoretical background of the paper. Then, we present methodology which we have employed in the analysis. In the next section, we present the findings and derive propositions. A final section discusses further aspects of future research that focuses on partner selection for open innovation.

## Maritime industry context

Maritime sector is an important industrial cluster in economies of many countries (Borch and Solesvik, 2015). In Norway, for example, the maritime cluster is the third largest in the national economy. Norwegian maritime cluster is one of the leading in the world. The cluster is responsible for added value created and employment of the significant number of people. Innovation development (Solesvik, 2015; 2016) and entrepreneurial orientation (Parsyak and Zhuravlyova, 1997; 1999a; 1999b; 1999c) are the most important success factors in the maritime industry.

Maritime industry consists of various actors, i.e. shipping companies, shipyards, suppliers of equipment, ship designers, ship consultants, financial institutions, classification societies, and educational institutions (Parsyak and Solesvik, 2014; Parsyak and Zhukova, 2016a; 2016b). One of the main features making the maritime industry special is a cyclical nature of the business, i.e. periods of very high demand for the goods or services of actors change with the periods of low activities when firms work on margins and compete severely for customers. There are many reasons for such dynamic in the maritime business. The discussion of them is out of the scope of this research and the detailed analysis of the reason can be found elsewhere (Stopford, 2009). Thus, industry specific motive for maritime firms is a need to act anticyclical in order to achieve a competitive advantage. The project nature of the activities of some actors also makes open innovation an attractive form of R&D. One of the main social features of the maritime milieu is 'everybody knows everybody', i.e. the community is not large (even beyond the country borders) and social links are rather tight. In other words, the role of social networks in forming alliances is significant.

## Theoretical background

Effectuation/causation theory (Sarasvathy, 2008) and social networking theory make up the theoretical background of the issues we examine. Effectuation theory is named as one of the key entrepreneurship theories (Moroz and Hindle, 2011). Originally, Sarasvathy (2008) and other researchers used this theory to explain behavior of entrepreneurs when they start and operate business. In this study, we attempt to go further and use the effectuation approach to explore cooperative behavior of entrepreneurial firms. But first a presentation of Sarasvathy's (2008) effectuation theory is required.

Effectuation theory has received much attention from entrepreneurship scholars in explaining decision-making approach of some entrepreneurs (Fisher, 2012). Entrepreneurs using the effectuation approach do not have a clear goal when they start the venture. In the first step or phase of a new venture, an entrepreneur or a top management team asks three key questions: relating to 'who are we', 'what do we know' and 'whom do we know'? Furthermore, the entrepreneur/the top management team decides 'what can we do?' with the existing set of resources and networks and decides how much money it is possible to "sacrifice" in the development of the new business, i.e. 'affordable loss' principle (step 2).

An important issue in effectuators' activity is 'stakeholders interaction' (step 3), i.e. customers, suppliers, even competitors are actively engaged into the new venture development. The last step is 'leveraging contingencies', i.e. effectuators should be ready to accommodate new pleasant and unpleasant turns of destiny and be ready to transfer them into opportunities (step 4). If we observe partner selection issues for R&D alliances through the lens of the effectuation theory, the top management team selects a partner on the first step together with an audit of own personal assets, i.e. skills, knowledge, and resources. Oppositely, causators act according to a conventional logic known from the business training programs. First, the market is analyzed for the prospective opportunities. The analysis is often based on marketing research and other scientific methods of analysis. After this, an entrepreneur or a top management team sets the goals. Then the set of means are determined in order to achieve these goals. In case of a lack of own resources, an entrepreneurial firm might consider forming an R&D alliance and finding a partner who owns necessary resources or knowledge. Then an entrepreneurial firm screens the market for potential partners. Afterwards, it selects one suitable partner to form an alliance.

Effectuation/causation theory has largely been developed and employed to analyze individual entrepreneurs or relatively small firms and their management teams. In this paper we aim to utilize the theory on a larger firm in a mature industry. We assume that such a firm will be involved in more partnerships, and that these have taken on an institutionalized character. This means that partner selection probably more often takes preexisting networks as a starting point, corresponding to an effectuation strategy, even though the firm may have the resources to pursue a more formal causation approach.

In general, some authors have distinguished between two modes of partner search: the institutionalized mode or mechanism and the social mechanism (Rangan, 2000; Solesvik and Encheva, 2010). Social network theory adds to the insights from the effectuation theory in the exploration of R&D alliances formation within open innovation. Social capital is related to an ability to benefit from networks, social relations and structures (Cope et al., 2007). Social capital originates at the individual level and the organizational level (Nahapiet and Ghoshal, 1998). Davidsson and Honig (2003: 308) noted that "social capital can be a useful resource both by enhancing internal organizational trust through the bonding of actors, as well as by bridging external networks in order to provide resources".

## Research method

*Case study approach*

This exploratory study was positioned within an interpretive research paradigm. Single case study method (Yin, 2003) will be used to explore the research questions related to open innovation partnership formation and partner selection issues for open innovation development. This technique enables the analyst to get deep insights into the mechanisms which stand behind the selection mechanism for open innovation. A qualitative case study method is appropriate because the aim of this study is to generate fresh and deeper insights into the process of partner selection related to an open innovation.

*Case selection*

We selected a case of development of a unique revolutionary ship which uses LNG and hydrogen power. There is only one ship in Norway under development of this type. We studied the process of partnership formation for this project and firms which were involved in open innovation process.

*Data collection*

In 2012, seven semi-structured interviews were carried out among the participants of an open innovation project aimed to develop an environmentally friendly hybrid platform supply ship for a Norwegian shipping company. The interviews lasted from 60 to 120 minutes with the project managers responsible for the project in the partner firms, i.e. the classification society, the shipping company, the engine producer, and the shipyard.

In order to triangulate information collected from face-to-face interviews, additional data sources were used (e.g., information from reports, company web pages, the Internet more widely and from trade/technical magazines). By combining several modes of data collection, in-depth description of partner selection process was obtained.

*Data analysis*

Narrative accounts relating to the development of entrepreneurial competencies were analyzed. Comments of interviewees were consistently coded, and most frequently reported partner selection criteria were identified. An iterative analysis relating to within-case analysis was conducted (Eisenhardt, 1989). Data were compared with existing theory and the data was allowed to talk. Several propositions were derived from the comments made in the interviews.

## Findings

The shipping company is rather innovation oriented and the idea of a ship which uses fuel cells emerged from the dialogues with the classification society, suppliers, and ship designers. The company had ties to these actors before this idea emerged. Earlier the shipping company was the first in Norway to introduce an offshore vessel which uses liquid natural gas (LNG) as its fuel. The Norwegian Government also stimulates green shipping and supports projects aimed to diminish $CO_2$ and $NO_x$ emission and to develop environmentally friendly technologies. The project of the ship which will use fuel cells as an alternative power source together with LNG was launched in 2003. Use of fuel cells permits saving 30 per cent of fuel, emission of $CO_2$ is up to 50 per cent less compared to conventional fuel, and there is no emission of $NO_x$, $SO_x$ and particles. Fuel cells use hydrogen, but hydrogen cannot be preserved on board of the vessel. Thus, an R&D alliance developed a technology which makes it possible to extract hydrogen from LNG. Det Norske Veritas, which is a large and R&D intensive Norwegian company specialized in engineering services oriented at safety, quality and the environment, is formally responsible for the project. The R&D work within the project started in 2004 and should be completed in 2014. Currently (end of 2012) the project is on the phase 3. This means that the vessel is ready, the smaller models of the fuel cell device are tested and the fuel cell equipment soon will be installed on board of the vessel.

The project used an open innovation approach and united enterprises based in Norway and Germany. Initially, five companies created an R&D alliance and contributed with 20 per cent each to a new alliance. They were the classification society Det Norske Veritas, two shipping companies, one Norwegian and one Swedish, a Norwegian ship design firm, and a Norwegian automation firm. Later the Finnish-based multinational Wärtsila has acquired both the ship design and the ship automation firm and now owns a two-fifths share in the R&D alliance. Partners contributed with their core competencies to a new product development. The project was later financially supported by the Research Council of Norway through a FellowSHIP program, and tax reduction schemes. The Government covered about 40% of the R&D expenses. As for partner selection issues for this project, the parties knew each other from before. The project manager of the fuel cell ship at the shipping company who initiated the cooperation stated:

*"We did not want to go to the market and announce a tender to develop parts of the project, i.e. ship design or elaboration of the engine. We worked with the partners whom we know over many years. And we are sure that the information will not leak. We know that we can cooperate effectively. We have compatible organizational cultures. And we are geographically close. We [the shipping company], ship designer, automation and engine developer and the shipyard are in the same district. So it is easy to organize meetings and travel will not take much time. The project leader, DNV, is in Oslo. But again, we all have cooperated with DNV for many years. DNV has established a contact with one of the best manufacturers of fuel cells in the world which is situated in Munich."*

So, for an open innovation project, the project initiator wishes to use only reliable partners with whom the cooperated earlier. This finding is in line with the previous study (Kock and Torkkeli, 2008), where the researchers found out that 65 per cent of open innovation projects are carried out with 'steady partners'. So, at the initial stage of project development, the initiator group at the shipping company asked themselves a set of question 'whom

we know?', 'who are we?', 'what do we know?' (step 1 of the effectuation process). In Table 1, the citations from interviews related to steps 1 to 4 of effectuation are presented. The shipping company had successful cooperation relations with the ship design firm, a shipyard, and an automation firm which developed the engine. They have tight relations with each other over twenty years and finalized an innovation project aimed to develop an LNG-driven vessel. The project was completed successfully. The shipping company became first in Norway which introduced environment friendly gas-driven platform supply vessels in Norway. This discussion leads to the following propositions:

*Proposition 1: Firms which had mutually beneficial relations with certain firms in the past aimed for open innovation development would tend to engage the same partners into new open innovation projects.*

*Proposition 2: Firms which prefer to keep sensitive information related to a product to be created in an open innovation project, tend to select partners from those firms which they know from the past and have established trustful relations rather than select partners in the market.*

Participants of the joint venture for a hybrid ship development are active in serving the highly profitable Norwegian oil sector. Thus, they could afford to use certain amount of their profits into the new product development (Step 2). The R&D alliance has estimated how much money they can afford to invest into innovation development and managed to attract money from the national research council to sponsor 40 per cent of R&D costs. Initially, they had a rough idea of how the final vessel would look like. The construction of the device which produces fuel cells has been changed over the project in the process of tight interaction among stakeholders (step 3).

The participants interacted not only with each other but also with other firms which did not own stakes in the R&D alliance but also were well known to participants (i.e., a shipyard). A number of contingencies occurred over the project development. The partners managed to turn many of them to the profitable solutions (step 4). First, the regulation framework for the fuel cell use on the board of ships did not exist. All parties involved in the project were involved in the creation of the maritime rules which will regulate the development, construction, and exploitation of hybrid vessels using fuel cells. Second, the German company has a very wide experience in development and production of fuel cells aggregates which are used on the ground, e.g. as auxiliary power source for the hospitals. In the open sea, the weather conditions are severe and the fuel cells machinery is in a constant movement. This was one of the tasks which practitioners have solved in the project, and they have acquired a patent for this invention. Third, hydrogen cannot be preserved on board since it is highly explosive. The alliance has found a solution how to produce hydrogen on board of the vessel. Next, the fuel cell machinery (which produces electricity which drives the engine) warms up over three hours and finishes the production of the fuel cells during 24 hours. In other words, the ship cannot stop when it needs to go the port or electricity would be just 'lost' in the sea in order to stop the ship. The alliance developed special accumulators to collect the electricity which the fuel cell aggregate produces. Again, this invention was also patented. The partners hope to sell licenses on products they have developed within this project, i.e. outbound innovation. They argue that the demand for the ecology friendly vessels will increase soon since international authorities constantly introduce new rules related to pollution and emission of $CO_2$ and other gases. This discussion leads to following propositions:

*Proposition 3: Initiators of open innovation projects tend to use effectuation approach to the new R&D venture formation when they do not know how the final product will look like.*

**Table 1.** The effectuation process over the open innovation process in the shipping company

| Step | Question | Citation |
|---|---|---|
| 1 Means-driven transformation | Who are we?<br>What do we know?<br>Whom we know? | "We are a shipping company which uses a proactive strategy to a new fleet development. We have newly developed a new technology which allows use both LNG and traditional marine oil as a fuel. We have got knowledge and competence in new product and revolutionary technology development.<br>We have established good relationship with a number of firms, i.e. suppliers, customers, banks, and authorities" (the head of the project in the shipping company). |
| 2 Technology of foolishness | What can we do? / Affordable loss | "We freshly developed and implemented a new technology which allows to reduce emission from our ships. [LNG-driven vessel was also developed in cooperation with the same ship design company and engine manufacturer as the ship which uses both LNG and fuel cells]. We have a good team of cooperation partners who created an innovative vessel. What can we do together further? May be we can try to make a Prius [a hybrid car of Toyota] in the sea" (the project engineer in the shipping company). |
| 3 Docility | Stakeholder interaction | "We decided to create a joint venture where each party will have 20% stake. The participants were two shipping companies (one later went out), the classification society, automation firm, and ship design company. The Norwegian government also was attracted to participate and contributed with about 40% of R&D expenses support" (the head of R&D department at the ship design firm). |
| 4 Leveraging contingencies | Making lemons to the lemonade | "Several challenging problems which were on the way to implementing ground-based hydrogen fuel cells technology in the sea occurred on the way, starting from the regulation obstacles together with a number of sophisticated technical tasks. Problems were solved. A number of patents were registered" (project manager at the automation firm). |

## Conclusions and implications

This article considered one of the central aspects of open innovation formation, namely R&D alliances, and in particular the issue of partner selection for open innovation. The concept of effectuation was applied to answer the research questions of this study. The results show that effectuation rather than causation is a suitable approach for open innovation development under certain circumstances. Innovations are related to sensitivity of information outflow and initiators of innovation prefer rather to deal with the existing partners which they trust than look for partners in an open market. In this manner, firms may retain certain benefits such as limited secrecy and first mover advantages even when working in an open innovation mode. The effectuation/causation dichotomy has earlier been applied largely to entrepreneurs and small and young firms, where the actors generally are more resource constrained and may be forced into more open modes of innovation. Our case describes a mode of limited openness: partner selection is based on current trustful relations, and each partner may be allowed to bring other trustworthy actors into the partnership. But even when supported by public R&D funding, the network has a limited number of partners, and it has resulted in inventions that are possibly new to a global market.

The results of the study would be interesting to policymakers responsible for the promotion of open innovation and development of innovation systems in the key sectors of economy. The results will also contribute to practitioners from firms interested in attracting external knowledge for the innovation promotion in their firms. The findings of the paper might be useful for open innovation scholars and academics involved in innovation development processes together with the businesses.



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