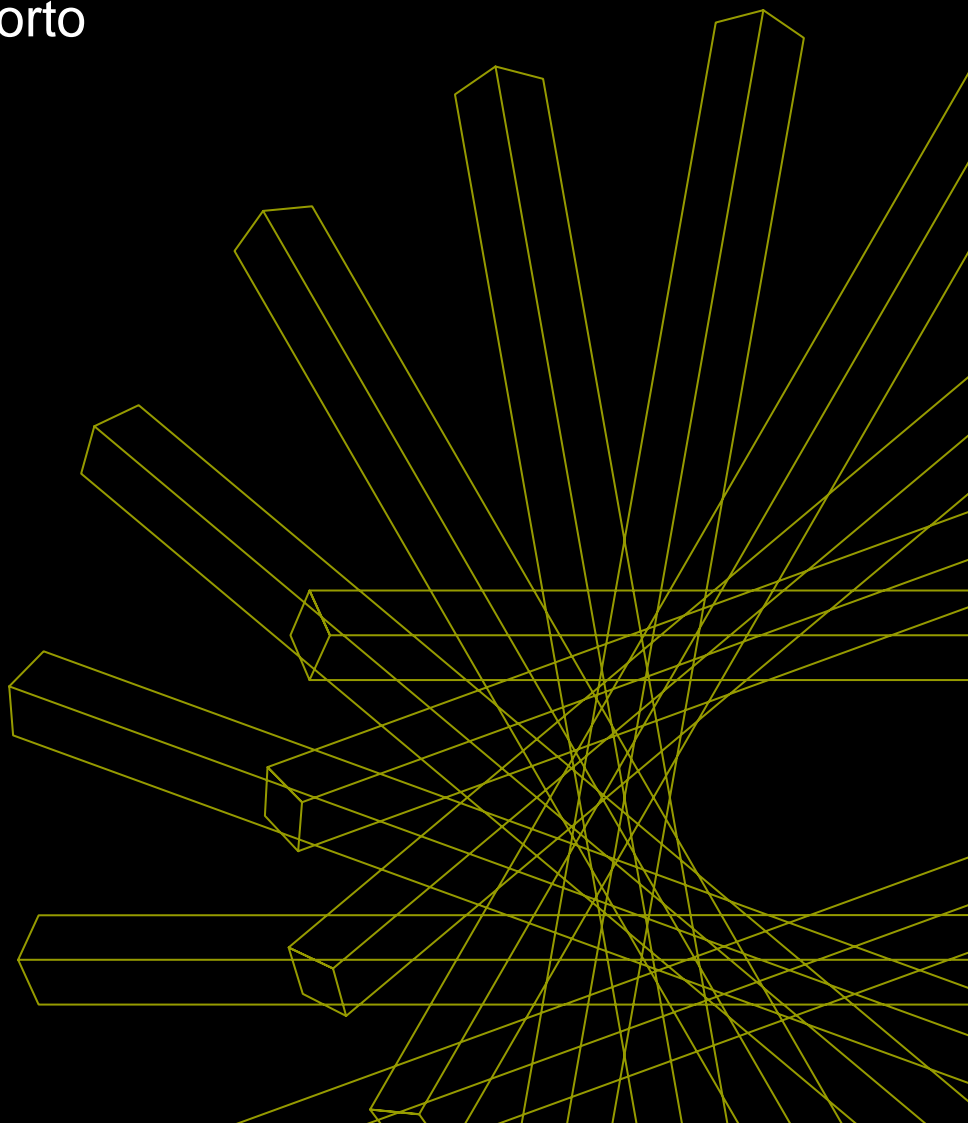


Special Purpose Entities in Megaprojects

The SPE Working Group Report
edited by Corrado Io Storto

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Executive summary

The primary objective of the “Special Purpose Entity” working group (SPE WG) was to gain a more in depth understanding of the reasons why having a SPE in the governing system of a megaproject may positively influence the project performance. A major attention was given by the group to the identification of operational taxonomies, frameworks, concepts, and sound research approaches and methodologies having clear in mind the following research needs:

- to take into account and not oversimplify the intrinsic complexity of megaprojects without running the risk to disregard critical variables from the analysis;
- to find a useful theoretical model in the literature to study the SPE from an organizational and management point of view;
- to preserve the idiosyncratic nature of megaprojects as “specific and unique entities” the evolution of which may be largely influenced by a variety of context factors, i.e. technology complexity, local culture, market dynamics, legislation, etc;
- to adopt a dynamic perspective useful to identify changes of the organizational configurations assumed by the SPE as the megaproject evolves.

These issues have been major determinants that oriented the planned research tasks of the working group. Furthermore, the group stimulated and supported an intense interaction of its members with the INNOMET working group to work on the choice of methodological approaches and techniques to analyze data.

Research goals and data analysis methodologies for the SPE WG were more clearly refined in the second meeting held in Warsaw on Feb. 26, 2014. Indeed, refinement was necessary from the first meeting after gaining new insights through a more in depth literature survey, critical analysis of cases selected from the whole COST Action MEGAPROJEC Portfolio and internal discussion. In particular, the intrinsic complexity of the megaproject nature suggested to pursue a multiple framework – multiple methodological approach research strategy.

The following research objectives were finally identified for the group:

- 1) understanding the nature and the main characters of an SPE
- 2) understanding what factors influence how an SPE evolves over time
- 3) understanding the role that an SPE has in the activation of management and technical capabilities necessary to deliver a megaproject

The work of the SPE WG resulted in a range of scientific achievements. The following ones can be highlighted:

- The conceptualization of the Special Purpose Entity from a “multiple dimension” perspective and the proposal of a SPE ontology;

- A better knowledge of the role played by the SPE in the delivery of infrastructure megaprojects in the transportation and energy industries gained from the analysis of the MEGAPROJECT Portfolio of cases;
- A lifecycle framework developed to analyze how and why the SPE organization changes and which are the major factors influencing its configuration at different stages over time;
- A methodological framework combining together concepts driven from the knowledge-based view, transaction cost economics and sociological network theory and using fuzzy cognitive maps and simulation to investigate the SPE behavior and determinants of poor or high performance.

Results have a number of implications for research and suggested useful recommendations for policy makers, the construction, transportation and energy industries and finance and funding institutions.

In particular, in terms of contribution to research:

- The proposed ontology and taxonomy can be useful to scholars to understand more in depth the role played by the SPE and its different functions at different stages of the project evolution, and finally to what extent the SPE organizational configurations fit the different stages of the megaproject lifecycle and the strategic goals and environment constraints and opportunities;
- Life-cycle models provide researchers with a very useful tool to characterize and model how SPE megaprojects evolve but that life-cycle more closely resembles that of a “project” rather than that of a “permanent” organization;
- The methodological framework based on simulation and the design of fuzzy cognitive maps for the SPE megaproject governing system provides useful insights about the behavior of a Special Purpose Entity in the delivery of an infrastructure megaproject in the particular case considered in the pilot test. Extending the implementation of the framework to a wider sample and different industries may help scholars understanding to what extent the SPE governing system contributes to project performance and how the SPE megaproject governing system that fits more the context characteristics should be designed.

In terms of contribution to practice, results particularly suggest that:

- The changing nature of the SPEs during the megaproject lifecycle demonstrates that governance in these type of megaprojects is not static and that it would be erroneous (if not dangerous) to regard it as such;
- Results emerging from the simulation of the fuzzy cognitive map of the SPE megaproject governing system showed that technical and management capabilities of the SPE are an important determinant of project performance;

-
- SPE megaprojects are characterized by “temporal flipping” where the organization with greater longevity is the “project” based organization which can substantially outlive the “permanent organization” from which it was derived. That shed new light on the nature of projects as temporary organizations;
 - Flexibility and adaptation to the environment are major factors supporting the evolution of an SPE organization along its lifecycle and allowing the adoption of different configurations. Henceforth, even though a governance system with a clear definition of responsibilities is necessary to provide investors with guarantees, the structural rigidity of the SPE should be balanced by a certain flexibility and adaptation capability that allow change when either the context or the strategic goals change;
 - Policy-makers and managers should consider that some functionalities of the SPEs can be ineffective or even negatively influenced by a stringent set of national regulations and/or prevailing business models that exist in some countries. Thus, using frameworks, methods and models that provide qualitative and quantitative supports to the analysis predicting how a particular SPE organization can operate in a certain context may help choosing the organizational configurations that fit more project characteristics at the different stages of its lifecycle.

The importance of SPEs to megaprojects

by Naomi J. Brookes and Tristano Sainati

The importance of SPEs to megaprojects

The MEGAPROJECT COST Action selected ‘Special Purpose Entities’ (SPEs) as the topic for one of its thematic working groups as it was judged that SPEs were of substantive importance in determining the behaviour of megaprojects. This decision arrived at the following two sequential activities: inductive pattern spotting across the MEGAPROJECT Portfolio of cases and deductive hypothesis testing firstly using the Fisher Exact Test and secondly using machine learning approaches.

An inductive pattern-spotting exercise was undertaken using a variant of Eisenhardt’s methodology to identify clusters of characteristics of megaprojects. The process of inductive pattern-spotting in the megaproject investigation was actually confined to pattern spotting across the ‘stakeholder’ related aspects of the dataset, in particular the social network maps collated for each megaproject case. The Action decided that this was an appropriate response given the issues of reliability in the secondary data that were collected. The Action determined that a formal relationship as evidenced through a publically available publication (e.g. contractual relationship, ownership relationship, regulatory relationships) was reliable enough to be used in the analysis activity. We then juxtaposed the social network maps of cases from the MEGAPROJECT portfolio against each other to see if any common pattern of actors and relationships could be identified. [Figure 1](#) shows examples of the social network analysis maps from the MEGAPROJECT portfolio.

Pattern-spotting across the social network maps enabled the identification of particular organizational actors who demonstrated high levels of centrality. (These actors are circled in red in the social networks in [Figure 1](#). These actors all had characteristics in common. They were all equity based special purpose entities (SPEs) whose specific purpose was to design, deliver and sometimes to operate large scale infrastructure megaprojects in the EU. These SPEs are constrained by specific objectives aims and hence are associated with a finite lifespan. Limitation to their scope of operation is frequently realized in legal terms or is *de facto*. (In the context of megaprojects, SPEs are constrained to designing, constructing and often operating a particular megaproject.) SPEs are entirely legally separate, independent organizations but they are controlled and sponsored by other external organizations.

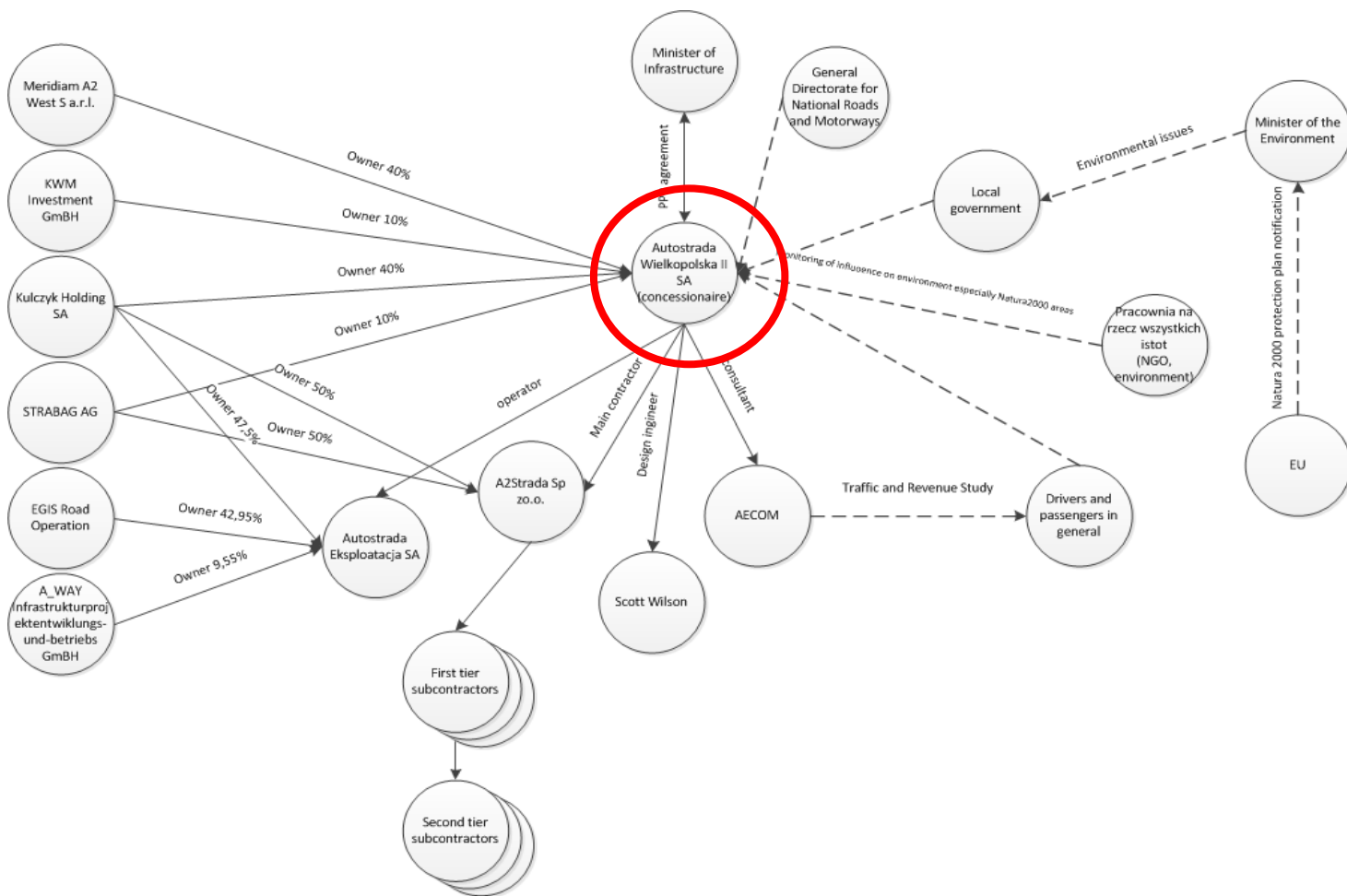


Figure 1a Social network map for the A2 Motorway Megaproject, Poland

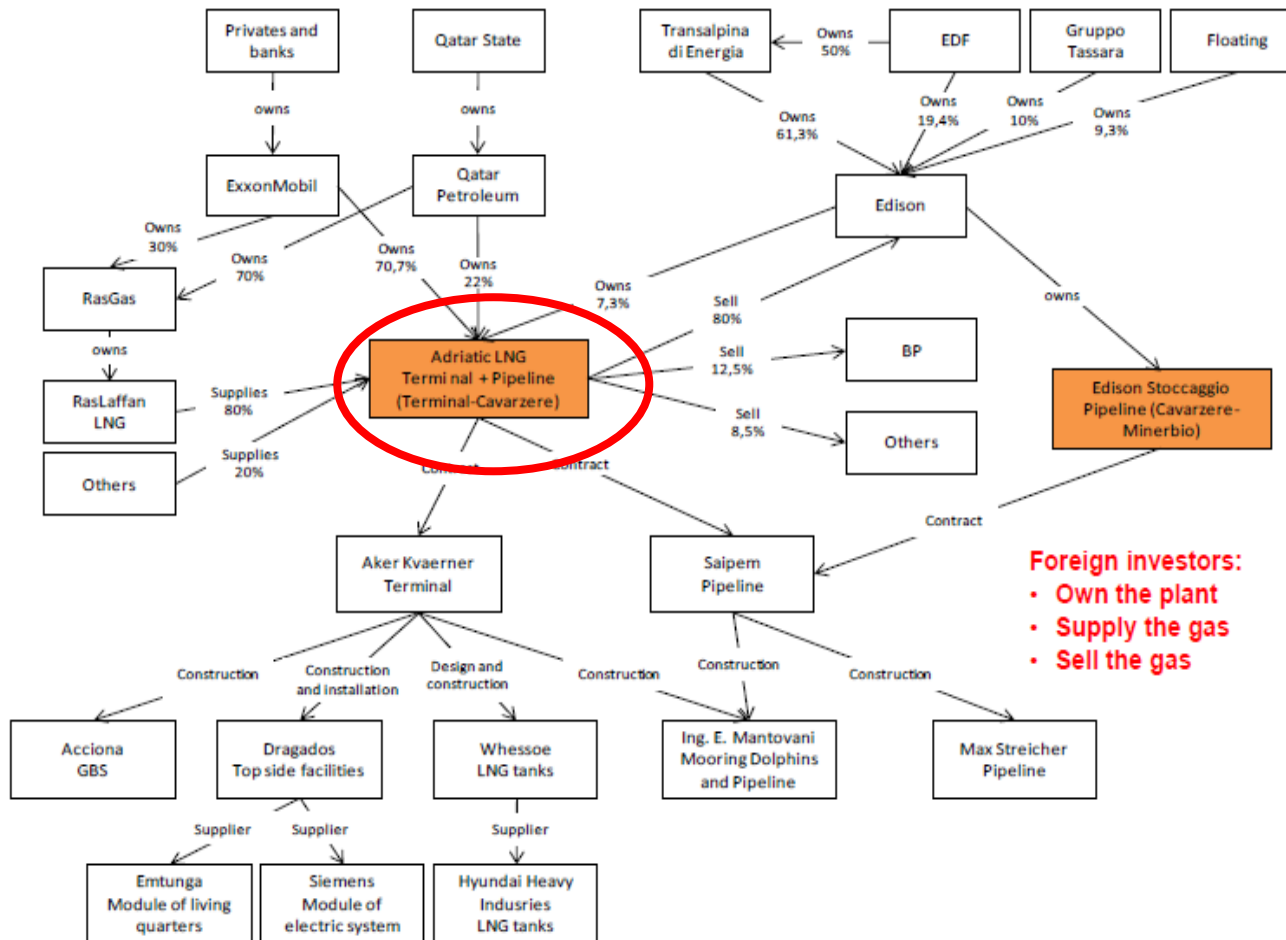


Figure 1b Social network map for the LNG Rovigo Megaproject, Italy

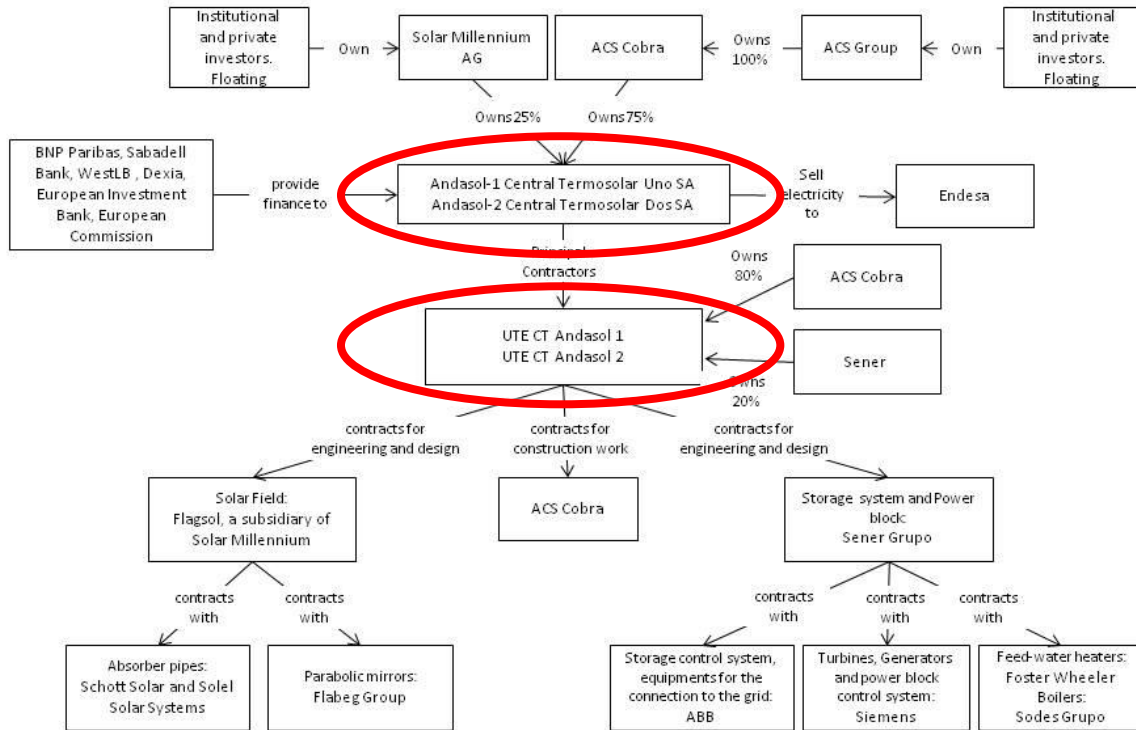


Figure 1c Social network map for the Andasol Solar Power Megaproject, Spain

Having identified the prevalence of SPEs in megaprojects, the next stage was to establish if those megaprojects which used SPEs in their governance had different performance characteristics than those which do not. In order to do this, the MEGAPROJECT Portfolio of cases was supplemented and codified in terms of dependent performance variables (expressed in terms of ability to deliver on-time and to budget) and independent variables relating to megaproject characteristics one of which was the presence (or absence) of SPEs within the megaproject. Using the Fisher Exact test to analyse this dataset indicated that a statistically significant relationship existed between the presence of an SPE and the ability of the megaproject to be on-time during the construction phase of the project and the ability to deliver the megaproject to budget. This statistically significant relationship was then verified by triangulation with more sophisticated machine learning techniques.

The MEGAPROJECT experience therefore demonstrated that not only were SPEs found in a substantive number of megaprojects but also that the presence of SPEs led to statistically significant difference in the behaviour of those megaprojects in which they were located. This strongly suggested that understanding SPEs was of vital importance in understanding megaprojects more widely and, thus, SPEs became one of the key areas of thematic concern for the MEGAPROJECT COST Action.

Ontology and functions of megaproject SPEs

by Tristano Sainati and Nenad Ivanisevic

Ontology and functions of megaprojects SPEs

Special Purpose entities (SPE) are a kind of project based organisations that are usually employed in a wide range of sectors such as transportations, energy, oil and gas, telecommunication, urban regeneration, mega events, etc.

Their purpose is to design, delivery, operate (or both) with a megaproject (Finnerty, 2013). Depending on their configuration and capabilities, the SPEs can cope with one or more of such purposes.

The lifecycle of the SPEs employed in megaprojects, often running into decades, can “out survive” their initial owners who frequently transfer them to other ones. By doing so, the SPEs enable to transfer a plenty of assets, liabilities and capabilities collected and developed during their entire lifecycle. For example:

- Tangible assets such as the infrastructure resulting from the megaproject endeavour;
- Intangible assets such as licenses, patents, etc;
- Financial assets and liabilities;
- Operating personnel;
- Etc.

Due to this long term dynamicity, the functions and the configurations of the SPEs may change during their lifecycle.

The extreme flexibility offered by this instrument permits to employ the SPEs for a plenty of applications and the megaproject is only one of them.

SPEs have been first used on the 70s when the “Government National Mortgage Association” (Ginnie – Mae) securitized government-insured mortgages (Ketzi, 2003). Starting from there the SPEs have been employed for several applications: e.g. securitisation of assets and liabilities, structuring financial derivate, off- balance sheet purposes, fusions and acquisitions (e.g. leverage buyouts) and megaprojects delivery.

In order to understand what a SPE is, this chapter introduces an ontology that is consistent to all these very different applications. The analysis of the existing literature is the preliminary step. Figure 2 presents the number of publications (in a relative and qualitative way) concerning the SPEs. This has been obtained by a bibliometric analysis based one the most relevant books, reports, and scientific papers (Sainati, Brookes and Locatelli, 2014).

Figure 2 presents the data using two ordered axes: disciplines and cross disciplinary topics; both axes are arbitrary and permit to plot the state of the art of the literature concerning SPEs.

Figure 2 shows in the top left corner the domain of knowledge coping with more explicit (i.e. published) knowledge. On the other hand, the bottom left corner presents the domains of knowledge whether few references are available; project management is one of these.

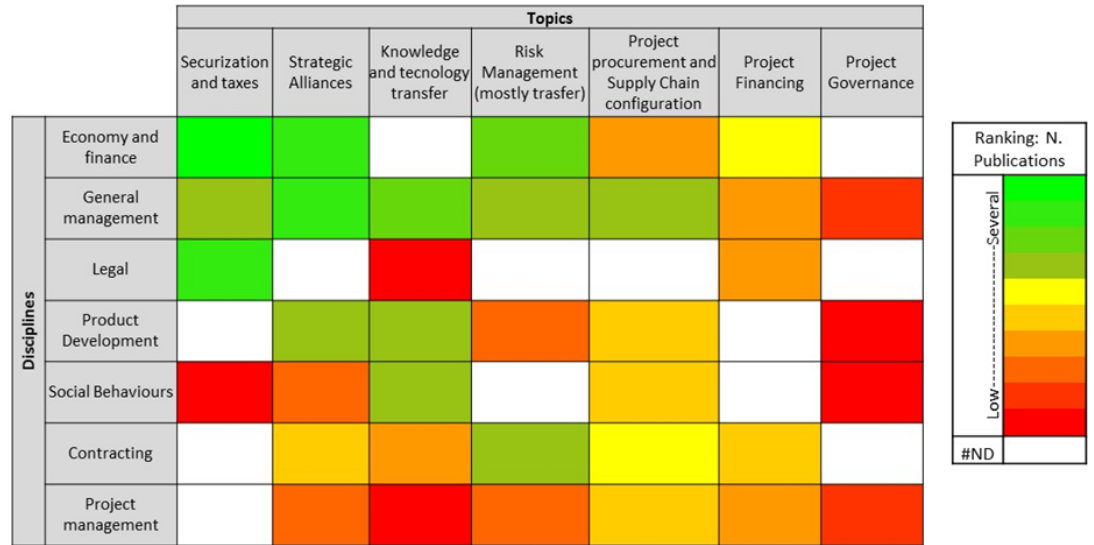


Figure 2 Map of the available literature concerning SPEs

The analysis of the literature shows that three main lines of thinking have been developed around the concept of SPEs. The three semi-independent domains of knowledge are: the financial domain, the legal domain and the project management one. The common understanding and the existing definitions of SPEs are also scattered according to these three domains.

Financial domain

The financial understanding and definition of SPEs focus on the current applications of this instrument in the financial sector: securitization of assets and liabilities, financial derivate, etc.

The following definition summaries the financial understanding and use of SPEs:

“A special-purpose entity, abbreviated as SPE and sometimes also called special-purpose vehicle (SPV) or financial vehicle corporation (FVC), is:

- a legal entity (an enterprise or sometimes a limited partnership or joint venture) formally registered with a national authority and subject to the fiscal and other legal obligations of the economy in which it is resident,
- established to perform specific functions limited in scope or time, with one or a few primary creditors,
- having no or few non-financial assets and employees, little or no production or operations and sometimes no physical presence beyond a "brass plate" confirming its place of registration,

- *related to another corporation, often as a subsidiary and often resident in a territory other than the territory of residence of the related corporation (lacking any physical dimension, the residence of a SPE is determined by the economic territory under whose laws it is incorporated or registered),*
- *its core business function consists of financing its group activities or holding assets and liabilities of its group, that is the channelling of funds from non-residents to other non-residents, and with only a minor role for managing and directing activities.*

There can be different reasons for setting up a SPE:

- *to protect a company from financial risk, often in the context of a large project;*
- *to separate different layers of equity infusion in complex financing operations;*
- *to own and more easily dispose of assets and associated permits and rights;*
- *to engage in a public-private partnership relying on a project-finance structure.*

As there is no universally accepted definition of a special-purpose entity yet, not all abovementioned characteristics or reasons have to be apply to called such.

A multinational enterprise (MNE) often diversifies its investments geographically through a SPE; examples are financing subsidiaries, conduits, holding companies, shell companies, shelf companies and brass-plate companies.” ([European Commission EUROSTAT, n.d.](#))

Legal domain

Legal and regulatory definitions are dynamic and different across countries. The dynamics comes from the continuous attempt of the legislator to take under control the evolving applications of SPE (e.g. securitizations, financial derivate, project financing, etc.). The differences among countries originate from their specific legal and regulatory frameworks. Legal and regulatory frameworks define SPEs for two main purposes: information transparency and fiscal recognition. Particularly critical is the recognition of the SPE into the accounting statements of the sponsor organizations (this also because the SPE is characterized to be a “self-fenced” organizations). With this respect, recent scandals occurred because of the gaps in the legislation like in the recent cases (e.g. Enron and Lehman Brothers scandals) ([Smith, 2011](#)).

In order to override this issue in 2005 the Financial Accounting Standards Board introduced the definition of Variable Interest Entity (herein considered as synonymous of SPE): “*Variable interests refer to the investments or other interests that will absorb portions of a VIEs expected losses and expected gains (expected residual returns). A variable interest means that the ownership or other interest varies or changes with changes in the VIEs net asset value*” ([Chasteen, 2005](#)). This definition emphasizes the external characterization of SPEs.

Another characterization of a SPE in legal terms, refers to the typology of corporation; SPEs are usually: trust, partnership, limited liability partnerships,

corporation and limited liability company ([Basel Committee on Banking Supervision, 2009](#); [Mei-Feng, Gramlich and Gupta, 2009](#)). This characterization is country specific; e.g. in Switzerland and India SPEs are always trusts, in Argentina SPEs take the form of mutual funds, trust or corporation, etc.

Further than the formal characterization, legal manuals and institutional reports usually consider nationality of SPEs; these are usually non-resident organizations placed in a country having special legislation in terms of information disclosure and tax. In particular the SPE is a financial institution (or company) characterized by having all financial relations with non-resident entities ([Basel Committee on Banking Supervision, 2009](#)); in particular it:

- is held by non-resident entity/entities
- receives funds from non-resident entity/entities
- channels funds to non-resident entity/entities

Project management- Megaproject domain

SPEs are used in megaprojects for two general purposes:

Project financing is: *'the raising of funds on a limited-recourse or nonrecourse basis to finance an economically separable capital investment project in which the providers of the funds look primarily to the cash flow from the project as the source of funds to service their loans and provide the return of and a return on their equity invested in the project'* ([Finnerty, 2013](#)).

Project financing enables to increase the financial capabilities for the project and obtain, at the same time, at lower cost of financing ([Finnerty, 2013](#)). On the other hand, project financing requires long due diligence in order to address carefully all the risks connected to the megaproject.

SPEs are essential for the project financing because enable to isolate the risks and financial flows at project level.

Project partnering. A SPE brings synergies among stakeholders by aligning their interest ([Clifton and Duffield, 2006](#)). Several typologies of partnerships exist, for instance, corporate partnership, joint venture, consortium ([Grimsey and Lewis, 2007](#)).

Megaprojects are often delivered through public-private partnerships (PPP). With this respect SPEs enable to settle down an equity joint venture among project stakeholders.

The following section presents the ontology of SPE. The focus is on the essence of the SPE and the search for consistency across the three domains considered.

Ontology of SPE

Ontology is defined as “a formal, explicit specification of a shared conceptualization” (Gruber, 1993). Ontologies are usually used to formally represent knowledge (explicit and implicit) within a given domain. These provide a common vocabulary to denote the types, properties and interrelationships of concepts in a domain (Gruber, 1995). Examples of ontologies in the management field are:

- Supply chain management (Scheuermann and Leukel, 2014)
- Risk Management (Tserng et al., 2009)
- Etc.

The current ontology of SPE provides two contributions:

1. The definition of SPE
2. A list of SPEs characteristics. Most of them do not permit to characterize a SPE if considered singularly. However, they are good proxies for the recognitions and classification of the SPEs.

Definition of SPE

The Special Purpose Entity is a fenced organization having limited pre-defined purposes and a legal personality. Three key aspects relate to an SPE:

1. **It is a fenced entity.** SPE is a “Self-Fenced organization” (Basel Committee on Banking Supervision, 2009; United Nations Economic Commission, 2011). There are legal and financial mechanisms to isolate assets, liabilities and risks associated to the SPE. This is essential for most of the SPE activities; e.g. securitization and project financing (Fabozzi and Kothari, 2008). A key aspect is the ‘Bankruptcy remoteness’ principle that permits to isolate the risk arising from the bankruptcy or the owner (Sewell, 2006).
2. **It has limited and pre-defined purposes.** SPEs are designed to pursue specific objectives and are usually constrained by their lifetime. In legal terms they have ‘Scope limitations’, i.e. the purposes are constrained by the limitations in the statute or financial and contractual mechanisms (Caselli and Gatti, 2005). In megaprojects, the limitation of the purpose is set by specific documents such as: the ‘shareholders agreement’ and the ‘certificate of incorporation’. In some megaprojects the SPE, after delivering the original purpose, changes its status and can become another form of organization. Once the SPE ceases to follow limited and predefined purposes, it stops being an SPE.
3. **It has a legal personality.** The SPE is a legally recognized entity, such as: trusts, partnerships, limited liability partnerships, corporations and limited liability companies (Basel Committee on Banking Supervision, 2009; Mei-Feng, Gramlich and Gupta, 2009). The legal characterization is country specific; e.g. in

Switzerland and India SPEs are always trust, in Argentina SPEs take the form of mutual funds, trust or corporation, etc. ([Reserve Bank of India, 1999](#)). In megaprojects the SPEs can be either trusts or corporations ([Nevitt and Fabozzi, 2000](#)). The legal personality is an essential status to enable the previous two characteristics.

Proxy Characteristics

The main aspects characterising the SPEs can be regrouped into five main categories: legal characterisation, purposes, activities undertaken, capabilities and assets and venue. The following list shows the options available for each of these categories:

1. Legal Characterization
 - a. Limited Liability Company
 - b. Limited Liability Partnership
 - c. Mutual Fund
 - d. Corporation
 - e. Trust
2. Purposes
 - a. Apparent profit-making motive
 - b. Tax optimization
 - c. Arbitrages
 - d. Balance Sheet management
 - e. Partnering and alliances
 - f. Isolating and homogenizing cash flows and business risk of a specific asset, asset-class
 - g. Enhancement of external finances (increase the financial leverage)
 - h. Improvement of the liquidability of a non-liquid asset
 - i. Risk Sharing and spreading
 - j. Easing Asset Transfer
 - k. Dealing with legal and regulatory requirements
3. Activities Undertaken
 - a. Insulation of Risk, Assets, Liabilities or Cash Flows
 - b. Risk Transfer, sharing and spreading
 - c. Risk Transformation
 - d. Securitization (assets & liabilities)
 - e. Project Financing
 - f. Leasing
 - g. Factoring
 - h. Commercial or fake transaction
 - i. Channelling, retention and exchanging of rights, licenses, permits
 - j. Channelling cash Flows
 - k. Infrastructure Related Activities (design & delivering, operating, other services)
4. Capabilities & Assets
 - a. Financial assets and liabilities
 - b. Intangible assets (E.g. Rights, licenses, Royalties, patents, etc.)

- c. Human related Assets
- d. Physic Assets
- 5. Venue
 - a. Resident in off-shore jurisdictions
 - b. SPE has a physical location

Functions of the SPEs

The three key characteristics defining the SPEs (i.e. fencing organisation, predefinition of purposes, legal personality) shape the functions that the SPE is able to perform.

In particular, the SPE can be understood as a legal and organisational vehicle permitting two basic/simplistic functions:

- Pooling and isolating assets, liabilities, knowledge and capabilities, risks, etc.
- Channelling and transferring the previous items according to specific rules and procedures settled by the underlying documents shaping the behaviour of the SPEs. In megaproject context these rules are usually contained into the shareholders agreement and certificate of incorporation.

These two basic/simplistic functions permit to perform the following functions:

1. Economics and Finance

1.1. Improve credit metrics

- 1.1.1. Improve partners credit metrics (off-balance sheet)
- 1.1.2. Improve project credit metrics
- 1.1.3. Indirect Credit Support

1.2. Enhance finance sources

- 1.2.1. Expanded Debt Capacity
- 1.2.2. Increase the financial Leverage
- 1.2.3. Enhance Financial differentiation
 - 1.2.3.1. Increase differentiation in senior tranches
 - 1.2.3.2. Increase differentiation in repayment time
- 1.2.4. Eases granting security
- 1.2.5. Lower Overall Cost of Funds

1.3. Reduce Financing Complexity

1.4. Return of Investment

- 1.4.1. Release of Free Cash Flow
- 1.4.2. Enhance asset liquidability

1.5. Reduce Transaction Cost

- 1.5.1. Efficient structuring of contracts
- 1.5.2. Lower transaction cost
- 1.5.3. Lower agency cost
 - 1.5.3.1. Reducing asymmetric information and signaling costs
- 1.5.4. Reduced Cost of Resolving Financial Distress
- 1.5.5. Reduced Legal or Regulatory Costs

1.6. Exploit Economic opportunities

- 1.6.1. Capturing an Economic Rent

1.7. Achieving Economies of Scale

2. Taxation

2.1. Tax Efficiency

- 2.2. Tax reduction
 - 2.2.1. Decrease fixed taxes
- 2.3. Tax Postponement
- 3. Governance
 - 3.1. Accountability
 - 3.1.1. Enforceability of contracts
 - 3.1.2. Ability to control and govern the project (independency/ separateness)
 - 3.2. Authority
 - 3.2.1. Delegation
 - 3.2.2. Protection of Minorities
 - 3.2.3. Decision-making complexity (decision stages, layers)
 - 3.2.4. Prescriptiveness of norms and procedures
 - 3.3. Alignment
 - 3.3.1. With corporate governance
 - 3.3.2. With policy/strategy
 - 3.3.3. With legislation
 - 3.3.4. With portfolio priorities
 - 3.3.5. Among stakeholders
 - 3.3.5.1. Align stakeholders' interests
 - 3.3.5.2. Ability to integrate knowledge and capabilities
 - 3.3.6. Of corporate culture and behaviours
 - 3.4. Disclosure
 - 3.4.1. Transparency
 - 3.4.2. Assurance
 - 3.4.3. Certainty of decision-making process
 - 3.4.4. Ability to retain knowledge
 - 3.5. Flexibility
 - 3.5.1. More effective corporate organization and management compensation
 - 3.5.2. Ability to redesign governance structure
 - 3.5.3. Active risk management focused on benefits delivery
 - 3.6. Decision-making Efficiency
 - 3.6.1. Decision making process speed
 - 3.6.2. Smart management of the sponsor/client interface
 - 3.7. Predictability/ certainty of decision-making process
- 4. Risk
 - 4.1. Ability to channel the risk to the right counterpart
 - 4.1.1. To the party that is better able to control the risk
 - 4.1.2. To the party that is better able to bear the risk
 - 4.2. Ability to secure the risk

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A Life-Cycle Approach to Understanding Megaproject SPEs

by Naomi J. Brookes

A Life-Cycle Approach to Understanding Megaproject SPEs

Creating the MEGAPROJECT Portfolio of cases highlighted one of the distinguishing features of SPEs in megaprojects: namely their dynamic nature. It was impossible to represent their governance in a static fashion.

The dynamic creation, growth and ultimate death of any entity immediately evokes a paradigm of a life cycle. Life cycles models have their roots in biology and are used to capture the progression of an organism through different stages of development over time. The MEGAPROJECT SPE Working Group decided to undertake an investigation with the following objectives:

- to identify to what extent the commonalities in the lifecycle displayed by SPEs matched those associated with generalized organizational lifecycles (i.e. 'permanent' organizations) or with the peculiarities of temporary organizations (i.e. the project lifecycle);
 - to use the identified life-cycle to model the development of two megaproject SPEs: The Greater Gabbard Offshore Wind Farm and the Andasol Solar Power Plant;
 - to understand the implications of these models for understanding the behaviour of SPEs in megaprojects.
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Lifecycle Models in Organization Design: Distinguishing the Temporary and the Permanent and applying to SPE Megaprojects

The use of the term ‘organizational lifecycle’ can be traced back to Chandler’s seminal work in the late 1950’s and early 1960’s for example (Chandler, 1962). The construct of an ‘organizational life cycle’ was subject to substantive further investigations by researchers in organizations. This resulted in a number of ‘life-cycle’ typologies which are still being used to explore organizational phenomenon. One of the most useful empirically supported typologies of a life cycle is provided by Miller and Friesen (1984) (see Table 1):

	Situation	Organization	Innovation & Strategy
Birth Phase: (cf. Scott’s (1971) Stage One, Greiner’s (1972) Creativity Stage, & Quinn & Cameron’s (1983) Entrepreneurial Stage)	<ul style="list-style-type: none"> —Small firm —Young —Dominated by owner–manager —Homogeneous, placid environment 	<ul style="list-style-type: none"> —Informal structure —Undifferentiated —Power highly centralized —Crude information processing & decision making methods 	<ul style="list-style-type: none"> —Considerable innovation in produce lines —Niche Strategy —Substantial risk taking
Growth Phase: (cf. Down’s (1967) Rapid Growth Stage, Adizes’ (1979) Go-go Stage, Lyden’s (1975) Second Stage)	<ul style="list-style-type: none"> —Medium sized —Older —Multiple shareholders —More heterogeneous and competitive environment 	<ul style="list-style-type: none"> —Some formalization of structure —Functional basis of organization —Moderate differentiation —Somewhat less centralized —Initial development of formal information processing and decision making methods 	<ul style="list-style-type: none"> —Broadening of product-market scope into closely related areas —Incremental innovation in product lines —Rapid growth
Maturity Phase: (cf. Scott’s (1971) Stage 2, Greiner’s (1972) Direction Stage Azides’ (1979) Maturity Stage)	<ul style="list-style-type: none"> —Larger —Still older —Dispersed ownership —Competitive and still more heterogeneous environment 	<ul style="list-style-type: none"> —Formal, bureaucratic structure —Functional basis of organization —Moderate differentiation —Moderate centralization —Information processing and decision making as in growth phase 	<ul style="list-style-type: none"> —Consolidation of product-market strategy —Focus on efficiently supplying a well-defined market —Conservatism —Slower growth
Revival Phase: (cf. Scott’s (1971) Stage 3, Greiner’s Coord’n. Stage, Quinn & Cameron’s (1983) Elaboration of Structure Stage)	<ul style="list-style-type: none"> —Very large —Environment very heterogeneous, competitive and dynamic 	<ul style="list-style-type: none"> —Divisional basis of organization —High differentiation —Sophisticated controls, scanning and communications in info. processing; more formal analysis in decision making 	<ul style="list-style-type: none"> —Strategy of product-market diversification, movement into some unrelated markets —High level of risk taking & planning —Substantial innovation —Rapid growth
Decline Phase: (cf. Down’s (1967) Deceleration Phase, Lyden’s (1975) and Kimberly’s (1979) Fourth Stages, and Adizes’ (1979) Prime Organizational Stage)	<ul style="list-style-type: none"> —Market size —Homogeneous and competitive environment 	<ul style="list-style-type: none"> —Formal, bureaucratic structure —Mostly functional basis for organization —Moderate differentiation and centralization —Less sophisticated info. processing systems and decision making methods 	<ul style="list-style-type: none"> —Low level of innovation —Price cutting —Consolidation of product-market —Liquidation of subsidiaries —Risk aversion & conservatism —Slow growth

Table 1 Miller and Friesen’s Organizational Lifecycle Framework

The construct of an organizational 'lifecycle' has implicitly been associated with what may be characterized as 'permanent' organizations (as opposed to temporary 'project' organizations). Project organizations have been deemed to adopt an entirely different life-cycle model for their development. The project 'lifecycle' is a fundamental part of classical PM theory (Turner, 2014). The project lifecycle is a construct which organizational researchers still find useful in understanding the phenomena within temporary organizations (van den Ende and van Marrewijk, 2014).

The question therefore arises as to which of the life-cycle models used to describe the growth of 'permanent' and 'temporary' organizations is of most utility in matching the experience of SPEs in megaprojects.

Given the longevity of SPEs in megaprojects, at first glance it may appear that the lifecycle associated with a permanent organization may be more appropriate for modeling its development. The first problem in applying the lifecycle associated with permanent organizations to megaproject SPEs is the lack of an apparent 'birth' and 'growth' phase. One of the identified functionalities of megaprojects in Chapter 2 of this book is to create sufficient resources to fund a megaproject (which is deemed so great that a single organization cannot on its own supply this with an acceptable risk profile). In this respect, megaproject SPEs are 'born large' organizations. They 'miss out' the 'birth' and 'growth' phases associated with a conventional organizational lifecycle. Furthermore, the growth that SPE megaprojects experience in their first years of existence is not derived from turnover (as they will not demonstrate any turnover for a substantial number of years) but will be gained from the capital employed in the SPE by its owners and financiers.

A further problem in applying a 'permanent organization' lifecycle to megaproject SPEs is, by definition, the singularity of purpose of that SPE. The formal (and in most cases legal) prescription of the scope of activities for SPE megaproject means that the diversification that characterizes the 'maturity' and 'revival' stages of the permanent organizational lifecycle are precluded from these type of projects. The nature of the final stages of a permanent organisation's lifecycle, typified by periodic increases in innovation, diversification and renewal, are not replicated for SPE megaprojects.

Furthermore, the governance structures of the permanent organization as exhibited in its life-cycle are very different from that of an SPE megaproject. The numbers of employees of a 'permanent' organisation grow during its lifecycle to match the growth in turnover (albeit this may be achieved by merger and acquisition). Growth in terms of a permanent organization (at least in terms of this organizational lifecycle typology) results in the formation of governance structures than comprise large corporate divisionalized structures. In enduring projects, huge increases in the turnover of the megaproject SPE are not matched by proportionally increasing number of employees. Growth is achieved by a governance structure comprising a network of supply chain contracts with other organizations (which may themselves be other SPEs).

Unlike the permanent organizations lifecycle, the project life-cycle model provides a good match for the longitudinal development of SPE megaprojects. As can be shown in [Table 2](#) below.

Project Phase	Activities in the Development of the SPE
Initiation	Initial discussions between the parties involved in establishing the SPE culminating at the end of the Initiation phase in the establishment of the SPE
Planning	All of the activities associated with gaining the appropriate planning and regulatory permits and the 'up-front' engineering design and supply chain structuring of the SPE
Execution	The construction of the infrastructural megaproject associated with the SPE
Transfer and Operate	The on-going operation of the megaproject by the SPE

Table 2 Project Lifecycles for Megaproject SPEs

The arguments presented in this chapter suggest that the project lifecycle is likely to form the most useful framework for undertaking the development of SPE megaproject organizations. That is an interesting finding because despite their longevity megaproject SPEs resemble more to 'temporary' than 'permanent organizations'

Applying Life-Cycle Models to SPE Social Networks in Megaprojects

Having determined that the project life-cycle is the most useful paradigm to model the development of an SPE, the next question is what actually do we need to model the development of. SPEs exhibit a change in the configuration of their networks of relationships and so social network modeling and analysis appears a fruitful way forward. Social networks have been used as constructs in social sciences since the 1950's. The social network perspective implies viewing systems in terms of relations between individual actors. These actors and actions are viewed as interdependent rather than independent. The relational ties between actors allow the transfer of resources (be those physical or information based). Networks structures are developed from combinations of these 'dyadic' relationships between two actors. Network models explain structures in terms of lasting patterns of relations between actors. A thorough examination of social network modeling and analysis can be found in the work of [Wasserman and Faust \(1994\)](#). Its use in understanding project behavior is examined by [Brookes et al. \(2006\)](#).

Even a simple representation of social networks can still provide a powerful way of understanding an organization. This is reflected in the use of social network modeling in the MEGAPROJECT Portfolio Template. All that is necessary is to discern the key actors in the network and identify the relationship and the nature of the relationship between them. (See [Figure 3](#) below). It is important that the unit of analysis of the network (individual, group or organizational) is consistently captured.

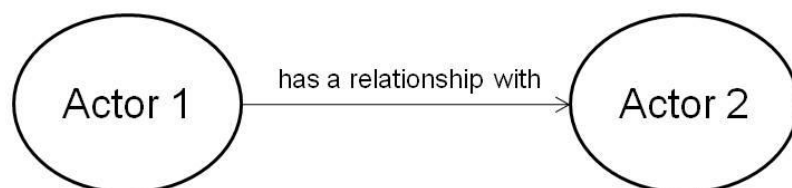


Figure 3 A Simple Social Network

By combining the ideas of the project lifecycle and social network modeling, a framework was devised that could model the development of the social network of the key SPE megaproject actors (owners, SPE and contractors) over the phases of the lifecycle of the megaproject (namely initiation, planning, construction and operation.) This framework was then used to model two SPE megaprojects from the MEGAPROJECT Portfolio:

- Greater Gabbard Offshore Windfarm, UK
- Andasol Solar Power Plant, Spain

The Greater Gabbard Offshore Windfarm

The following model shows the network development over the first seven years of planning and construction of the Greater Gabbard megaproject (Figure 4). Interestingly, this framework shows how, in the case of GGOWL, the development of the SPE megaproject remained relatively stable during the start of initiation and the construction phases but went through a fairly rapid development through the planning phase. It would be interesting to see if this pattern of development was replicated in other SPE megaprojects.

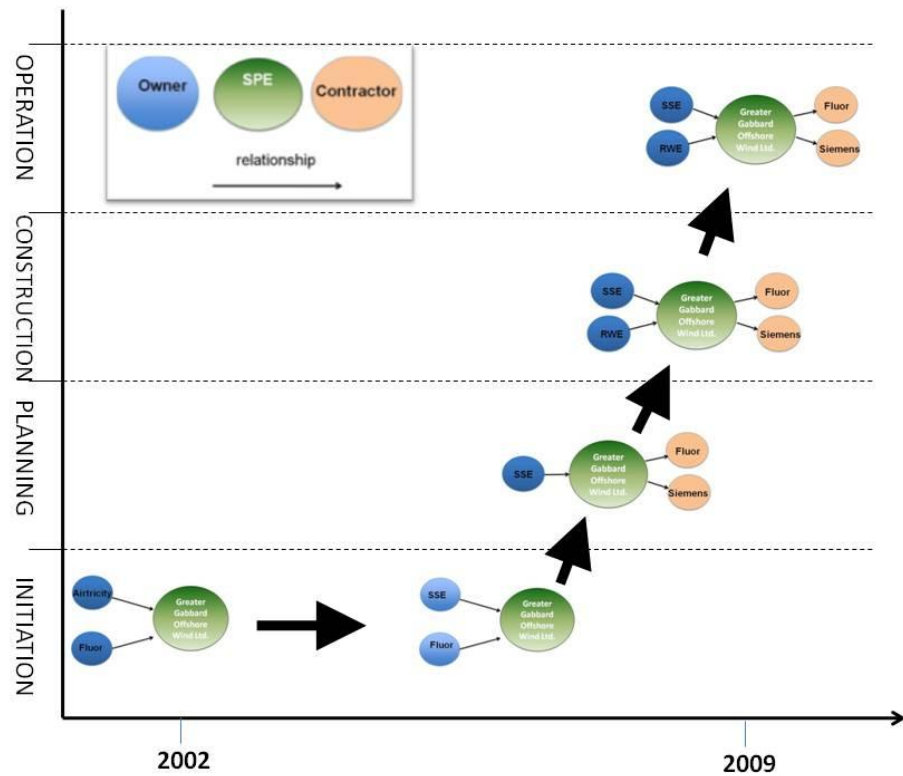


Figure 4 The Greater Gabbard megaproject SPE life-cycle

Andasol Solar Power Plant, Spain

The model below again shows the development of an SPE megaproject, the Andasol Solar Power Plant in Spain, over its first seven years of operation. In a similar fashion to Greater Gabbard it shows changes in ownership (see Figure 5). Unlike the case of Greater Gabbard however, these occur in the planning and operation phases. Furthermore, it demonstrates the birth and death of another SPE associated with the megaproject that was created purely to construct the megaproject.

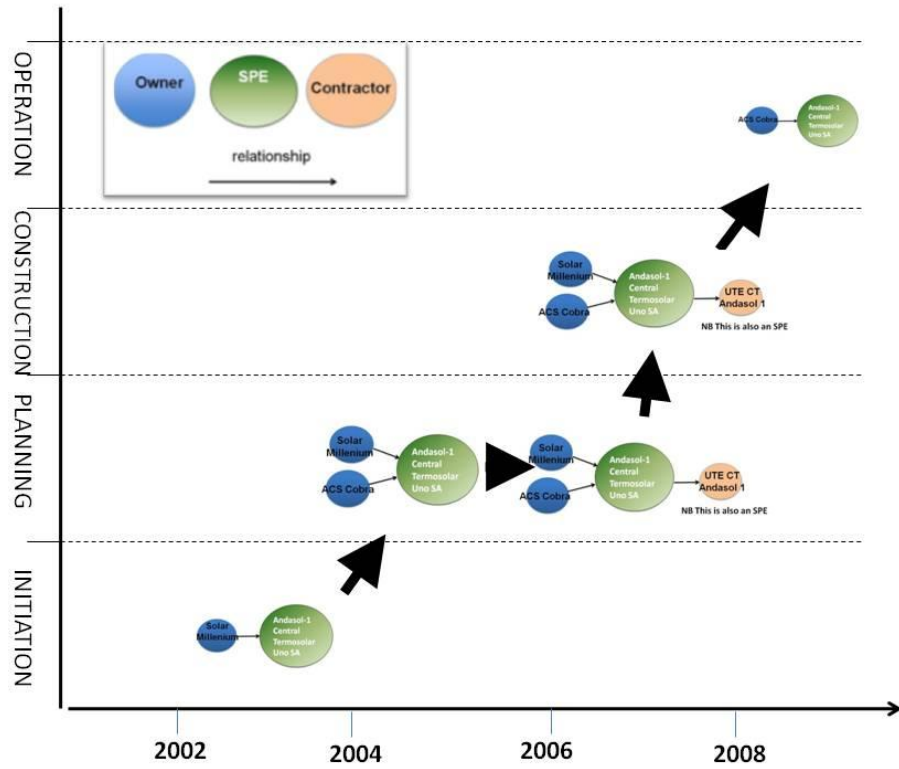


Figure 5 The Andasol megaproject SPE life-cycle

Learning Points from Lifecycle Models of SPEs in Megaprojects

The development and application of a combination of a social network and project life-cycle approach to modeling SPEs in megaprojects yielded the following learning points:

- + Life-cycle models are very useful in characterizing and modeling the development of SPE megaprojects but that life-cycle more closely resembles that of a 'project' rather than that of a 'permanent' organization.
- + Mapping the lifecycle of SPE megaproject exhibits the high degree of change to which they are subject. Both the owners and contractors can change in this type of megaproject and changes can occur at any stage of the development life-cycle be that initiation, planning execution or operation.
- + Given that project governance is represented by the management and decision making-framework of a project, the changing nature of the SPEs during the megaproject lifecycle demonstrates that governance in these type of megaprojects is not static and that it would be erroneous (if not dangerous) to regard it as such
- + Albeit SPE megaprojects exhibit dynamic change in their external networks during their development, their innate and defined nature (a legal entity that is distinctly separate and with a singularity of purpose) means that although the external network governance is changing, the internal governance of the DPE at the heart of the megaproject remains the same. The SPE (as in the case of Greater Gabbard) can outlive the existence of its original progenitors. In this respect, SPE megaprojects demonstrate 'temporal flipping' where the organization with greater longevity is the 'project' based organization which can substantially outlive the 'permanent organisation' from which it was derived. This flies in the face of much conventional wisdom on the nature of projects as temporary organizations.

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Investigating the Behaviour of an SPE: a Methodological Framework based on Simulation

by Corrado lo Storto

Investigating the behaviour of an SPE: a methodological framework based on simulation

The analysis of the megaprojects cases collected in the portfolio showed that one of the strongest predictors of megaproject performance is the presence of a special purpose entity to design, deliver and eventually operate the megaproject. Whilst some research work has specifically addressed the SPE as a research issue in the area of project finance and financial risk management, there is a general lack of concern about management and governing issues related to the project delivery, and, particularly, issues more related to capabilities of the SPE and its individual partners.

Moreover, some specific characters of the megaprojects, such as the idiosyncratic nature and complexity of every megaproject, suggest to adopt a “systemic” research approach to the study of the SPE that does not reduce, but rather preserves this complexity, and take into account some context factors that may influence the SPE decision-making and its role as “trigger and integrator” of technical and management capabilities either available in the same SPE organization and its partners or acquired from the market.

This chapter presents an integrated and comprehensive methodological framework to investigate the behavior of an SPE in the delivery of an infrastructure megaproject:

- the framework assumes that the SPE has a major coordination and triggering role in governing the megaproject evolution throughout its lifecycle, activating and integrating different resources and capabilities when needed;
- the framework combines a number of concepts driven from various organizational theories, e.g. the knowledge-based view, the transaction cost economics, and the sociological and network theory - with the aim to get a more comprehensive view and understanding of the role played by an SPE in the delivery of an infrastructure megaproject. Literature suggests a multiplicity of theoretical organizational perspectives that may be adopted as a reference to gain a more in depth knowledge about the complex relationship existing among the SPE behavior and decision-making, the management of the project over its lifecycle, and final performance, such as the transaction cost economics (TCE) (Walker and Wing, 1999; Whittington, 2012), agency theory (AT) (Ceric, 2013; Müller and Turner 2005), knowledge-based view (KBV) (Grabher, 2004; Grant, 1996; Hanisch, Müller, Lindner and Wald, 2009), institutional theory (IT) (Mahalingham and Levitt, 2007; Orr and Scott, 2008), relationship management (Pryke and Smyth, 2006) the political view (PV) (Clegg and Courpasson, 2004), the sociological and network theory (SNT) (Grabher, 2004; Chinowsky, Diekmann and O'Brien, 2010). However, adopting either one specific perspective each time or two or more perspectives but

independently can bring to partial or conflicting results. Vice versa, as these multiple perspectives can coexist together, the use of an integrated framework that includes different theoretical perspectives in the analysis may avoid to have as a final output different sometimes contradictory recommendations (Hanisch and Wald, 2011). For instance, while the knowledge-based view might suggest that the greater the project complexity and the SPE technical capability, the greater the probability that project tasks are not outsourced outside the partnership boundary of the SPE, according to the TCE decision to outsource is based on the trade-off analysis of costs related to the two alternatives. There can be several motivations for contracting out either technical or management tasks, i.e. the need to have greater operational flexibility, to benefit from specialization in core business activities, the effort to lower technical, financial and strategic risks, the necessity to access critical knowledge, and so on;

- the adoption of a systemic perspective in the development of the framework allows constructing the complex network of variables of the project governing system regulated by the SPE, finally identifying those variables and relationships that may influence much more project performance. In the framework, concepts elicited from expert knowledge which are associated to the variables of the SPE project governing system are connected together to form a Fuzzy Cognitive Map;
 - the framework allows producing different scenarios to get useful insights that may support more sound decision-making and get information about more critical variables.
-

The Theoretical Perspectives behind the Framework

The knowledge-based view (KBV)

In the knowledge-based view, knowledge is considered as a special asset and a key resource of the organization that influences the decision-making process (Grant, 2002; Spender 2006; Kogut and Zander, 1992). According to the KBV perspective, an SPE can be viewed as a bundle or system of knowledge capabilities that are more or less distributed in the organization (Tsoukas, 2005). These knowledge capabilities may be related to many domains, such as management, engineering economics, design and construction techniques, etc., and have different nature, being either explicitly codified in formal documents and procedures, IT repositories, or tacitly embodied in the organization culture, minds and behaviors of people. The KBV suggests that knowledge is one major determinants of project performance (Desouza and Evaristo, 2006; Jugdev, Mathur and Fung, 2007; Winter et al., 2006). Contracting out the execution of project tasks is a vehicle to utilize technical knowledge or management expertise of specialized organizations that are not available inside the SPE. Because of the temporary nature of a megaproject, an SPE has a great organizational and strategic flexibility and can be easily reconfigured modifying its structure, boundaries, plans and capabilities around the needs of the project as the context changes, thus making new knowledge available to deliver the project.

However, the successful exploitation of the knowledge capabilities provided by external contractors requires that external knowledge capabilities are effectively integrated with the SPE partners capabilities.

Such integration may occur more or less easily, depending on the technical complexity of a project. If technical complexity of project is great and interface management among parts and sub-systems of the infrastructure to develop is critical. A greater interaction between the SPE and the contractors and suppliers is generally necessary. Moreover, when project requirements cannot be easily defined as the degree of uncertainty and ambiguity related to project scope is still high when the project is started, a large amount of knowledge remains tacit and not codifiable. The tacitness of knowledge makes the involvement of contractors and suppliers a difficult task and coordination between the SPE and its contractors may be negatively affected by such a low specifiability of project knowledge. Target objectives cannot be fixed, and costs of tasks cannot be easily predicted. Thus contractual agreements may have serious shortcomings and be vaguely defined generating several conflicts. Furthermore, project requirements in terms of goals, infrastructure features, functionality, and performance, may change during the project development lifecycle as the project scope changes because of new market demand imperatives, lack of funds, new regulatory standards, technology advancement, and so on. These changes may largely affect the characteristics of tasks that the contracting organizations have to perform, in some cases, requiring

knowledge that is no more available in the selected contractor organization. Generally, frequent and intense changes of project scope and environmental turbulence can increase the risk that technical knowledge of contractors may be scarcely useful to perform project related tasks.

The Transaction Cost Economics (TCE)

The central idea behind the TCE paradigm is that an organization has to make a decision between two alternatives, i.e. one concerning the outsourcing of the execution of tasks, and the other the internalization of the execution of the same tasks. The outcome of this decision is influenced by the balance between the need to lower investment necessary to have very specialized assets and/or resources internally and the need to reduce transaction costs arising from the implementation of a complex coordination and governance structure to acquire the same specialized assets and/or resources from the market.

In the case of an SPE, environment characters and specific project attributes may have an influence either on the coordination costs or on the internalization of costs, i.e. the project size, scope, complexity, technology novelty, system interfaces, etc. Particularly, as project complexity increases, an SPE has to search for technical capabilities outside the organization by contracting out the execution of critical tasks to deal with such a complexity that requires higher technical specialization on the one side. But, on the other side, higher project complexity requires a greater coordination and control effort to the SPE to manage project tasks, henceforth suggesting internalize important tasks. In this case, the SPE may absorb new partners that have the required capabilities as managing interdependencies among parts and subsystems may be critical to project success.

The Sociological and Network Theory (SNT)

A megaproject is generally delivered within a social structure which is made of a wider network of inter-organizational and institutional relationships. Indeed, usually a large number of stakeholders become actors of this network playing different roles as the megaproject development progresses, i.e. the client organization, the project sponsor, suppliers and contractors, local and national governmental institutions, the Special Purpose Entity organization, construction companies, funding institutions, etc. This extended network is generally not static, but assumes different configurations during the lifecycle of the project as a consequence of the need to adapt to changing requirements from context. The SPE has an important role in governing and feeding this network of relationships. Network relationships are a vehicle for the SPE to acquire specialized technical and management capabilities from the environment. Governance and coordination capabilities of the SPE become relevant to manage working relationships between internal and external parties. Furthermore, while external sources can bring about benefits to the project, it is widely recognized in literature that collaboration may transfer many risks to the project, such as leakage of information, loss of control or ownership, divergent aims and objectives, great variance of capabilities among partners resulting in an asymmetric distribution of power (Hamel, 1991).

The Fuzzy Cognitive Maps (FCMs) as a Tool to Analyze the Structure and Dynamic Behaviour of the SPE Governing System

The use of FCMs allows introducing in the analysis the influence of judgments, perceptions and shared sense-making of individuals and teams involved in the development of a megaproject. Indeed, Fuzzy cognitive maps (FCMs) allow eliciting knowledge relative to cause-effect linkages, values and goals at the individual and organizational level (Kosko, 1986; Laukkanen, 1992; Taber, 1994).

The adoption of cognitive maps as a tool useful to analyse knowledge in a structured way was suggested by Axelrod (1976). Cognitive maps model human thinking in a complex fuzzy feedback dynamic system by representing graphically nodes associated to cognitive states that indicate causal events, nodes associated to cognitive states relative to resulting (effect) events, and linkages that show how causal events determine effects (linkages between nodes) (Laukkanen, 1992). However, the traditional cognitive maps as introduced by Axelrod have a number of limitations as allow only an extremely simplified representation of the knowledge structure: a) variables associated to cognitive states may only have a binary measurement, either 0 when the variable is not activated (the event does not exist and, consequently, there is no cause or effect), and 1 when the variable is activated (the event exists, being either a cause or an effect); b) variables associated to cause-effect linkages between two events/cognitive states as weights may assume one of the three values of the scale [-1, 0, 1]. In particular, the measurements of these variables are -1 when there is a feedback effect, 0 when there is a lack of effect, and 1 when there exists an effect. Moreover, this kind of cognitive maps has also an intrinsic contradiction, because while it aims at modelling human thinking, it is unable to take into account the ambiguity underlying the definition of concepts that individuals commonly use to communicate and develop their knowledge.

To avoid this limitation, Kosko (1986) introduced the concept of fuzzy cognitive map (FCM). While the geometric model of a fuzzy cognitive map is similar to that of a traditional cognitive map, the representation of the knowledge structure is much richer. Variables indicating cognitive states can take on all values of the continuous scale $\{0, 1\}$, and weights associated to cause-effect linkages between two events can be measured continuously over the scale $\{-1, 1\}$, or, sometimes, over the scale $\{-\infty, +\infty\}$. Let us suppose to have a fuzzy cognitive map in which, at the time t_k , the variables associated to the events-cognitive states take on the values $C_i=C_i(t_k)$, for $i=1, \dots, n$. The overall state of the map at time t_k remains thus defined by the vector $c=(C_1, C_2, \dots, C_n)$. At time t_{k+1} the measurement of the variable associated to each state is assumed to be either constant or modified to take into account the influence of other events-cognitive states, the value of which

has been eventually modified. The events-cognitive states are connected through the cause-effect linkages $e_{ji}(t_k)$, where j is the index of the causal event-cognitive state, i is the index of the affected event-cognitive state, and e_{ji} is the weight of the cause-effect linkages at t_k . The new value of the variable associated to the event-cognitive state at time t_{k+1} is obtained summing the vector $C_j=C_j(t_k)$ modified by the squashing function S

$$C_i(t_{k+1}) = S\left(\sum_{j=1}^n e_{ji}(t_k) C_j(t_k)\right) \quad (1)$$

A Pilot Test of the Methodological Framework: the Case of the METRO XYZ SpA

A pilot test to assess the usefulness of the methodological framework was performed using data relative to the role that a Special Purpose Entity had in the delivery of a light urban railway infrastructure project in Italy.

The study setting

The framework was implemented according to the following steps:

- 1) The generation of an “open” cognitive map
 From the analysis of empirical studies available in the literature and the portfolio of megaproject cases, some concepts and relationships between these concepts were preliminarily identified, generating a double list of concepts and relationships. Two experts from the industry were asked independently to revise the list, eventually suggesting new concepts and relationships or eliminating existing ones from the list. The two lists obtained were merged and the two experts were invited to participate in a joint session of brainstorming moderated by the author to obtain a final list. To reduce bias, information was interpreted and codified through content analysis techniques (Berelson, 1976; Holsti, 1968; Kolbe and Burnett, 1991). This step was particularly critical, as either the aggregation in the same category or the separation in different categories of concepts remain a subjective choice of the text analysts. This double list includes 28 concepts and 160 potential dyadic relationships between couples of concepts (80 direct relationships + 80 feedback relationships). Because at this stage relationships between concepts were only of virtual type because no project was yet examined, the cognitive map was considered as being still open. These 28 variables assess the economic, political and regulatory environment, the project and the adopted technology in terms of their complexity, some characteristics of the SPE and the project contractors (i.e., their technical and project management capabilities, etc.) and organizational processes occurring during project evolution (i.e., conflict management, cooperation and trust, information exchange, decision-making, etc.). [Table 3](#) displays the list of concepts.

variable	
[1]	project cost overrun
[2]	delay of project completion time
[3]	infrastructure asset quality
[4]	environment turbulence
[5]	project scope change
[6]	project unplanned tasks

[7]	design changes
[8]	construction changes
[9]	SPE technical capability
[10]	SPE project management and planning capability
[11]	SPE additional technical capability acquisition
[12]	unforeseen technical problem-solving
[13]	contractor(s) technical capability
[14]	construction cost overrun
[15]	complex system interface integration
[16]	project or technology complexity
[17]	additional financial resource needs
[18]	joint problem-solving between SPE and contractor(s)
[19]	need for conflict management between SPE and contractor(s)
[20]	negotiation of contract change with contractor(s)
[21]	cooperation and trust between SPE and contractor(s)
[22]	SPE capability to adapt to environment changes
[23]	complementarity between SPE partners capabilities
[24]	technical capability of SPE partners (considered as individual business entities)
[25]	project management and planning capability of SPE partners (as individual business entities)
[26]	unexpected decision-making needs
[27]	interaction (i.e., information exchange, joint decision-making) between SPE and project sponsor or project client
[28]	information exchange between SPE and contractor(s)

Table 3 List of concepts

2) The questionnaire development

In the next step, a questionnaire was developed as a tool to collect information on specific megaprojects and SPEs. The questionnaire contains 80 blocks. Every block is associated to one specific direct relationship between two variables selected from the list of 28 variables identified in the previous step, either of reinforcing or weakening type. In the questionnaire, the respondents are asked to provide a set of 5 assessments for every block/couple of relationships: (a) to what extent the *first variable is influencing the second one* and the *type of relationship*, i.e. if the increase of the amount of the first variable increases (decreases) the amount of the second variable or, vice versa, (b) to what extent *the second variable is influencing the first variable* and *the type of relationship*, i.e. if the increase of the amount of the second variable increases (decreases) the amount of the first variable; (c) the confidence that the respondent has in providing his/her judgment. Different alternatives are available for each assessment. Finally, by using a 5-levels scale the respondent is asked to rate a restricted number of variables according to the weight they have on project evolution. As an example, the Block 1 of the questionnaire is reported below (see [Figure 6](#)).

	Has [2] enough influence on [1] to change it?	Vice versa, is it [1] that has any influence on [2]?	To what extent are you confident in your judgment?
<div style="border: 1px solid black; padding: 5px; width: fit-content;">[2] delay of project completion time</div> <div style="text-align: center; margin: 5px 0;">↓</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">[1] project cost overrun</div>	not at all <input type="checkbox"/>	not at all <input type="checkbox"/>	not so much <input type="checkbox"/>
	very weak <input type="checkbox"/>	very weak <input type="checkbox"/>	enough <input type="checkbox"/>
	weak <input type="checkbox"/>	weak <input type="checkbox"/>	much <input type="checkbox"/>
	some <input type="checkbox"/>	some <input type="checkbox"/>	very much <input type="checkbox"/>
	strong <input type="checkbox"/>	strong <input type="checkbox"/>	
	very strong <input type="checkbox"/>	very strong <input type="checkbox"/>	
	If [2] has influence on [1], then [2] increases [1] <input type="checkbox"/> [2] decreases [1] <input type="checkbox"/>	If [1] has influence on [2], then [1] increases [2] <input type="checkbox"/> [1] decreases [2] <input type="checkbox"/>	

Figure 6 Block 1 of variables of the questionnaire used to collect data

3) Field analysis

The questionnaire was administered to a sample of SPEs that had been established to deliver megaprojects in the energy and transportation industry in Italy.

4) Data analysis

Information collected through the questionnaire was used to model the fuzzy cognitive map of the SPE governing system associated to a specific megaproject. The MentalModeler software package (Gray, Chan, Clark and Jordan, 2012; Gray, Gray, Cox and Henly-Shepard, 2013) has been used to build the map and perform scenario simulation analysis. A unipolar logistic function was used as a squashing function

$$S(C_i) = \frac{1}{1 + e^{-(g(C_i+B))}} \quad (2)$$

where $g (>1)$ is the gain, C_i is the input, and B is the bias added component. The input C_i is the result of the vectorial summation and it can take all the real values. The output $S=S(C_i)$ is the value of the new activation state and varies in the range $\{0, 1\}$.

The METRO N - XYZ SpA

For confidentiality purposes, neither the SPE nor the megaproject names are revealed.

The METRO N is a subway line that crosses an Italian large city from the upper to the lower limits. The total length of the line is about 12 km, while the number of stations is 19. Development cost is close to 500 million Eur. The project started in 2006 and is expected to be completed by the end of 2015, even though passenger service started at the beginning of 2013, after the end of the construction of the main section of the network railway line. This project is characterized by a high level of technological innovation and the METRO N line is

completely automatic and driverless. The project is developed adopting a PPP financing scheme, and more than 40% of funds are provided by the private actor.

METRO N - XYZ SpA was established in 2006 as the Special Purpose Company (private concessionaire) for the construction and operation of the subway line. Leading companies in the construction and infrastructure transportation industries are shareholders of the SPE. METRO N - XYZ has the responsibility for the technical and project plan, construction, and operation of the infrastructure.

The cognitive map

Figure 7 shows the cognitive map of the SPE project governing system within the proposed framework that integrates the KBV-TCE-SNT perspectives.

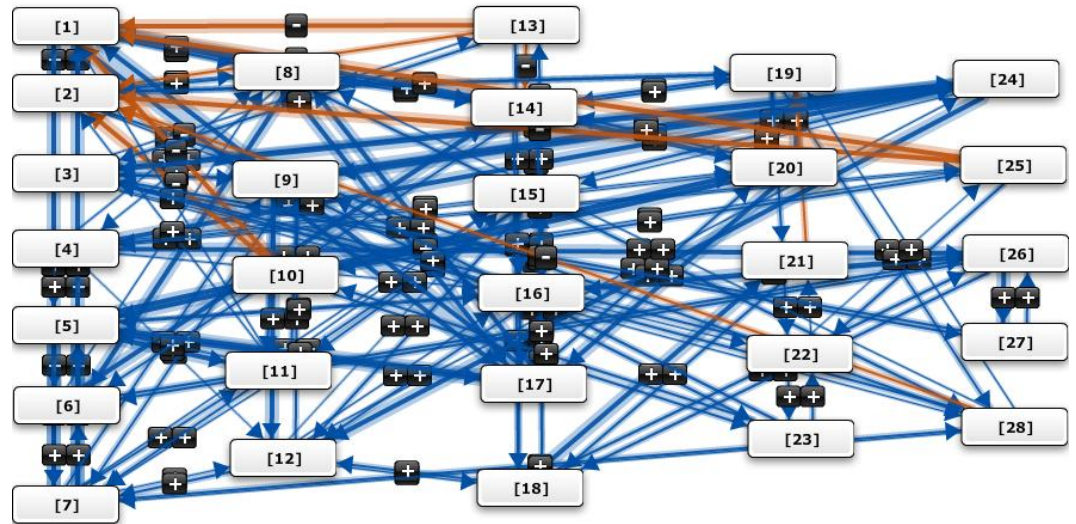


Figure 7 The network of relationships among concepts

The map has 147 relationship ties and a measurement of the connection density equal to 18.75%. The low index of density emphasizes that there are many inner circles showing nonlinear capacity. Blue colored ties indicate *sustaining or reinforcing* relationships, that is to say those relationships in which an increase of the value of the cause-event variable leads to the increase of the value of the effect-event variable. Vice versa, brown colored ties indicate *unsustaining or weakening* relationships, i.e. relationships in which an increase of the value of the cause-event variable determines a decrease of the value of the effect-event variable.

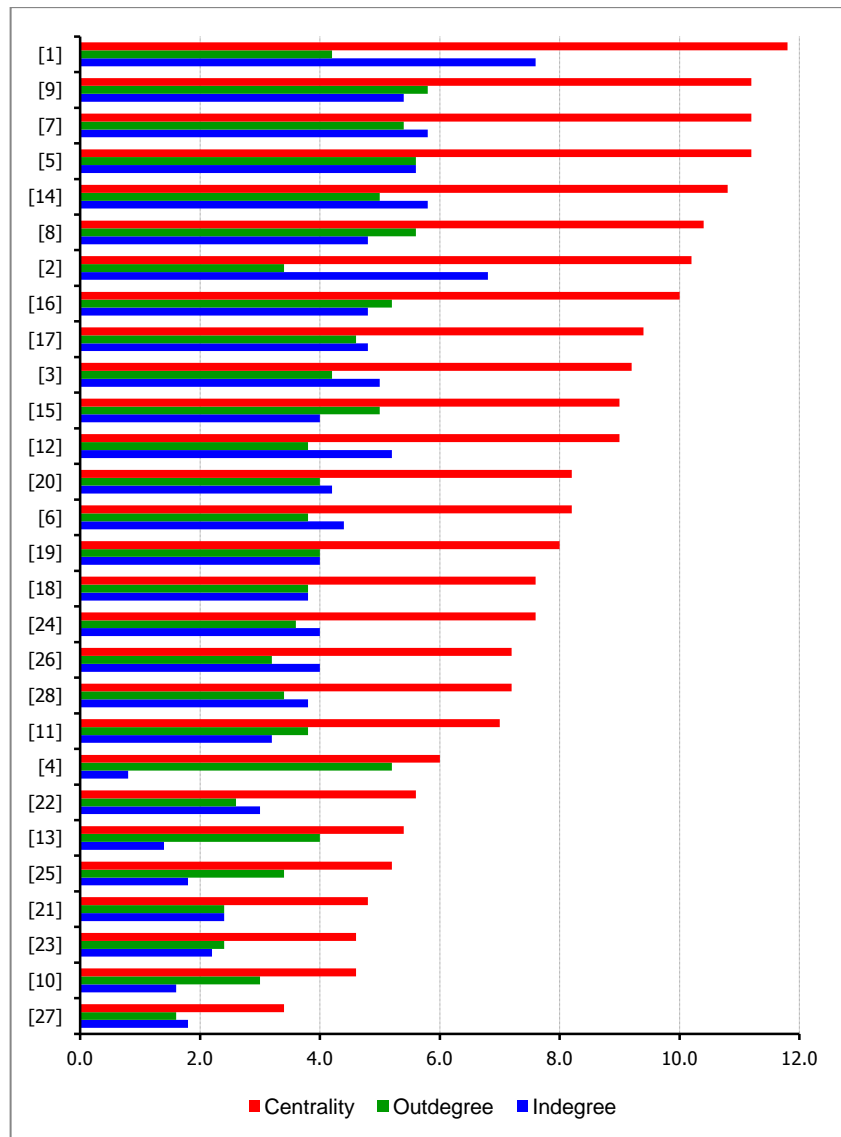


Figure 8 Measurements for the Centrality, Outdegree and Indegree indices

Indices suggested by the graph theory allow describing the structure of FCMs and characterizing single concepts. The bar chart in [Figure 8](#) reports in a graphic way the measurements of the centrality, outdegree and indegree indices of map concepts. In particular, the measure of the centrality index is obtained as a summation of the outdegree and indegree measures. The ‘indegree’ and ‘outdegree’ indicate respectively the degree to which a given concept is affected by and affects other concepts within the FCM. Concepts have been ordered with respect to the centralization index. The centrality measure is between 3 and 12. Concepts having a higher centrality index have a greater influence in the map. The most central concept in the map is [1] “project cost overrun”, even though it is more affected by other concepts that influencing them. A number of concepts has a similar behavior, i.e. [2] “delay of project completion time”, [3] “infrastructure asset quality”, [12] “unforeseen technical problem-solving”, [14] “construction cost overrun”, [26] “unexpected decision-making needs”. With respect to the performance related concepts ([1], [2], [3],[14]), [1] “project cost overrun” is the most

critical because it is largely affected by other concepts. Focusing attention on concepts associated to management and technical capabilities – [9], [10], [11], [13], [23], [24], [25] - [9] “SPE technical capability” and [24] “technical capability of SPE partners (considered as individual business entities)” are the most critical because of their higher centrality indices, even though the SPE technical capability as an unique entity is more important than technical capabilities of individual partners. The SPE technical capabilities are far more critical to achieve successful project performance than contractors’ technical capabilities. Moreover, [9] “SPE technical capability” is the second most central concept in the map. Concept [10] associated to SPE “SPE project management and planning capability” shows a low centrality index in the map, but the contribution of the outdegree index to the centrality index is higher than the indegree, indicating that this concept affects the other concepts more than is affected by them.

Scenario analysis

Seven concept-variables have been selected to conduct scenario analysis and explore the dynamic behavior of the map. These variables were considered particularly critical to project performance as reported in the literature or suggested by experts. Eighteen scenarios have been generated by increasing or decreasing the value of one individual concept variable or a combination of them each time (see Table 4). While the FCM software allowed to have 3 positive levels of changes, very high, high, some, and 3 negative levels of change, very low, low, some, simulation was performed changing selected variables to the extreme level of the scale (vh=very high, vl=very low).

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
[4]	vh	vl			vh	vl												
[9]											vl			vl	vl	vl	vl	vl
[10]				vh	vl	vl	vh											
[13]												vl	vh	vl	vl	vl	vl	vl
[15]															vh	vl		vh
[16]							vh	vl	vh	vl					vh	vl		vh
[24]									vl	vh							vl	vl

Note: vh=very high; vl=very low

Table 4 List of scenarios

Table 5 illustrates the outcome of the scenario analysis. In particular, measurements indicate the relative change of the concept variable from the steady state after the introduction in the system of a perturbation due to variable changes as planned in scenario configurations. For the sake of brevity, only simulation results relative to a reduced number of scenarios are discussed.

	S1	S2	S3	S4	S5	S6	S7*	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
[1]		2%	-3%	7%	7%	-1%		3%		3%	1%	7%	-2%	7%	7%	7%	7%	7%
[2]		5%	-6%	45%	45%	-2%		7%	1%	7%	25%	34%	-4%	50%	50%	48%	50%	50%

project performance, as delay of project completion time increases by 45%. Furthermore, SPE capability to adapt to environment changes remains also negatively affected by its reduced project management and planning capability. Contrarily to what emerged from the analysis of centrality indices, simulation has showed that the SPE project management and planning capability is a critical one to the achievement of acceptable project performance (completion time).

- **scenarios S7 and S8:** increasing project or technology complexity has no effect on the map. Decreasing project or technology complexity has an important effect on contractor(s) technical capability, requiring a reduced amount of this capability. However, as a counter fact, reducing contractor(s) technical capability reduces project performance too.
- **scenario S11:** a strong reduction of the SPE technical capability causes an important increase of the delay of project completion time.
- **scenarios S12 and S13:** a strong reduction of contractor(s) technical capability has a strong negative impact on project performance. Particularly, delay of project completion time results increased by 34% and project cost overrun by 7%. Increasing contractor(s) technical capability has only a relatively small effect on project performance.
- **scenario S14:** reducing in the same time the SPE technical capability and contractor(s) technical capability has a tremendous negative effect on project performance: project cost overrun increases by 7%, delay of project completion time increases by 50% and the infrastructure asset quality decreases by 19%.

A Pilot Test of the Methodological Framework: the Case of the METRO XYZ SpA

The results of the simulation conducted for the pilot test are encouraging. In particular, the scenario analysis has identified some critical variables that, individually or combined together, may have a negative impact on project performance. These variables are the contractor(s) technical capability, the SPE project management and planning capability and the SPE technical capability. This outcome is partially supported by the analysis of the network properties of the cognitive map as the centrality indices measurements identify only the technical capabilities of the SPE and the contractor(s) as critical variables that need more attention, but not the SPE project management and planning capability.

Findings are also consistent with the theoretical integrated construct on which the methodological framework was developed. Technological capabilities possessed by the parties involved in the delivery of the project, and specifically, by the SPE are an important determinant of project performance.

The methodological framework, even though may be refined and probably improved by adding new concepts and identifying further relationships extending the empirical study and testing to other industries and geographical contexts, provides useful insights about the behavior of a Special Purpose Entity in the delivery of an infrastructure megaproject in the transportation industry.

The implementation of the framework in the pilot test has showed how, by eliciting expert knowledge, the Fuzzy Cognitive Mapping tool, the network metrics and the specific attention given to the technical and management capability concept can be used together to gain a better understanding about the effective management and delivery of megaprojects, and the cognitive processes that that support decision-making and are important to face ambiguous situations typical of complex projects more efficiently.

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Conclusions and recommendations

The subject of “Special Purpose Entities” (SPEs) was recognised by the MEGAPROJECT COST Action as an essential one in determining the behaviour of megaprojects. There are different perspectives to look at these entities. The most common is to consider them as legal entities which are created mainly to fulfil, narrow, particular, and temporary objectives. In this perspective, SPEs in megaprojects are typically used by public bodies or private equity companies to isolate project management process and financial risks from their roots (e.g. public administration, parent company). They are commonly used to own a single asset and are associated to permits and contract rights to manage facilities delivering public services (such as highways, high speed railways, power plants, etc.). They are also commonly used for public private partnerships model. There is no doubt that the role of such business structures will become more relevant, along with launching new mechanisms to stimulate economy inter alia through the Public-Private Partnership model, both in the activities undertaken by the European Commission and national governments. The SPEs are crucial actors to convey financial resources into the project.

What exactly is a SPE? In literature lots of definitions (described in the Chapter of this book “Ontology and functions of the SPEs”) are available resulting both from the variety of typologies of this organizational subject and the different focus adopted by scholars who privilege only some aspects to look at each time. In particular, there is the need to take into account differences in definitions between countries due to the legal and regulatory systems. Indeed, the legal and regulatory environment plays an important role to control the evolving functions of SPEs. Research has mostly focused on SPE as a vehicle to collect funds for the project and properly manage financial risks. However, more attention needs to be given to governance, management, project development capabilities and asset management along the megaproject lifecycle. The analysis of the cases collected in the MEGAPROJECT Portfolio clearly shows that the SPE configuration changes as the megaproject evolves over time, supporting its development and adaptation to the context at different stages of its lifecycle, becoming, sometimes, a separate organism in the business environment. As mentioned in the Chapter “Investigating the behavior of a SPE: a methodological framework based on simulation“, because of the temporary nature of a megaproject, a SPE usually presents a great organisational and strategic flexibility and can be easily reconfigured modifying its structure, boundaries, plans and capabilities around the needs of the project as the context changes, thus making new knowledge available to deliver the project.

The dynamics of SPEs structure and behaviour are dependent on the intrinsic complexity of megaprojects and the wide spectrum of stakeholders. However, as the network of stakeholders’ relations is generally changing at each stage of the megaproject lifecycle, SPEs need to adapt to such fluctuating environment. Thus, the SPEs have to govern and coordinate a more or less extended network of

external actors to acquire resources and capabilities to deliver (and sometimes operate) the megaproject.

Lessons and insights for researchers

The SPEs seem to be an important topic to focus on for various groups of interest, like policy makers, practitioners and researchers. Research findings emerging from the MEGAPROJECT COST Action suggest that a more in-depth understanding of the SPEs as temporary organizations established in the context of megaprojects gained through the adoption of a multidisciplinary perspective, a time-dependent framework, and non conventional methodological tools may contribute to the growth of the organizational theory and project management discipline to a significant extent. Particularly, these topics are worth of concern and further investigation:

- To develop an ontology and a comprehensive taxonomy of SPE typologies and configuration states along the project lifecycle. They may help to better understand what is the role played by the SPE and its different functions at different stages of the project evolution;
- To identify more critical variables that define the governing system that the SPE implements to manage the megaproject. This knowledge is important to understand to what extent the SPE governing system contributes to project performance and how to design the governing system that fits more the context characteristics;
- To develop a contingent model able to predict project performance as a variable influenced by certain characteristics of the SPE. Such a model would explain the performance of a megaproject in terms of the fit (or misfit) between the characteristics of the project stages along its lifecycle and the particular organizational configurations assumed by the SPE;
- To deal with the dilemma related to the ambiguous role that sometimes is played by the SPE which acts as a temporary and permanent organization in the same time particularly when the operation and maintenance of the infrastructure asset is an important stage of the megaproject. To shed light on this aspect of the SPE nature and behaviour may contribute to add new knowledge to the organizational theory within a lifecycle perspective by introducing a new organizational typology that has not been investigated enough.

Lessons for practitioners

SPEs may be flexible organisations that provide plenty of opportunities to improve delivery performance of megaprojects from the practitioners side. Indeed, SPEs offer a special way of aligning goals and interests among various stakeholders related to the megaproject, and collecting and integrating resources and capabilities necessary to realise the project. In particular, findings suggest that:

- One of the SPEs role is providing guarantees for investors, so a more rigid structure is needed as a demand of clear responsibilities in the governance system of the project is a critical concern;

- From an organizational design perspective, too much attention is often given to finance issues and legalities, while, on the contrary, there is no concern for the availability of technical and management capabilities in the SPE and the coordination mechanisms and resources that model the governing system. Findings showed that technical and management capabilities of the SPE are an important determinant of project performance;
- Flexibility and adaptation to the environment are important factors that support the evolution of the SPE organization along its lifecycle allowing the adoption of different configurations. Therefore, even though a governance system with a clear definition of responsibilities is required, the structure rigidity should be balanced by a certain flexibility and adaptation capability;
- SPEs should be properly structured and equipped to pursue different purposes and strategic goals during the evolution of the megaproject from conceptualisation and design to construction and operation;
- SPEs in megaprojects often are characterized by ‘temporal flipping’ where the organization with greater longevity is the “project” based organization that can considerably outlast the “permanent organization” from which it was sprung.

Likewise an important issue is the relevance of the contextualization of an SPE. Particularly,

- SPEs are highly contextual in nature depending on the country context and although the general aim is the same in various countries their design and functioning might be of much difference;
- Modelling and predicting how a particular SPE organization might operate in certain national legal framework may help choosing the more effective configuration at different stages of the project evolution. Indeed, there are some functionalities of the SPEs that might be ineffective or even negatively influenced by stringent national regulations existing in some countries;
- SPEs are much used in Public-Private Partnership (PPP) models to design, deliver, operate and maintain infrastructure assets, but the country context might vary a lot. Therefore, different solutions should be found depending on the historical, business and cultural background of the specific country, and no universal and unique solutions exist.

Summarising, the subject of SPEs in megaprojects still need deeper analysis and exploration, especially with respect to SPE design, management and governance. The effort of researchers should be addressed to gain a better understanding of their functioning, structure and role played in contributing to megaprojects performance to help practitioners and policy makers to choose the organizational option for the SPE that more likely will led to project success.

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Furthermore, a number of scholars belonging to other working groups of the Action joined by invitation the SPE WG meetings whenever they had an interest for a specific theme:

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Technical meetings of the SPE WG

Over the course of the Action, the SPE WG has held the following meetings:

- *Dubrovnik, 01.10.2013* (kick-off meeting SPE WG)
- *Warsaw, 26.02.2014*
- *Liverpool, 11.07.2014*
- *Bratislava, 09.09.2014*
- *Brussels, 24.02.2015*

The members of the group have been very active in participating in the Annual Workshop and the events organized by the Action, where they presented their ongoing research:

- *Bruxelles, 02.04.2014*
- *Liverpool, 10.07.2014*