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Optimize The Supervision Of Complex Projects By Taking Into Account Interactions Between Actors

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Abstract: TOTAL buys a large percentage of its complex development projects, in the form of studies, equipment deliveries and installation of structures. All these parts are structured as a contractual strategy, which is a key element of project execution performance. Due to the number of contracts defined and the complex environment of projects, this process involves a large number of actors, either internal or external to TOTAL. The risk is a lack of coordination between these interdependent actors, with suboptimal decisions depending on local interests, notably due to contractual relationships between them. The objective of this paper is to propose a new approach to improve collaboration between interdependent actors so they can make more coordinated decisions. To do so, specific actors of the project are highlighted and grouped together, using an Actor/Actor matrix model and a clustering approach which takes into account the static and dynamic aspects of the relationships between actors.

Keywords: Complex project management; Risk management; Project Organization; Coordination; Clustering; Propagation chains; Loops

1. Introduction

Oil and Gas projects involve multiple and diverse stakeholders, including the operating company, contractors, partners, host countries, and non-governmental organizations (Eweje et al., 2012). This requires the collaboration of employees of different organizations, but also coordination processes across organizational boundaries (Perrow, 1984; Milch and Laumann, 2016). Actors are selected based on their current and past assignments, skills, expertise and experience regarding one or more areas. There are many interactions between these actors and those involved in the early stages of the project such as preliminary assessment, pre-project studies, etc... Badenfelt argues that collaborative behavior can have a positive impact on project outcomes, especially in the case of incomplete contracts (Badenfelt, 2011), which claims for the use of approaches which can enable greater coordination between actors in complex projects.

Project complexity combines technical and organizational aspects (Baccarini, 1996; Bosch-Rekvelde et al, 2011). Complex project management thus focuses on the management of the product components and interfaces between these technical elements of the project (physical and functional aspects), as well as the management of the actors and their interrelations (organizational aspect). At the same time, human beings are characterized by a limited cognitive capacity, and cannot easily manage several

dimensions and temporalities simultaneously. They are also characterized by cognitive biases (Ramser, 1993; Busenitz and Barney, 1997; Williams and Samset, 2010), which means that their previous experiences, both professional and personal, influence the way they perceive and construct information according to their opinions. This implies that their behavior is often dictated by unconscious thought processes, either individually or collectively. One reason for this limited capacity to cope with this is the actual pace and speed of the project, which requires to make quick decisions, even with ambiguous or unknown information. This can imply long-term consequences. Complex “Oil and Gas” development projects have an additional dimension, which is the involvement of multiple contractors, subcontractors and suppliers which are related to the company through contractual relations.

All these factors clearly underline the difficulty to coordinate complex projects (Whitty and Maylor, 2009) with multiple actors who perform or manage multiple activities to achieve multiple targets at different stages of the project lifecycle, from engineering to commissioning. Poor management of these relationships among the multiple actors during the various stages can lead to many potentially serious problems:

- Limited areas of expertise: Several authors (Cedergren, 2013; Nenonen and Vasara, 2013; Milch and Laumann, 2016) stated that if each organization remains within its own area of competence, it will be difficult to achieve a comprehensive and integrated vision of the complex project and multiple problems will occur.
- Poor communication due to poor information flows (Nenonen and Vasara, 2013, Albrechtsen and Hovden, 2014), which may stem from mistrust or difficulty in building trust between different actors within different organizations or not (Kochan et al., 1994).
- Coordination difficulties during the decision-making process, either through poor integration of multiple (and often contradictory) sources of information, or by a poor anticipation of the indirect consequences of the decision. For example, (Love and al., 2013) studied the dynamics of changes associated with design specifications or customer requirements. These factors, known as unforeseen disruptions, occur as a result of non-coordination between the various project stakeholders, for example, managers, consultants, contractors and suppliers. Turner and Simister have studied the influence of the cooperative posture of the actors concerned, especially with decisions about the selection of the type of contract (Turner and Simister, 2001). Poor communication and coordination are emerging issues highlighted by recent literature reviews (Svejvig and Andersen, 2014; Kwak and Anbari, 2009; Pitsis et al., 2014).
- Lack of trust between stakeholders. Trust and commitment to create a climate which encourages cooperation and coordination among stakeholders are key success factors of projects (Stoddart-Stones, 1988; Chow et al., 2012). (Lau and Rowlinson, 2009) have highlighted one of the great advantages of such a climate of trust: a tendency not to interpret contracts as a sign of mistrust.

The remainder of the paper is as follows. Section 2 introduces the objective and the approach. Section 3 illustrates this approach on a real case study. Finally, Section 4 draws some conclusions.

2. Objective and approach

During my bibliographic study, I analyzed the different points of view on the complexity of a system (Le Moigne, 1994; De Rosnay, 2014), on the communication between humans (Watzlawick and al, 1972) and on the clustering approaches; I noticed that there was a lack on taking into account the dynamics of complex systems and especially on organizations within companies / projects. The clustering approach is mainly used at a specific moment without taking into account the possible propagations that can occur in complex systems (in our article: organizational). This article aims at optimizing the management of the contracting and execution phases of the project by proposing complementary organizational structures. The latter take into account the vulnerabilities of the actors and their relations within the project at different levels. This will permit to anticipate and mitigate the risks associated with poor communication and coordination while making key decisions. A two-stage approach is proposed:

- Modeling the interactions between actors. This involves:
 - Identifying the actors linked to the project (internal or external), (Marle and Vidal, 2016),
 - Estimating the vulnerability of collaboration between actors (Jung and al, 2017),
 - Detecting potential chains and feedback loops (Brunel, 2015) in order to understand the dynamics of collaboration between project actors. An actor may not be critical at an individual level, but may trigger complex propagation phenomena at the collective level.
- Using a clustering approach to build group of actors according to the vulnerability of their interactions in order better to anticipate and attenuate the negative potential propagation phenomena between them (like loops or amplification chains). By focusing on the most vulnerable interactions, it is possible to gather actors from different internal and/or external entities involved in complex phenomena. This helps them to make coordinated and hopefully less risky decisions, notably by integrating the most vulnerable actors of the project to the supervision group of the project (and not only internal actors or actors with a high hierarchical position).

Note: The main assumption is that the extra effort needed to perform this approach during the contract preparation phase is much lower than the potential savings during the contract execution phase.

3. Case study on the implementation phase of the Pazflor project

Pazflor is the first project in the world to deploy, at the scale of several fields, a development plan based on a gas-liquid separation at the bottom of the sea. This major technological innovation meets the challenge of the difficult production of oil Heavy and viscous of three of the four fields of this gigantic development of the deep Angolan offshore. The project organization is broken down into a classical organization chart, where the first level is the project manager and the second level corresponds to the

package manager. Between these two levels, some actors of the operating company TOTAL support the project: risk manager, project control manager, contract managers, etc. Other actors are more or less linked to the project, at a global level, or specifically for a single contract: contractors and subcontractors of different packages, non-governmental organizations, government and surrounding communities in the host country, partners of the “Oil and Gas” sector, etc.

The teams were mainly located at the headquarters of the project management and close to the facilities of the contractors or the headquarters for the different packages. For example, design offices can be in one location and manufacturing facilities in another, which means that the company's operating supervision teams should be at different locations at different stages. A great deal of information has been exchanged and many actions have been taken between the different actors: the project management team and headquarters, the project management team and the central affiliation administration, the Project management and the host country, and the project management team and partners. Requirements and deliverables have been associated with key stakeholders (company, host country) and key objectives such as cost, time, production and H3SEQ (Health-Safety-Security-Society-Environment-Quality). The activities were structured according to the distribution Packages x Phases and assemblies in the contracts. The actors were structured at the department level in the company (project department, affiliation, risk management and interface, etc.) and at the level of the organization for external actors (Host Country Authority, local communities, contractors, the key subcontractors).

3.1. Vulnerability approach

In order to estimate the vulnerability associated with the collaboration between actors, the use of a 4-level vulnerability scale was proposed. This scale was developed in cooperation with the TOTAL actors and uses several indicators and methods available in the literature, notably the cyndinic approach (Kerven, 1999), (Vaaland, 2004), (Calamel et al, 2012), etc.

Vulnerability		Mitigation			
		4	3	2	1
Criticality	1	Negligeable	Negligeable	Tolerable	Tolerable
	2	Negligeable	Tolerable	Tolerable	Supervise
	3	Tolerable	Tolerable	Supervise	Supervise +
	4	Tolerable	Supervise	Supervise +	Unacceptable

<u>Mitigation: collaboration between the actors</u>		<u>Criticality / importance of the relationship</u>	
1	Very good collaboration	1	Negligeable
2	Good collaboration	2	Not very important
3	Bad collaboration	3	Importante
4	Few, see no collaboration possible	4	Very importante

Figure 1: Vulnerability scale related to actors

3.2. Stage 1: Modeling the interactions between actors

When modeling the interactions between actors in the project, multiple chains and loops were detected using the ASM (Actors Structure Matrix) matrix arising from the DSM (Design Structure Matrix) method introduced by (Steward, 1981). This method is used in several industrial domains (Fang et al., 2010; Eppinger and Browning, 2012). It allows analyzing interactions and dependencies between elements / objects, and was notably extended to the study of risks in complex projects (Marle and Vidal, 2008). The novelty of the proposed approach consists in identifying and analyzing the dynamics of the interactions between actors that can be modeled by chains, feedback loops (...) as shown in Fig.2, and to group the dynamics considered critical within the same cluster. Concerning the algorithm, we used that of (Marle and Vidal, 2016) by adding constraints in order to be able to take into account this dynamic. Our approach is thus not only focused on a static array (organization at a given moment) but also dynamic. Fig. 2 shows the Actor / Actor matrix of the Pazflor project in the execution stage (at the "n" and "n-1" levels; other actors such as subcontractors are not directly represented in the matrix for readability reasons). Within this matrix, 2 chains and 2 loops are highlighted since they can entail dangerous dynamics for the project (such as amplification effects).

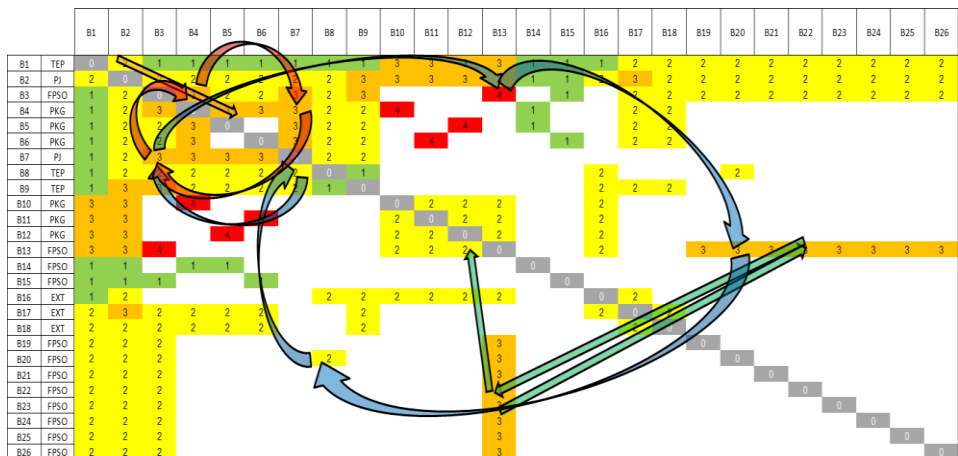
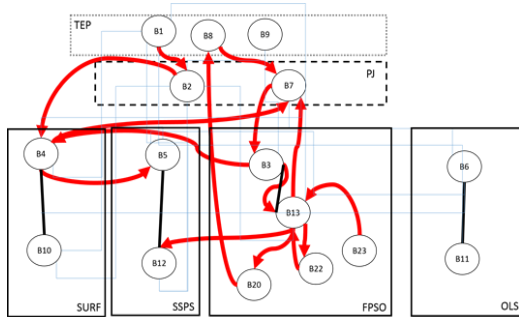


Figure 2: Illustration of dangerous phenomena identified within the Actors / Actors matrices

The initial configuration was organized in packages, then by contracts. For example, B3 is the FPSO (Floating production storage and offloading) package manager, B13 is the prime contractor, and B20, B22 and B23 are (among others) subcontractors (responsible for delivering a piece of equipment or doing part of the process). Fig.3 illustrates the interactions included in both loops and chains (in red). It also shows critical interactions (respectively values of 4 in Figure 3 in black, and values of 3 in light blue).



- TEP Total Exploration Production
- PJ Project
- SURF Subsea Umbilicals Risers and Flowlines
- SSPS Separateur Subsea Production System
- FPSO Floating Production Storage and Offloading
- OLS OffLoading System

Figure 3: Illustration of the main interactions in the configuration of the initial organization. As shown in Fig.3, complex phenomena (in red) involve actors who are in different organizational entities, located on different sites, even on different continents. This means that the management of these chains or loops depends on the coordination of different and potentially conflicting interests of actors with different cultures and a common history that may be positive, negative or null.

3.3. Stage 2: Using a clustering approach to build group of actors

Several configurations are possible, with or without the incorporation of detected complex phenomena, with or without disjunction constraints, and with different cluster sizes (Jaber et al., 2015; Marle and Vidal, 2013). The details of the clustering approach used are not included here, but there were multiple possible solutions, with advantages and drawbacks. Fig. 4 shows the chosen solution, which allows the overlap between the 3 groups proposed, since some actors have been involved in more than one phenomena (B3 and B7 for loops 1 and 2, B13 for loop 2 and chain 2, B4 for chain 1 and loop 1). Then, the secondary objective was to include as much as possible the critical interactions (values of 4, then 3). This involved to put B5 simultaneously in C1 (because it belongs to chain 1) and C3 (because it is strongly related to B12).

	B5	B11	B6	B2	B1	B9	B10	B4	B7	B3	B8	B20	B13	B22	B23	B12	B14	B15	B16	B17	B18	B19	B21	B24	B25	B26
B5	0			2	1	2		3	3	2	2					2	1			2	2					
B11		0																								
B6		4	0	2	1	2		3	3	2	2						1			2	2					
B2	2	3	2	0	2	3	1	2	2	2	2	3	2	2	2	3	1	1	1	2	3	2	2	2	2	2
B1	1	3	1	2	1	0	3	1	1	1	1	1	2	3	2	3	1	1	1	2	2	2	2	2	2	2
B9	2	2	2	1	0	1	2	2	2	3	1									2	2	2				
B10				3	3		0	4				2				2				2	2					
B4	3		3	2	1	2	4	1									1			2	2					
B7	3		3	2	1	2			2	2																
B3	2		2	2	1	3			2	2	2	2	2	2	2					2	2	2	2	2	2	2
B8	2		2	2	1	1		2		2	0	2								2						
B20				2	2					2	2	2	2	2	2	3										
B13		2		3	3		2									2							3	3	3	3
B22				2	2																					
B23				2	2																					
B12	4	2		3	3		2									0	1			2						
B14	1			1	1			1									0									
B15				1	1																					
B16		2		2	1	2	2				2					2					0					
B17	2		2	3	2	2	2	2												2	0	2				
B18	2		2	2	2	2	2	2												2	0					
B19				2	2															2	0					
B21				2	2										3							0				
B24				2	2										3							0				
B25				2	2										3								0			
B26				2	2			2						3										0		0

Figure 4: Illustration of configuration of Matrix clustered

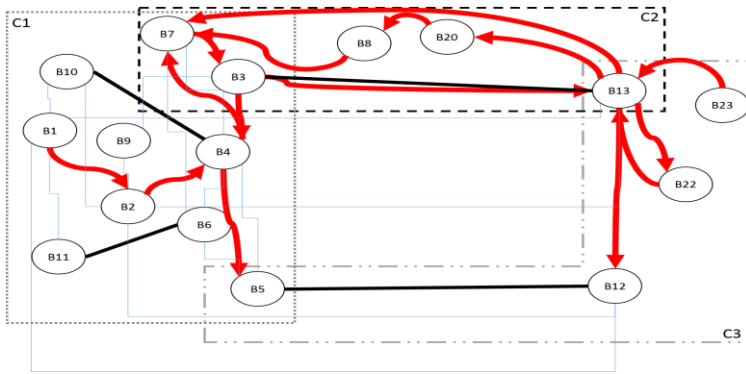


Figure 5: Illustrations of the selected clustering configurations

Fig. 6 shows the difference between initial and clustered configuration. For example, cluster C1 includes loop 1 (B4-B3-B7), which was initially split into three organizational entities (Fig. 6). This is all the more important for loops, which are phenomena that can possibly occur more than once.

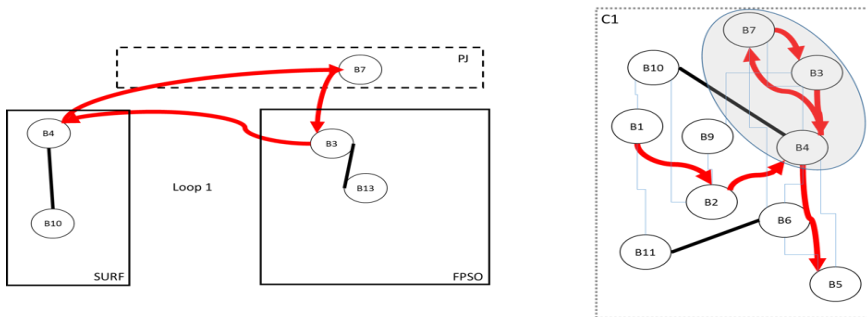


Figure 6: Comparison of the initial (right) and cluster (left) configurations for loop 1

3.4. Stage 3: Introducing a complementary vision of project governance

Companies tend to create a multitude of supervision groups and committees in order to improve the management of the actors of the project (Ventroux, 2016). These groups mainly involve persons from the operating company who have significant hierarchical positions. Despite this multitude of groups, collaboration between the actors linked to the project, both internal and external, has yet to be improved. In order to solve this problem, we propose to create a supervision group based on the results of the clustering of the matrix of interactions between actors (Fig. 7). This is done by regrouping the

actors located on the most vulnerable interactions and on at least one complex phenomenon (even more if positioned on two clusters).

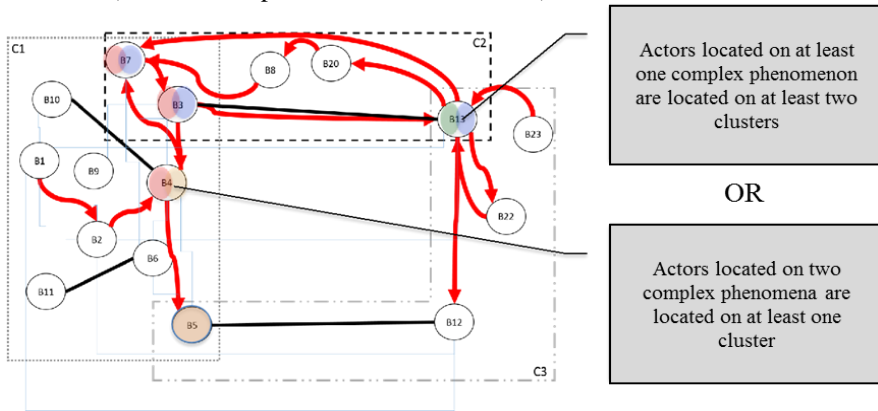


Figure 7: Illustration of the members integrated into the supervision group

For the Pazflor project, the actors of this supervision group are: B3, B4, B5, B7, and B13. This allows the supervision group to improve the decision-making process by focusing on the major dangers of the project while promoting collaboration. An important point is the fact that the actors constituting this group do not necessarily have an important hierarchical position within the project, but are rather the most vulnerable ones in terms of collaboration about interconnected decisions.

The other advantages of our proposal are to:

- Limit efforts to supervise interactions between groups; even if it is not forgotten, clusters are built to group higher interactions and dangerous chains and loops, which means that the supervision focus will be on the coordination within clusters;
- Avoid duplicating some supervision tasks;
- Know more precisely the impact / influence of risks and how to avoid / limit their occurrence;
- Limit the human and financial resources associated with this supervision.

4. Conclusion

This article introduces the possibility of making a step forward in improving collaboration between actors by considering the vulnerability of their interactions.

It proposes an original and complementary organizational structure to supervise the project, based on a DSM-based model and a clustering approach. This new organizational structure is complementary to the existing organizational structures (operating company, contractors, host country government ...) based on the analysis of

the vulnerability of the collaboration between actors and the detection of complex phenomena. The most vulnerable actors in the project are integrated into a supervision cluster, so that they can collaborate together (increasing trust between those actors who are collectively involved in the potential problems that may affect each of them) and better (the aim is not to find those who are responsible for future failures, but to promote collaboration to avoid them). This new structure makes it possible to better manage the project by making a better return on risk management to decision-makers so that they can make more coordinated decisions.

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