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# **A new governance approach for multi-firm projects: Lessons from Olkiluoto 3 and Flamanville 3 nuclear power plant projects**

## **Abstract**

We analyze governance in two contemporary nuclear power plant projects: Olkiluoto 3 (Finland) and Flamanville 3 (France). We suggest that in the governance of large multi-firm projects, any of the prevalent governance approaches that rely on market, hierarchy, or hybrid forms, is not adequate as such. This paper opens up avenues towards a novel theory of governance in large projects by adopting a project network view with multiple networked firms within a single project, and by simultaneously going beyond organizational forms that cut across the traditional firm-market dichotomy. Our analysis suggests four changes in the prevailing perspective towards the governance of large projects. First, there should be a shift from viewing multi-firm projects as hierarchical contract organizations to viewing them as supply networks characterized by a complex and networked organizational structure. Second, there should be a shift in the emphasis of the predominant modes of governance, market and hierarchy towards novel governance approaches that emphasize network-level mechanisms such as self-regulation within the project. Third, there should be a shift from viewing projects as temporary endeavors to viewing projects as short-term events or episodes embedded in the long-term sphere of shared history and expected future activities among the involved actors. Fourth, there should be a shift from the prevailing narrow view of a hierarchical project management system towards an open system view of managing in complex and challenging institutional environments.

Keywords: governance, large project, multi-firm project, project network, nuclear power plant project, Olkiluoto 3, Flamanville 3

## 1. Introduction

This paper opens up avenues towards novel theory of governance in large projects. The well-known theory of institutional economics (Coase, 1937) and transaction cost economics (Williamson, 1985) introduce market and hierarchy as two polar ends of a continuum on which economic transactions can be placed. In addition, hybrid forms, combining elements of both market and hierarchy have also been suggested (Powell, 1987; Spina & Zotteri 2000; Lee, 2001). Furthermore, the extensive literature on corporate governance, adopting an agency perspective, has focused on identifying situations in which the goals of the principal may not be in alignment with the goals of the agent, and proposed mechanisms and measures (predominantly contractual in nature) to counter this problem (Jensen & Meckling, 1976; Eisenhardt, 1989; Shleifer & Vishny, 1997). While both streams of literature have primarily focused on dyadic relationships, either between two transacting actors or between a principal and an agent, in the *governance of large multi-firm projects*, however, we face the challenge of governing an internal complex supply chain of multiple firms (Stinchcombe & Heimer, 1985; Cox & Ireland, 2006; Kelly, 2006; Walker et al., 2008), and governing the network of external stakeholders (Aaltonen & Sivonen, 2009; Freeman, 1984). Such governance of internal and external networks of multiple firms and stakeholders includes elements which are not discussed adequately in the existing literature, and which cannot be explained only through the mere treatment of market, hierarchy, or hybrid.

In the context of project business of multiple firms and stakeholders, there is an evident need to clarify the concept of *project governance*. A number of concepts for project governance have been proposed. The Association for Project Management has coined the term *governance of project management* to signify areas of corporate governance related to project activities (APM, 2004). Miller and Hobbs (2005) have introduced the concept of *governance regime* to describe context and time-dependent and self-organizing processes in large projects involving multiple actors. Crawford et al. (2008) have discussed how projects

need to be governed from the perspective of their parent organization. Winch (2001) has discussed the *governance of a project coalition* involving multiple actors, focusing attention towards multiple transactions that occur throughout the project life cycle. Williams et al. (2010) have discussed governance frameworks used in various public investment projects. Finally, the broad literature on *corporate governance* addresses the various agency problems caused by the separation of ownership and control in modern organizations (La Porta et al., 2000; Letza, Sun & Kirkbride, 2004).

A large project can be viewed as a dynamic network of organizations that combines the resources, capabilities and knowledge of the participating actors to fulfill the needs of the owner. In addition to a goal shared by all participating actors, such as the construction of a nuclear power plant, each actor is directed by its own and often partially implicit objectives or expectations. As these objectives and expectations may conflict, large projects face several challenges not evident in the contexts of projects carried out by individual firms. In literature, various terms, such as complex project (Barlow, 2000), major project (Morris & Hough, 1987), giant project (Grün, 2004), megaproject (Flyvbjerg et al., 2003), large project (Miller & Lessard, 2001a, 2001b) have been suggested to describe projects involving several organizational actors that are involved in delivering a system or deliverable of considerable complexity, e.g. a power plant or an airport terminal. Based on the research on large projects referred to above, we define a large project as a significant undertaking characterized by multiple organizations seeking success with different objectives, changing priorities of project objectives, and finally, the project being subject to the impacts of a wider socio-political environment. Ruuska et al. (2009) have discussed the governance of Olkiluoto 3 nuclear power plant project and shown how the responsibility and risk was transferred to such project actors that were not able to carry it. These practices of allocating risks down to subordinates in the hierarchical supply chain are in stark contrast to Heathrow Terminal 5 (T5) project as discussed by Brady (2007), Brady et al. (2007), and Brady (2008). In the T5 project, an approach relying primarily on collaborative approaches to dividing risk in a balanced way among project participants was chosen. In our view, different approaches to

project governance in the context of large projects may significantly contribute to the outcomes and progress of the project.

For this paper, we empirically studied governance in two nuclear power plant projects: Olkiluoto 3 in Finland and Flamanville 3 in France. Both projects involve a complex network or multiple organizational actors. Throughout the implementation phase of the project, Olkiluoto 3 has faced several problems related to progress and the quality of work, resulting in severe financial difficulties for many involved parties. At present, in 2010, the estimated deadline for starting the production of electricity is 2012 - three years behind the original schedule. Also Flamanville 3 has suffered from difficulties, in particular related to the quality of work and materials. In this paper we seek answers to the following two research questions:

*What is project governance in the context of large projects, such as nuclear power plant projects?*

*What are the implications of different governance approaches on project performance?*

We start our analysis with a review of literature that has elaborated the concept of governance and its key elements and more specifically, discuss the concept of governance in the context of large multi-firm projects. Based on this review, we attempt to provide an understanding of governance of multi-firm projects and to propose a working definition of the concept of multi-firm project's governance. In the empirical part of this paper, we analyze the two nuclear power plant projects Olkiluoto 3 and Flamanville 3, including the governance approaches adopted in these projects. We then discuss how the adopted approaches may have contributed favorably or unfavorably to project progress and performance. Finally, we discuss the implications of our analysis to the area of governance of large projects and we provide suggestions for further research.

## 2. Literature review

In literature, the term governance is often related to mechanisms or processes that affect to how either a single transaction or recurrent transacting is organized ex ante and carried out ex post between two or more actors, either within the boundaries of a single organization or between two or more organizations. Literature on institutional economics literature focuses, in particular, on governance structures required for carrying out economic exchanges, such as purchases of raw materials or purchases of complex projects (Williamson, 1975, 1985). Furthermore, literature on corporate governance emphasizes various agency problems resulting from the separation of ownership from control that characterizes modern corporations (La Porta et al., 2000; Shleifer & Vishny, 1997; Letza et al., 2004). In particular, this literature examines mechanisms and measures applied by shareholders to ensure that their hard earned capital is not wasted on inefficient investments, or even outright stolen by managers that have been provided the authority to run the corporation.

It has been argued that an actor engaging in any economic transaction needs to deal with three fundamental problems: coordination, safeguarding, and adaptation (Williamson 1975, 1985). Transaction cost economics has highlighted three different forms of governance, market, hierarchy and hybrid, *i.e.* network. Within the boundaries of the organization, *i.e.* in a hierarchical governance form, the entrepreneur-coordinator directs production, and outside the boundaries of the firm, when market governance is utilized, production is directed by price movements (Coase, 1937). A hybrid is often considered an intermediate form between market and hierarchy (Williamson, 1985; Powell, 1990). Additional forms of governance frequently mentioned in literature include relational governance, *i.e.* relational contracting (Poppo & Zenger, 2002), and network governance (e.g. Powell, 1990; Jones et al., 1997). Central elements of governance often mentioned in literature include contractual arrangements, including incentive schemes, safeguards, and distribution of risk. In addition, the problem of how the buyer should monitor the compliance of the seller ex post has been discussed extensively (Ouchi, 1980; Walker & Poppo, 1991; Sriram et al., 1992; Turner &

Simister, 2001). Finally, literature, in particular in the field of sociology, has examined how relational ties based on trust and norms of reciprocal behavior between transacting actors affect the governance of transactions (e.g. Artz & Brush, 2000; Heide & Miner, 1992; Dyer, 1997; Jones et al., 1997; Adler, 2001). An archetypal categorization in terms of supply chain management is to divide the relationships into transactional-type relationships and partnership-type relationships (Lee, 2001), the former based on contracts and rules and the latter involving risk and benefit sharing. Accordingly, the transactional type of relationship can be characterized as an arms-length, competitive type of relationship and the latter as a collaborative, embedded and cooperative relationship (Granovetter, 1992; Uzzi, 1996, 1997).

In addition to literature discussing the governance of economic transactions, there is a vast literature on corporate governance which concentrates primarily on the agency problem, i.e. the separation of ownership and control. A number of studies and other examples (such as the collapse of the Enron Corporation in late 2001) have provided compelling evidence that, when provided opportunity for personal gains, managers do not necessarily prioritize the interests of the shareholders over their interest for personal benefit (Jensen, 1986; Zingales, 1994). To address this problem corporate governance literature sheds light on the design of governance systems that aim to ensure that the capital invested by shareholders is put to effective use by managers that act as their agents. A central element of these governance systems is the contractual arrangement between the principal and the agent, and several scholars have devoted attention to the identification of incentives that help to align the objectives of the managers with the objectives of the investor. In practice, these incentives manifest in a number of forms, including stock options and the ownership of shares (Jensen & Meckling, 1976; Fama 1980). In addition to contractual arrangements, academics have shed light on governance exercised by shareholders, in particular large investors, and discovered considerable national differences (Shleifer & Vishny, 1997). For example, while large shareholdings are relatively uncommon in the United States and as a result, shareholders have limited power to exercise governance, large shareholdings are commonplace in Germany and Japan, and within these national contexts, large investors also actively exercise their power to govern (*ibid*). While the vast

majority of corporate governance literature adopts both a straightforward agency perspective and the viewpoint of the shareholder, during the recent two decades additional, and complementary, viewpoints have started to gain foothold. For example, Letza et al. (2004) discuss four distinct perspectives to corporate governance, and further separate the broad literature to a shareholder perspective and a stakeholder perspective. The latter perspective encompasses contributions that consider the corporation as an entity embedded in the society which needs to consider the different claims and needs of various stakeholder groups such as employees, creditors, suppliers, and customers. Effectively, the various groups of stakeholders that “surround” a corporation or constitute it (in particular employees) also play a central role in governing it (Blair, 1995; Turnbull, 2002).

Several articles have discussed governance in a project context. Reve and Levitt (1984) have described trilateral governance arrangements involving a client, consultant, and contractor in engineering projects and highlighted different types of relationships between actors participating in large projects. Turner and Simister (2001) have discussed how risk and uncertainty affect the choice of contract type in projects and introduced a framework of four contracting approaches. Winch (2006) has further discussed the organization of a large project involving multiple firms as a nexus of treaties, emphasizing the importance of viewing large projects as temporary organizations involving several actors interconnected via inter-organizational relationships. Floricel and Miller (2001) introduced the concept of governability, referring to a group of properties that enable a project to react to unexpected events that occur during its life cycle. Governability further develops and complements Bettis and Hitt’s (1995) notion of flexibility. Furthermore, the organizational structure of a project with the use of contractors, the shaping of the project, the project’s institutional framework and the capacity of self-regulation are essential features of governance (Miller & Lessard, 2001a, 2001b; Miller, 2006). Winch (2001) has developed a conceptual framework for understanding project governance across the project life-cycle and argued that the greatest difference between traditional subcontracting and quasi-firms relates to transfer and sharing of risk between main contractor and subcontractors. Miller and Hobbs (2005) have presented a framework for understanding

governance in large complex projects and emphasized the dynamic, even unexpected nature of governance in large complex projects. Turner and Keegan (2001) have discussed governance structures adopted by successful project-based organizations and argued that the governance structure of the project should take into account whether few large projects, or many small projects are undertaken, and whether projects are undertaken for few, large dominant clients or many small clients. In addition, Turner and Keegan (2001) introduced the role of a broker and the role of a steward to support efficient and effective governance of projects within a firm's organization. Also Müller (2009) has discussed governance within a firm's organization by suggesting a governance model linking governance at different project-related levels (e.g. project management, program management, strategic management).

*Conclusion 1 - The need for an understanding of governance in the context of large multi-firm projects*

There are three kinds of literature discussing governance in project contexts. First, literature focusing on analyzing a single firm's governance scheme with its multiple projects. Second, literature considering large multi-firm projects as contract organizations. Third, literature considering projects as hybrid or network like structures involving multiple interconnected actors, as opposite to atomistic market structures directed by the invisible hand of competition or governance structures relying solely on the presence of one supreme hierarchical authority. According to our view, a clear and sufficiently broad definition for project governance that would fit the context of large complex projects does not exist. More specifically, there is a lack of agreement concerning what governance of large projects encompasses, or in other words, what are the *practices*, *complex interactions*, and *institutions* that are relevant when large projects are carried out between the client, the seller, and other involved firms, and to what *outcomes* do different practices and institutions lead to.

*Conclusion 2 - The context and institutional factors affecting the selection of elements of governance of a large multi-firm project*

First, we adopt the view that the *generic features of project business* affect to how projects are organized and carried out and thus, should be taken into account when considering the governance scheme of a large multi-firm project. Generic features of project business include inherent discontinuity, uniqueness, and complexity (Mandják & Veres, 1998). Furthermore, project-based firms participate in projects to fulfill their business interests and goals (Artto & Wikström, 2005). In addition to generic features of project business, the *specific industry context* may influence the governance of a large project. For example, the governance of offshore projects is likely to differ from the governance of nuclear power plant projects. Finally, we assume that governance is influenced by *project specific conditions*, such as institutional exceptions in global projects (Orr & Scott, 2008). For example, the practices or institutions describing the governance of a given project may differ based on whether the project is carried out in France or in Japan, or whether the project is delivered for a long-term client or an entirely new client.

### *Conclusion 3 - Key elements of governance*

Based on the review of existing literature on projects and governance, we claim that there are several *elements* that clearly play a major role in shaping the governance of a large project, including (but not necessarily limited to):

- Contracts between involved actors
- How procurement is organized and carried out
- How networks of suppliers are managed by project actors
- How risks are managed and shared by project actors
- How work is monitored and coordinated during the project life cycle
- How do the project actors collaborate and develop practices
- How is communication between project actors organized

Many of these elements, such as procurement, contracts and monitoring of the progress of work have very often been emphasized (e.g. Jensen & Meckling, 1976; Ouchi, 1980; Jarillo, 1988; Ring & Van de Ven, 1992; Thompson et al., 1998; Turner & Simister, 2001; Winch, 2006; Rothengatter, 2008). As large projects have been described as project coalitions, or networks involving several interdependent firms, elements emphasizing the interconnectedness of participating actors, such as communication and strategies selected by participating actors may play a particularly important role in the governance of large projects.

#### *Conclusion 4 - Beneficial and adversarial effects of governance of a large multi-firm project*

It is a common argument that the fit between contextual factors and the adopted form of governance is a key determinant for the efficiency of the transaction between a buyer and a seller (Williamson, 1975; Jones et al., 1997; Adler, 2001). Similarly, the form of project governance, or more specifically, the use of different elements of governance, may contribute favorably or unfavorably to the outcome of a large project. More specifically, according to our literature review, the use of the elements of project governance can be expected to contribute to the efficiency and effectiveness of work carried out. Both efficiency and effectiveness are considered as important for project success and financial performance of project actors. In addition to efficiency and effectiveness, we also consider the use of the elements of governance to explain various long-term effects that may result from carrying out a project, such as the development of capabilities, knowledge and learning.

### **3. Research methods**

Our empirical data consists of publicly available information on two major nuclear power plant projects: Olkiluoto 3 in Finland and Flamanville 3 in France.

More specifically, the data concerning Olkiluoto 3 consists of:

- The total coverage of articles published in the Finnish leading financial periodicals and newspapers about Olkiluoto 3 between years 2001-2009 (these periodicals and newspapers include: Kauppalehti, Talouselämä, Tekniikka ja Talous, Helsingin Sanomat).
- The total coverage of articles published in electronic periodicals and newspapers in French language about Olkiluoto 3 between years 2003- 2009 (these periodicals and newspapers include: Le Monde, Le Figaro, Le Canard enchaîné, Les Echos, L'Express, Le Nouvel Observateur, Le Point, Challenges).
- Public information provided in the Internet sites of the key actors: AREVA, TVO, STUK (Radiation and Nuclear Safety Authority, Finland) and Ministry of Employment and the Economy and broadcasted TV documents and news broadcasts about the plant.
- The extensive and in-depth investigation report about the Olkiluoto 3 project's challenges published by STUK in June 2006 (STUK Investigation report 1/06: Management of safety requirements in subcontracting during the Olkiluoto 3 nuclear power plant construction phase).

Our research data of Flamanville 3 consists of:

- The total coverage of articles published in electronic periodicals and newspapers in French language about Flamanville 3 between years 2003- 2009 (these periodicals and newspapers include: Le Monde, Le Figaro, Le Canard enchaîné, Les Echos, L'Express, Le Nouvel Observateur, Le Point, Challenges)
- Public information provided in the Internet sites of the key actors: AREVA, EDF, Bouygues, ALSTOM and ASN (the French national authority in radiation and nuclear safety) and news broadcasts about the plant.
- Information provided by specialized web sites: [www.world-nuclear-news.org](http://www.world-nuclear-news.org), [www.world-nuclear.org](http://www.world-nuclear.org), [www.francenuc.org](http://www.francenuc.org), [www.french-nuclear-safety.fr](http://www.french-nuclear-safety.fr), [thomsonreuters.com](http://thomsonreuters.com), [www.reuters.com](http://www.reuters.com), [www.cbc.ca](http://www.cbc.ca), [www.telegraph.co.uk](http://www.telegraph.co.uk), [www.guardian.co.uk](http://www.guardian.co.uk),

[www.spiegel.de/international](http://www.spiegel.de/international), [www.mobile.france24.com](http://www.mobile.france24.com), [www.french-nuclear-safety.fr](http://www.french-nuclear-safety.fr),  
[www.bmu.de](http://www.bmu.de), [www.energy.edf.com](http://www.energy.edf.com), [www.unistarnuclear.com](http://www.unistarnuclear.com), [www.bouygues-construction.com](http://www.bouygues-construction.com).

We analyzed the written material by using the qualitative data analysis program ATLAS.ti (version 5.2). The primary rationale for using ATLAS.ti was to facilitate the management of large amount of research data. Data was first coded into categories based on the seven key elements of governance resulting from our literature analysis (see Conclusion 3 above - key elements of governance). As several individuals were involved in the coding process, we defined explicit criteria for coding to ensure the consistency of analysis. More specifically, the criteria specified in detail what type of content would be coded as related to each key element of governance. After the coding process was completed, the coded data was further examined by focusing on the issues related to overall network, the main actors of projects, contracts, and collaboration practices. This was done for both projects separately. Cross-case comparisons were then carried out to compare the progress and outcomes in both projects. Conclusions resulting from these comparisons were organized under the themes of project being over budget, delays on schedule, quality control issues on concreting problems and quality control issues on other problems, collaboration among actors, and conflicts among actors.

When an incident or problem was repeatedly reported in several sources like newspapers, for example that a plant was late in schedule, a comparison was made of how the reporting differed in the sources. We considered especially the French and Finnish media coverage and their differences, in all applicable cases. Concerning different sources, if there were any discrepancies in the documented data from newspaper and periodical articles and broadcasted news and documentary materials, the information from the official authorities or from the actors involved was considered more reliable than information provided by external parties.

Concerning the validity and reliability of this research, the use of this type of rich public evidence, archival records and documentation, has both advantages and disadvantages. According to Yin (1989, p. 17) archival analysis in case study research can be used to answer such questions as what, how often and when. However, typically archival and documentary data are completed with other types of evidence such as interviews for the purposes of triangulation. Hence, our sources of evidence may potentially affect the validity of our findings (Yin, 1989). However, one advantage of the use of this kind of rich and public data is the fact that we can openly discuss the data and our findings in the analysis, by posing the data and the findings for public critique. Such public critique may help to test the correctness of the content of our analysis.

Since our findings are based on two specific nuclear power plant cases, and our literature review is focused on the literature addressing large projects in infrastructure, engineering construction, and engineering industries, our results should not be generalized in a too straightforward manner outside such projects and contexts.

## **4. Results**

### **4.1 The Olkiluoto 3 case**

#### *Overall network and background information*

Olkiluoto 3, a 1600 Megawatt plant, is the fifth nuclear power plant built in Finland. Olkiluoto 3 involves a group of diverse organizations with differing roles and responsibilities, which together form a complex multi-organizational project network. TVO has the role of the owner and it has selected AREVA to deliver the entire power plant as a lump-sum turnkey delivery. As the main contractor AREVA is responsible for organizing both the engineering and construction of the entire plant. Figure 1 depicts the supply network of the main actors in the Olkiluoto 3 project.

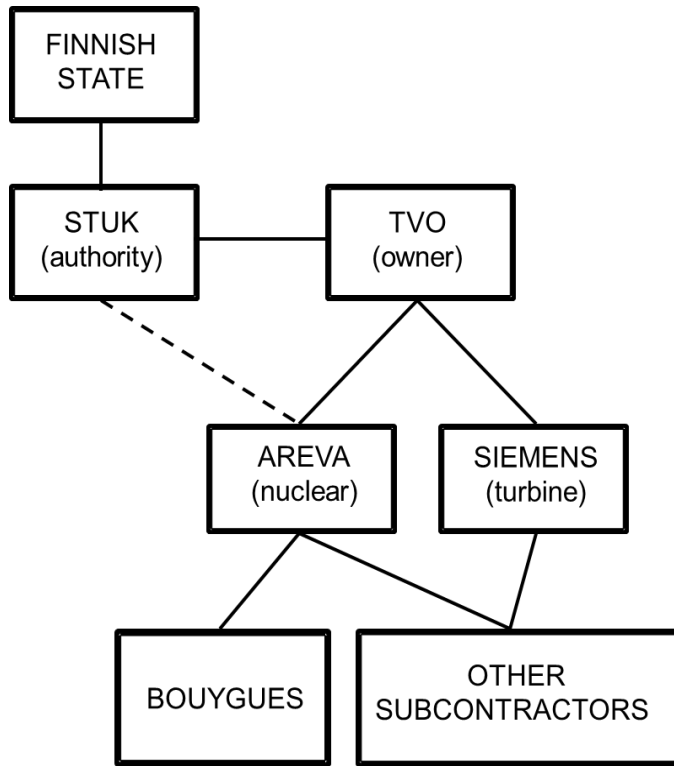


Figure 1 The supply network of the Olkiluoto 3 project

#### *The main project actors*

*Teollisuuden Voima (TVO)* is a private limited company founded in 1969 to produce electricity for its shareholders at cost price. It states its mission as: “To produce electricity for shareholders safely, reliably and economically while preserving the environment.” TVO's largest owners are Fortum Power and Heat and Pohjolan Voima, with a combined ownership of over 80%. TVO already owns the two NPPs operating in Olkiluoto.

*AREVA* is a French industrial group owned more than 90% by the French state. It is divided in three main divisions which cover all the aspects of generating electricity with nuclear technology: *AREVA NP* - Nuclear Power: in charge of developing and building nuclear reactors; *AREVA NC* - Nuclear Cycle: covers

the entire nuclear fuel cycle, from mining to waste disposal; *AREVA T&D* - Transmission and Distribution: power transmission and distribution.

*Bouygues*, a French construction company, is the main subcontractor of AREVA regarding construction of civil work in Olkiluoto 3.

*Finnish state* – The Finnish state interacts with the project through authorities. The supreme management and supervision in the nuclear energy sector are vested with the Ministry of Employment and the Economy. *STUK* (Radiation and Nuclear Safety Authority) operating under the Ministry of Social Affairs and Health, is responsible for the supervision of nuclear safety and the use of radiation. It is a regulatory authority, research centre and expert organization, whose mission is to protect people, society, environment and future generations from the harmful effects of radiation. The ultimate quality objective of operations is to keep the radiation exposure of people as low as is reasonably achievable and to prevent radiation and nuclear accidents with a very high certainty.

In addition, many other governmental and local organizations, as well as the municipalities locating the nuclear power plants, participate in the supervision of the nuclear power plants required by the nuclear energy law or other legislation.

#### *Relationships between the project actors*

Prior to Olkiluoto 3, TVO and AREVA had not been involved in any significant project together. TVO initiated the project with the strategy to give the turnkey responsibility to a single company. The ambiguity in defining the responsibilities between TVO and AREVA has received public criticism in media (the Finnish media, e.g. (1); (2); (3); (4), and the international media, e.g. (5); (6); (7)). The results of this have been illustrated at different levels, including a high turnover of construction site personnel, including superiors, at early stages impeding the clarity in responsibilities. TVO is an experienced actor in the Finnish

nuclear business, as it has been involved as a client and owner in the building of two earlier nuclear power plants in Finland, Olkiluoto 1 started production of electricity in 1979 and Olkiluoto 2 in 1982. AREVA is the world leader in the nuclear power field and very experienced in building nuclear. As the project has proceeded and severe problems have arisen, the relationship between AREVA and TVO has become clearly confrontational as both parties are placing the blame on each other claiming economic compensations for the delays in the international arbitrary procedure (8). Finally, concerning the relationships with the authority, TVO and STUK have an established relationship. AREVA and STUK did not have a relationship or experience on previous joint projects.

#### *Goals of the project and objectives of the project actors*

Safety and quality were at the top of all official priority lists, as the case concerned the building of a nuclear plant. AREVA was willing to take some risks to win the bid and gain edge on the competitors in the international market (9).

#### *Contracts between the project actors*

The Olkiluoto 3 project is conducted as a lump-sum turnkey project. AREVA acts in the position of the main contractor. Price-based competition was emphasized in the tendering phase. AREVA, according to the French media, has underestimated the price of the EPR in order to win the tender, thus underestimating the credit insurance given by Coface (10).

The value of the contract between TVO and AREVA is 3 billion Euro, and the contract was signed in late 2003. The turnkey project was sold as a new technology project, since there was a new type of nuclear technology involved. At the time of the contract signing it was speculated in the Finnish media that the price of the deal, as well as the estimated schedule, was really strict from AREVA's point of view (11). Two other companies took part in the tender competition: General Electric with ABB as its key

subcontractor, and a Russian company, Atomstroieksport, which was evaluated not to have competence to deliver a plant of such a large scale. Finally, AREVA, with a low bid, was selected by TVO.

#### *Collaboration practices between the project actors*

Complex multi-firm network embodies various roles and responsibilities. By utilizing a turnkey contract TVO delegated authority to AREVA. AREVA as the main contractor further delegated certain responsibilities to its own suppliers. The turnkey contract impeded TVO to control the subcontractors and monitor that the safety issues are properly dealt with. During the building of the plant, this lack of control manifested, e.g., as a conflict due to unclear responsibilities in defining the composition of the concrete (12). Furthermore, both AREVA and TVO experienced challenges that were related to their roles in the project (12). For example, STUK identified deficiencies in TVO's capabilities to act in the role of a buyer (12). Doubts have also been presented about the reconciliation of dissimilar operational and communicational practices between the Finnish, German and French (13).

## **4.2 The Flamanville 3 case**

#### *Overall network and background information*

The second European EPR (European Pressurized Reactor) is under construction in Flamanville 3, a commune in the Manche department in northwestern France on the English Channel. Flamanville 3 has already two operational reactors commissioned in 1986 and 1987. The new EPR represents a first-of-a-kind plant under construction by the new French supply chain of a project, which differs from the one in the Olkiluoto 3. This is the first of several plants scheduled to substitute the aging reactors providing the 75% of the country's electricity. Figure 2 illustrates the supply network of the main actors in the Flamanville 3 project.

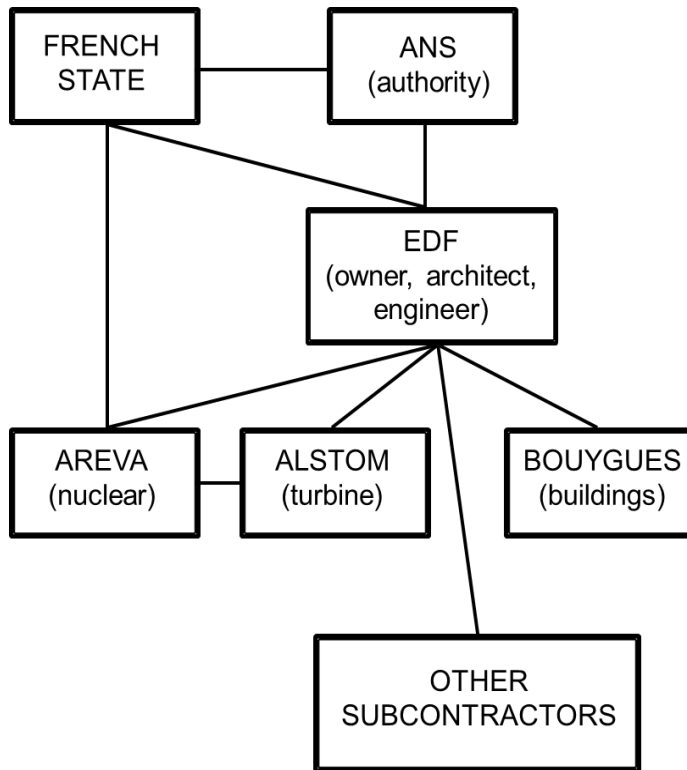


Figure 2 The supply network of the Flamanville 3 project

#### *The main project actors*

*EDF* - Électricité de France is the main French Utility. The French government owns 85% of its shares. EDF operates 59 nuclear reactors with the total capacity of over 63 GWe. EDF acts as the architect-engineer in the project. In nuclear power projects, the role of an architect-engineer is highly similar to that of a main contractor. It is in charge of managing the project at the highest level, defining technical reference standards, allocating, managing and overseeing, contracts, and interfacing with the safety regulator (ASN). Compared to the role of a main contractor, the role of the architect-engineer emphasizes the overseeing of planning and design while a considerable degree of responsibility for construction is carried by other project actors (14).

*AREVA* – see the Olkiluoto 3 case

*Alstom* is a large French multinational conglomerate. The company has been awarded of a contract of 350 million Euro for all engineering, procurement, construction and commissioning of the complete turbine island (steam turbine, generator, condenser, moisture separator reheaters and auxiliary equipment). Every EDF reactor already in service uses conventional island equipment supplied by Alstom

*Bouygues* is a French construction company. Bouygues stated in a press release (15) that in the Flamanville 3 plant their contract, worth more than 300 million Euro, covers engineering and main civil works for construction of all industrial buildings on the site.

*French State* – The government controls directly the Authority (ASN), the buyer/utility (EDF), and the most important contractor (AREVA). Moreover, many other important contractors are French, among them: Alstom and Bouygues. France, as stated by President Sarkozy (16); (17), aims at becoming a leading exporter of atomic energy.

*ASN* - Autorité de sûreté nucléaire - French Nuclear Safety Authority is the administrative authority in charge, on behalf of the State, to regulate the nuclear safety and radiation protection in order to protect the workers, patients, the public and the environment from the risks involved in nuclear activities.

#### *Relationships between the project actors*

EDF and AREVA have good relations, they are both owned by the same owner, the French State, resulting in less incentive for competitive bargaining. The relationships between these actors are based on long-term collaboration. In the Flamanville 3 project EDF and Bouygues signed the contract in August 2006, after an international call for tenders. EDF and Bouygues are partners since the 1990s: in May 1994 Bouygues and EDF signed a strategic international partnership agreement to develop joint operations in the area of public utilities management. Actors share the same objective of establishing the French power plant reputation. The strong network of actors facilitates the solving of problems that arise during the project in a cooperative manner.

### *Goals of the project and objectives of the project actors*

It is clear that the EPR will be a “made in France” reactor in which the French state is the main actor since it controls the supply chain: directly the Authority (ASN), the buyer/utility (EDF), and the most important contractor (AREVA). This approach is similar to the one used in the 70s and 80s. The units follow the same standardization to maximize the learning economies thus improving the efficiency of the investments.

### *Contracts between the project actors*

EDF - Électricité de France is in charge of the contracts: detailed design studies of suppliers, on site construction, and the start-up. EDF is the architect engineering and coordinates the work of participating suppliers. AREVA is responsible for the nuclear island and Bouygues for the civil works.

### *Collaboration practices between the project actors*

A regular bidding phase (similar to Olkiluoto 3) has not taken place in Flamanville 3, since EDF selected AREVA for the construction of this reactor directly. This is the logical consequence since the French state owns both firms. This enables a close co-operation (18). Even if ASN is also part of the French state, it prioritizes safety over the interests of EDF/AREVA and acts independently and transparently. This has been made evident by the decisions made by ASN (19). For example, it ordered the suspension of the works for reactor base-slab for one month in May 2008 and to submit a corrective action plan, followed by the detection of several deviations in concrete structural work early in 2008 (20).

## **4.3 Progress in the two nuclear power plant projects**

The progress and outcomes in both projects are compared by the following issues: Project being over budget, delays on schedule, quality control issues on concreting problems and quality control issues on other problems, collaboration among actors, and conflicts among actors. However, it should be noted that

Olkiluoto 3 and Flamanville 3 are proceeding in different phases. Olkiluoto 3 has progressed considerably further than Flamanville 3.

#### *Project over budget*

In Flamanville 3, EDF initially estimated a total cost of 3.3 billion Euro. Media sources (21) report that the project is 1 - 1.6 billion Euro over budget. Therefore the total cost can be estimated at about 5-6 billion Euro. World nuclear News (5) published in October 2009 that EDF will be on time and will appeal around 200 additional workers with an exceeded budget of 20% costs reaching 4 billion Euro. More recently, media sources have claimed that the project will be completed 9 months late as compared to original plans (22).

In Olkiluoto 3, the original budget of 3 billion Euro has already been exceeded at least by 50 per cent (23). Delay in the start of the production of electricity in Olkiluoto 3 has been estimated to cost AREVA an additional 2.3 billion Euro (24). TVO as the owner will suffer the lost in revenues of three years of production of electricity (25).

#### *Delays on schedule*

Concerning Flamanville 3, Communications officer of EDF has stated that the conventional island is on schedule (26). However, media report of AREVA (27) claimed that the commissioning of the reactor will be in 2013, a year late of the original schedule. However, EDF has declared that they will apply new technologies to deliver the power plant on time (28).

AREVA, the turnkey supplier of the Olkiluoto 3 nuclear power plant unit, has confirmed TVO's earlier estimation that the Olkiluoto 3 unit will not be completed until 2012 (29). Originally, the project was to be completed in 2009. The delays in Olkiluoto 3 have evolved into a serious confrontation between TVO and AREVA. AREVA decided to run an international arbitration procedure in December 2008 due to delays,

accusing TVO of taking too much time to study documents. AREVA has claimed for compensation of 1.4 billion Euro. On the contrary, TVO has claimed 2.4 billion Euro from AREVA as penalties for the delay (30); (31). Moreover, AREVA publicly announced that TVO will have to change its procedures to be able to maintain agreed schedules (32).

### *Quality control issues, concreting problems*

According to ASN, the concrete that forms the reactor base in Flamanville 3 has been poured incorrectly (33). In May 2008 ASN stopped concrete pouring activities because of concerns regarding the EDF quality management system. In order to restart the work EDF submitted to ASN an action plan to improve the efficiency of the quality management system. Problems in Flamanville 3 concerned, besides the concrete, the assembly of the metallic structure and welding of the liner part which will isolate the confinement area. Concrete composing of the structure of the power plant and welding of different parts of the reactor were problems that occurred in both studied projects.

In Olkiluoto 3 the concreting work was halted twice due to severe problems. The concrete supplier, *Forssan Betoni* was selected from four candidates, even though the small size of the company was considered a risk factor (12). Special requirements of nuclear power plant building were not emphasized in the call for tenders (12). No training related to safety culture was provided to the personnel of the concrete supplier prior to concreting of the base slab (12). In addition, STUK continuously made notions related to actors' safety culture and education (12). Despite these requirements, the actors developed the safety practices in a quite unsystematic manner. An audit done by TVO and Framatome ANP (The Nuclear Island for the turnkey project is supplied by Framatome ANP) into Forssan Betoni's headquarters in May 2005 (12) revealed three significant deficiencies, which along with four minor deficiencies proved, that the firm's quality system was inadequate. The deficiencies were related to the flow of information and documentation between the companies involved in the project, leading to quality problems with the composition of the

concrete. Despite the explicitly expressed promises of the concrete supplier to implement the quality system presented in the tendering phase, development related to the system had not actually taken place.

#### *Quality control issues, other problems*

Besides the concrete, other minor problems on quality control have been discovered in Flamanville 3. For instance the welding process differed from what was planned (34). A company without the required certification welded the liner and some welds were deficient. In January 2009 ASN pointed out other findings about the quality in Flamanville. However, reportedly the magnitude of these problems is less severe than in Olkiluoto 3.

#### *Collaboration among actors*

In Flamanville 3, for the reasons already presented the collaboration among the industrial actors has been relatively successful. They are also partners in the UniStar joint venture established to promote nuclear energy in U.S. markets (35). AREVA and EDF are mostly owned by the French government, ALSTOM and Bouygues Group look for a long term relationship. They aim to become the standard contractor for the EPR design. In Flamanville 3, so far there have not been significant conflicts among the project actors.

In Olkiluoto 3, several challenges concerning the collaboration between the actors have occurred, as described earlier. Problems have caused friction between project actors (mainly TVO and AREVA), which has led to an “us vs. them” –atmosphere and the conflicts have become public in the media (36). AREVA and TVO are debating over contractual reparations (37).

In conclusion, more information on Olkiluoto 3 is available in the Finnish media than in the French media. The open debate going on in Finnish media does not, to a similar extent, take place in the French media. Concerning Flamanville 3 the main communication problem has not existed between the project actors, as in the Olkiluoto 3 case, but instead with the public. French media has reported that the government made

quick decisions focusing mainly on the importance of the French energy policy neglecting the security leading to a lack of sufficient public debate (38); (39); (40). There is an established relation between different media and two of the main stakeholders involved in the project, i.e. the French government and Bouygues (41). In addition to operating in construction, Bouygues is a media player in France as it owns TF 1. This relates to the relationship with the TV media rather than newspapers.

The owner TVO allocated all responsibility to the main contractor AREVA by using a turnkey contract in Olkiluoto 3. Further on, AREVA delegated certain responsibilities to its suppliers. The owner's role was weak, impeding it to exercise control in the network and be convinced that safety regulations were managed properly amongst all suppliers. In Flamanville 3 EDF carried considerable responsibility itself by acting as the architect-engineer. TVO's capabilities as an owner were deficient by the conception of STUK, the nuclear authority. Roles and responsibilities specifically between TVO and AREVA were unclear and frequently led to conflicts, and reportedly led to difficulties with the monitoring of suppliers in Olkiluoto 3. The call for tenders lacked the specific requirements for nuclear construction, and safety training provided for subcontractors was insufficient. Additionally, STUK made several notions on the inadequate safety culture. During the implementation of Olkiluoto 3 and Flamanville 3 similar technical problems occurred and construction on both was suspended by the national authorities STUK and ASN. Relationships between the actors of Olkiluoto 3 can be characterized as distant, whereas the relationships in the Flamanville 3 were collaborative and established in nature. In Flamanville 3, the French state can be seen as the main actor as it controls the key organizations of the supply chain, leading to congruent objectives. Price-based completion was emphasized in Olkiluoto 3, both in the selection of the main and the sub-contractors, whereas the overlapping ownership of the central actors in Flamanville 3 resulted in no incentives for the use of competitive bargaining.

## **5. Discussion**

### **5.1 Relating results from Olkiluoto 3 and Flamanville 3 analyses to existing knowledge on project research**

Project literature has discussed numerous cases of both success and failure in large project implementation. Morris and Hough (1987) discuss two projects where all the responsibility was allocated to the contractor. In the Thames Barrier, the technical specifications were prepared in a detailed manner, but the responsibility of the work was allocated to a contractor without mechanisms to ensure the early commitment of skilled resources. In the Channel Tunnel, there was no one person 'objectively' representing the project's interests who would have had the aim, need and charter to discuss and interact with all the parties (Morris & Hough, 1987). In a similar manner, in Olkiluoto 3, all the responsibility was allocated to the turnkey contractor AREVA. TVO as the principal did not realize or accept its responsibility as the owner of the project. Instead, TVO assumed that contracts will be a sufficient way to delegate authority to the turn key contractor. In Flamanville 3, EDF, the owner, acted as an architect-engineer. The case of the construction project of Heathrow Terminal 5 (T5), in turn, presents a successful project implementation case with multiple involved firms. Brady (2007), Brady et al. (2007), and Brady (2008) have analyzed T5, carried out by multiple participating firms and discuss how the management principles of the owner accepting not to dump risks to contractors contributed to the project's success. BAA as the owner of T5 enhanced interest alignment with contractors through long-term framework agreements, incentive-based contracts, and identity building of the core integrated team. The principles of the framework agreement were successfully applied in construction leading to the project being delivered on time and within budget. However, a major disaster took place at the opening day due to series of problems leading to cancellation of flights and lost luggage. Not enough attention was paid to the build-up of the opening of the terminal (Brady & Davies, 2010). Brady and Davies (2010) discovered that the integration and togetherness of the airport operator and the airline operator deteriorated prior to the opening and the principles that were followed during the construction phase were not followed through to the operational phase. Later on, BAA

has abandoned the framework agreement model. This does not imply, however, that the project was a failure nor devalue the successful outcomes in the implementation of T5. Reversion to the old mode of operation possibly has other motives, such as the change of ownership of BAA with different strategic priorities as well as institutional and commercial practices that are easier to apply than radical new models.

Monitoring of an agent's adherence to the principal's objectives is a critical component of any governance system (Jensen & Meckling, 1976; Ouchi, 1979; Evaristo et al., 2004). When knowledge or trust increases, the level of monitoring can be decreased (Adler, 2001). In the case of Olkiluoto 3 proper monitoring of suppliers was neglected by both TVO and AREVA. Instead, problems related to suppliers were frequently dealt with only after they posed a threat to the progress of the project. The extent to which policies and standards are in place and upheld has a significant effect on an organization's ability to maintain project integrity (Evaristo et al., 2004). Evaristo et al. (2004) emphasize both the existence of policies and standards and the extent to which the policies or standards are actually upheld in an organization. Critical standards areas include scope control, estimating methodology, communications standards, scheduling methodology and programming standards. Values of the existence of standards and policies may range from existent (strictly upheld, generally upheld, weakly upheld) to non-existent. Olkiluoto 3 lacked monitoring policies for ensuring of different organizations having the required safety and quality standards implemented. Further, the practices related to documentation transfer and the way or processing them were unsystematic. Synchronicity refers to the extent of people working on the same project concurrently (Evaristo et al., 2004). Evaristo et al. (2004) argue that a way of evaluating synchronicity is to assess checkpoint frequency. Continuous checkpoints indicate real-time interaction. Synchronization occurs both in quality and in content. In most cases, monitoring of synchronous work is more difficult than that of sequential work. It requires careful design of the monitoring methods to assure that project tasks are updated to reflect all aspects of synchronous activity. A project manager must create carefully designed monitoring methods to manage the flow of information on project status. Besides the project manager and the sponsors, the monitoring methods must also provide information between synchronized units of the

project. Similarly, Söderlund (2002) refers to frequent milestones and tests of sub-parts on the system-level that give feedback information. In Olkiluoto 3 AREVA decided to implement concurrent engineering as a response to TVO's project acceleration requirements. However, TVO did not respond to this by adapting the project status check practices. In Olkiluoto 3 the investigation authority suspected that the price was heavily emphasized as the selection criterion both when TVO selected the turnkey contractor as well as when AREVA selected the subcontractors. Emphasizing price as the main supplier selection criterion may increase the selection of a supplier with inadequate experience and capability profiles, which requires more monitoring from the buyer.

## **5.2 The contract organization and the owner's role**

The governance in Olkiluoto 3 and Flamanville 3 differed considerably in terms of what kind of roles the owners adopted: in Olkiluoto 3, TVO allocated all responsibility and inherent risks to AREVA, whereas in Flamanville 3 EDF carried considerable responsibility itself by acting as an architect-engineer. The need to achieve goal alignment between the owner and the contractor, and to reduce the chance and benefit for opportunism by the client or contractor has been considered as the most significant issue when choosing a governance structure (Jensen & Meckling, 1976; Eisenhardt, 1989; Turner & Simister, 2001). For dyadic relationships, Turner and Simister (2001) argue that the selection of appropriate governance structures for a project should be based on incentivization through contracts. The purpose of a contract is to create a project organization, and it should be based on a system of cooperation instead of conflict, and therefore the need for goal alignment is more significant. According to Levitt and March (1995), the purpose of a project and contract organization is to create a cooperative system, and this is accomplished by achieving common objectives by properly incentivizing the contractors with contract pricing terms. Miller and Lessard (2008) stress that large projects should be governed as evolutionary systems. Governing evolutionary systems requires the development of a holistic understanding of the stakes and goals of different actors and often requires the project team to come up with creative responses to difficult and even "messy" situations. According to Turner (1999), such goal alignment comes from aligning the three P's: process, product and

purpose. The lack of goal alignment will result in maladaptation of one or more of the three Ps (Turner & Simister, 2001). In the case of Olkiluoto 3 the goal alignment did not seem to be strongly supported by the established governance structures. Actors entered the project with conflicting goals and with different foci. Communication was inadequate and misunderstandings arose. In literature, ineffective communication has been linked to poor performance (Maznevski, 1994; Lerpold, 2003). In Flamanville 3 relationships were based on long-term collaboration and the actors had experience on working with each other, which increased trust between the actors in the project. Long-term collaboration with a relatively stable set of suppliers may reduce transaction costs and affords interactive learning processes that benefit involved partners (Grabher, 2004).

The owner's competences and the owner's interest in putting resources into the process and carrying the responsibilities are crucial (Morris & Hough, 1987; Grün, 2004; Miller, 2006). It is the responsibility of project owners to establish the project management structure (Miller, 2006). The organizational structure of a project initiated by the owner with the use of contractors, the shaping of the project, the project's institutional framework and the capacity of governance and self-regulation are essential (Miller & Lessard, 2001a, 2001b; Miller 2006). Based on an empirical evidence from an analysis of a large project, Brady (2007), Brady et al. (2007), and Brady (2008) argue that effective principles of governance in the researched megaproject include the following: the owner accepts all relevant risks in the framework agreement (the owner also agreed to partially bear contractors' risks/concerns as to future projects), incentive-based contracts, and interest alignment and identity building of the core integrated team. Also Rothengatter (2008) has emphasized the importance of involving different stakeholder groups to minimize costly problems conceived during the procurement process. Flyvbjerg et al. (2003) and Samset (2003) suggest that the financing party's involvement at an early phase is vital as this helps to shape the project right from the start, and the financier's commitment to objectives would guarantee the support in the later phases in terms of financing. There should be balanced authority and responsibility among the different stakeholders (Morris & Hough, 1987; Grün, 2004). Extensive use of contractors will release the owner's

capacity and enable the owner to concentrate on core tasks (Grün, 2004). However, the owner should not mix fixed prices and reimbursable contract forms, i.e., the owner must not allocate such responsibilities or risks to the contractor that are more appropriate to keep under the owner's responsibility (Morris & Hough, 1987). In Olkiluoto 3, a turnkey contract with fixed price was used between TVO and AREVA, where the owner's strategy was not to retain any, but to move all transferable responsibilities and risks to AREVA.

Olkiluoto 3 and Flamanville 3 faced somewhat similar problems during their implementation. Construction on both plants was temporarily stopped by the authorities STUK and ANS due to quality problems. Quality played a significant role in both cases, especially concerning concreting. The main problems in Flamanville 3 were largely explained by inadequacies in quality control. There was not enough supervision, and the quality checks and assurance were time consuming. For example, Olkiluoto 3 faced major quality problems with concreting, as its subcontractor had difficulties in providing high-quality concrete suitable for a nuclear power plant. However, Olkiluoto 3 had very significant problems both in the conventional and the nuclear islands, whereas Flamanville 3 problems were related mostly to the nuclear part. In Flamanville 3 this was associated with the learning process and accumulating learning to the next project, partners had previous experience on working on similar projects. Concerning Olkiluoto 3, nuclear power plants had not been built in Finland for several decades, leading to the lack of accumulated learning and capabilities. This involves also the lack of capable and experienced suppliers. Davies and Brady (2000) and Brady and Davies (2004) argue that learning must be transferred to forthcoming projects to allow for economization of past experience. Economies of repetition (Davies & Brady, 2000) refer to transferring lessons from individual projects into firm-specific organizational tools, a distinctive culture and a repertoire of stories. The economies of repetition refer to accumulating knowledge into modules that can efficiently be recombined in subsequent projects. Yet there remain some open questions concerning accumulated knowledge. Bouygues is working on both plants, yet some of the lessons learned in Finland were apparently not transferred to France, as in Flamanville 3 Bouygues was having problems with steel welding work and the work was progressing very slowly.

## **6. Conclusion: towards a theory of new governance approach in large multi-firm projects**

Based on the preceding discussion, we present four implications for changes in governing large projects that may possess potential for enhancing both effectiveness and efficiency within large and complex projects. Further, we suggest that the four changes – introduced in the following – would pave the way towards a novel theory of governance in large multi-firm projects.

First, we suggest that the focus of both research and practice should shift from a hierarchical contract organization, or hierarchical supply chain towards a supply network with networked organizational structure. The theory of institutional economics and transaction cost economics introduce market and hierarchy as two ends of a continuum on which economic transactions can be placed. Transactions, positioned in between the market and hierarchy, are suggested as hybrid forms of transactions. The current project governance discussion in the project literature tends to suggest a hierarchical contract organization and therefore such discussion tends to represent the hierarchy approach. Furthermore, literature on corporate governance emphasizes the role of the contract in a dyadic setting, between the principal and the agent. However, we suggest that in the governance of large projects, any these approaches – market, hierarchy, or hybrid – are not as such adequate when the analysis is limited to a dyadic setting. Large projects face the challenge of governing a project's internal complex supply chain of multiple firms, and of simultaneously governing the network of external stakeholders. The existing project literature suggests that these internal and external firms and organizations interact through their dyadic business relationships and transactions within the project, but, however, we argue that there are other – more complex direct and indirect – interactions within the network of firms. For example, the project and its performance is affected by complex institutional environments, and by the underlying business network of organizations which combines the past, present and future into a network of business actors that are or could potentially be involved in mutual business activities in current or future projects.

Second, we suggest that our conception of project governance and the underlying mechanisms of coordination should shift from simplistic governance carried out by either the price mechanism or administrative fiat towards mechanisms that emphasize relationships and self-regulation in networks. Both earlier research and our findings imply that network level mechanisms such as macroculture and open information sharing play a key role in shaping governance in networked project contexts (Stinchcombe & Heimer, 1985; Jones et al., 1997). Also research carried out within the corporate governance discourse has acknowledged that the participation of stakeholders, such as suppliers and customers may lead to improved efficiency and effectiveness as more accurate and unbiased information may be used as a basis for decision-making (Turnbull, 2002). Similarly, the nature and development of the relationships between involved actors and their impacts on the activities carried out need to be considered. Differences between the two studied nuclear power plant project cases were strikingly clear as the relationship between TVO and AREVA in the Olkiluoto 3 project could be characterized involving high distance between the parties, as the relationships between the core actors in Flamanville 3 were more collaborative in nature and established over a long period of time.

Third, we suggest that both research and practice should shift from viewing a multi-firm project as a temporary endeavor with a clearly limited life cycle, to viewing a project as something incorporated in the business interests of participating actors over much longer period of time than that of a mere project's duration. In this sense, the shared history of the involved actors i.e. the shadow of the past, and the expected future i.e. the shadow of the future, have an impact on the governance of any single project. Similarly, the excessive focus on internal processes and resources characterizing most project management literature should be complemented by a focus on the resources and capabilities possessed by external actors.

Fourth, we suggest that the focus should shift from a narrow view which conceptualizes the project as a hierarchical management system, towards an open system view on managing projects that are embedded and interwoven with challenging institutional environments. As large projects operate in complex

international contexts involving hundreds or even thousands of business and non-business actors that constitute a complex network of actors connected by various kinds of relationships, it is insufficient and at worst misleading to consider that a large multi-firm project can be governed by the closed activity system of one or only by few actors.

## **7. Further research**

This paper focuses on the difficult and even misunderstood concept of governance in the context of the highly topical nuclear industry which appears be heading towards a new renaissance, in particular within the European Union's political climate to aggressively reduce carbon dioxide emissions.

This paper contributes to new knowledge in the governance of large multi-firm projects by going beyond organizational forms that cut across the traditional firm-market dichotomy. We welcome further research that would further elaborate these novel findings of the governance in large multi-firm projects, with an emphasis on the complex supply network, various business approaches of the network actors, relationships, and the impacts of the complex institutional environments where the projects take place.

Further research on project governance in the context of large and complex projects is needed especially in four specific areas. First, management of contractor and subcontractor networks through several tiers in the project's supply chain requires further research. Second, management in institutionally challenging environments with actors from several socio-cultural environments where the local and global players meet poses several interesting subjects for further study. Third, further studies are also needed on the business performance implications of various governance schemes: for example, despite different governance approaches, Olkiluoto 3 and Flamanville 3 faced similar types of problems in project implementation. Fourth, especially nuclear power plant projects face a challenging interface with local safety authorities that have their particular approach to project management and nuclear safety. Therefore there is a need for

further research that would address the governance issues with local safety authorities and project management approaches in nuclear power plant projects, in order to shed light on this major challenge with for global contractor firms that become responsible for building new nuclear power locally in diverse national and institutional contexts.

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