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An assistance to identification and estimation of contractual strategy alternatives in oil and gas upstream development projects

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Abstract:

The development of new oil and gas production facilities starts by the design of a contractual strategy (CS). A CS is a set of coordinated actions, defined as a split of project scope into contracts, with smaller scopes, specific types of remuneration and contractors selection mode. These contracts will later drive the execution of the project. When designing a CS, three main issues are faced: (i) the identification of a relevant set of alternatives; (ii) the estimation and evaluation of such alternatives; (iii) the need to substantiate the chosen one.

In this work, we propose a 3-step structured approach for selecting the appropriate CS through the exploration and selection among a detailed, albeit reasonable number of alternatives. The focus in this communication is on identifying and estimating alternatives, using a combination of Domain Mapping Matrices (DMM) and Design Structure Matrices (DSM).

Keywords: Project Management, Oil and Gas industry, WBS, Contracts management, Multiple Criteria Decision Aiding, DSM, DMM

1 Introduction

Complex projects deal with many activities, from different natures, with important issues. They “involve a large number of actors, often associated with a high degree of uncertainty and technological complexity” (Olsen and al, 2005). This work takes place in upstream projects of an international Oil and Gas company. Upstream projects can be Offshore or Onshore, seeking for hydrocarbons in their different forms (crude oil, oil sands, natural gas, shale oil, shale gas, coal bed methane, etc...). Since these projects are mainly subcontracted, one key step in such projects is the elaboration of the CS.

A fully developed CS determines the scope split of contracts, their types, their selection modes, and the names of the selected contractors. It is defined among a two-dimension matrix composed of objects (e.g. Platforms, Pipelines, Drilling wells, etc.) and temporal phases of the project (see Figure 1). Constructing a CS is a tricky step before deploying a project. Indeed, the success of the project is strongly related to the success of the contracts composing this project, meaning notably proper management of their interfaces. The difficulty lies in the fact that there are a large number of possibilities, which cannot all be considered. In addition, the performance of CS alternatives depends on criteria from different natures and scales, such as: cost, schedule, level of uncertainty, or level of local content, which are difficult to compare and aggregate. This makes the evaluation and comparison of CS alternatives complicated. To overcome this issue, a 3-

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level DSM-based approach is proposed, in order to identify, estimate and evaluate increasingly big alternatives.

The remainder of the paper is as follows. Section 2 presents some concepts related to contractual strategy selection. Section 3 introduces the 3-level DSM-based approach to model the problem through a decision-making process based on identification, estimation and evaluation steps to screen out and rank alternatives, each of the three levels being detailed. Finally, Section 4 draws some conclusions and perspectives.

2 Preliminary concepts for constructing a contractual strategy

In this work, we are interested in the problem of constructing a contractual strategy for upstream development projects. This construction is constrained by three parameters: the scope of the contracts, the type of each contract and the contractor selection mode (see Figure 1). One can easily perceive that the combination of these three parameters can generate a relatively important number of possible options. To better understand this, we present hereafter the relation between such parameters and the CS.

Contractual Strategy		Basic Engineering (BE)	Detailed Engineering (DE)	Procurement (P)	Construction (C)	Transport & Installation (T&I)	Commissioning (Com)
Object 1	Elementary Object 1,1	(CFT) BE	(CFT) EP LS		(CFT) C T&I Com R		
	Elementary Object 1,2		(CFT) EPC T&I Com UR				
	Elementary Object 1,3						
	Elementary Object 1,4						
Object 2	Elementary Object 2,1	(OBT) EPC R			(DC) EPC LS+ T&I EO 2,1 LS		
	Elementary Object 2,2						
...	...						
Object k	Elementary Object k,1	(CFT) E R		(CFT) P R	(CFT) C T&I Com R		
	Elementary Object k,2	(CFT) EPCm LS +C R					
	Elementary Object k,3						
	Elementary Object k,4						

Figure 1. Contractual Strategy of an oil and gas upstream development project

2.1 The scope of contracts

A large literature has been dedicated to project Work Breakdown Structure (Chen et al., 2005; Danilovic, 2006; Haughan, 2002), which is the methodology used in the oil and gas industry to split the scope into technical objects and temporal phases, but also to form contracts perimeters. As mentioned by (Simon, 1962), project complexity increases gradually as the number of contractors are involved in the project. For (Danilovic, 2006), the approach to manage complexity of a product is by a systematic decompositions of its components and elements into sub-systems. This allows to define the physical building blocks, in terms of scope and interfaces with the rest of the product. In oil and gas development projects “*physical building*” represents the elementary and technical objects definition; the “*development process*” represents the split of the temporal phases: Basic Engineering, Detailed Engineering, Procurement, Construction, Transport and Installation, and Commissioning, to form the scope of the contracts (see Figure 1).

A complementary approach to handle complexity in projects is to represent and analyze the dependences and relations between structures (Danilovic and Browning, 2007). Matrix-based methodologies, such as Domain Mapping Matrices (DMM) and Design Structure Matrices (DSM), are popular tools to handle the complexity of the system in different domains (Browning et al., 2006; Danilovic and Browning, 2004; Steward, 2013; Eppinger and Browning, 2012). Such tools offer domain specific visualizations in

a natural way (Grice et al., 2014). In our context, oil and gas upstream development projects, DMM approach is used for crossing domains like technical objects and temporal phases (see Figure 1), and DSM for representing interfaces between contracts.

2.2 Types of contracts

“A contract strategy is the process used for selecting a particular type of contract” (Vesay, 1991). Contracts go from a fixed price lump sum contract to a non-risk cost reimbursable contract. However, some constraints (such as contractors' preferences, host country's norms), or contracting options (incentive schemes) may influence the choice of a contract type over another. Indeed, (Olsen et al., 2005) defend the fact that contract forms focus on three governance mechanisms: (i) incentives, (ii) authority, (iii) norms.

For Elbeltagi (2009), the identification of remuneration types is highly related to its uncertainty and the level of risk in it:

- **Low level of risk:** in the case of low scope uncertainty, costs and schedule estimates are accurate; the most appropriate type of contract is the Lump Sum (LS).
- **Average level of risk:** in the case of average scope uncertainty, cost and schedule estimates are not very precise; the Unit Rate (UR) contract is the appropriate one.
- **High level of risk:** in the case of high scope uncertainty, cost and schedule estimates are unpredictable. The Reimbursable (R) contract is the less risky.

2.3 Selection mode of contractors

According to several authors, the tendering process is a key decision in the design of an appropriate CS (Perry, 1985; Smith, 1995; Aboushiwa and Bower, 2000). In the construction field, Dhanushkodi (2012) analyzed the advantages and disadvantages of the selection modes; in our context the following classification seems appropriate:

- **Call for Tender (CFT):** it consists in a tender between potential suppliers, only one is assigned to develop the scope. It is the most advantageous selection mode, in the case scope clarity. Indeed, it insures competition, and allows obtaining low prices;
- **Design Competition (DC):** it consists in assigning the basic engineering phase to several contractors, only one being assigned to further phases of the project. It is therefore recommended for complex or uncertain design, with competition;
- **Open Book Tendering (OBT):** it consists in awarding a scope to one contractor with transparency on cost and schedule structures, and then converts the contract into a particular type, depending on the remaining uncertainty. It is relevant in the case where the design and construction are both uncertain, and no competition;
- **Single Source (SS):** the contract is established with one contractor based on its expertise, without a tendering process. It is considered when facing constraints such as: no competition, imposition of a local contractor, critical schedule, etc.

In addition to the literature concerning CS, the following paragraph describes how to design and implement a Decision-aiding process within an oil and gas organization.

2.4 A model for decision-aiding process

A large literature has been devoted to decision aiding for complex industrial problems. These problems induce decisions where experience and judgment are not sufficient, and

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for which a scientific approach is required (Beer, 1959; Easterbrook, 1991; Le Moigne, 1977; Vincke, 1992). Tsoukiàs (2008) notably proposed a 4-step descriptive model:

- **The representation of the problem situation.** The step aims to model the problem situation for which the decision maker (DM) has asked the analyst to intervene.
- **The formulation of the problem.** The analyst then provides the DM one or more problem formulations. Moreover, the decision problem is identified within this step. Roy (1985), defined four types of decision problems: 1) Description Problematic; 2) Selection Problematic; 3) Sorting Problematic and 4) Ranking Problematic.
- **The construction of an evaluation model.** It consists in identifying a tuple comprising: the set of alternatives on which the model applies; the set of dimensions (attributes) under which the alternatives are described; the set of scales associated to each dimension; the set of criteria under which each alternative is evaluated in order to take in account the DM's preferences; and an aggregation procedure.
- **A final recommendation.** It is the final deliverable which translates the output of the evaluation model into the decision maker's language.

Based on this generic process and our analyses of the Oil and Gas Company's current CS selection process, the proposal is a 3-level model (instantiated on a fictitious example). Decision-related data like inputs, drivers and conditions are used to identify, estimate and evaluate alternatives, represented through DMMs and DSMs. The final aim is to come up with CS proposal(s). Only the two first steps of identification and estimation are presented in what follows. Evaluation and selection are out of the scope of this communication.

3 A 3-step approach for selecting a contractual strategy

The followed methodology consists in a three-level model, constructing progressively alternatives from bigger sizes. Starting from the components of a CS (scopes of potential contracts, their potential types and selection modes), elementary alternatives are identified and estimated. From that, intermediary alternatives are built through assembly of compatible elementary alternatives. It is only at this intermediary level that the first evaluation is run. This permits to avoid unnecessary estimates and evaluations at lower level, and thus considerably reduce the number of workable alternatives. Finally, a reasonable but relevant set of CS alternatives, combining compatible intermediary alternatives, are identified, estimated and evaluated.

3.1 1st level: identification and estimation of elementary alternatives using DMMs and DSMs

In our context, the starting point is the decomposition of the project into homogeneous objects and their life cycle. This is represented by a Domain Mapping Matrix (DMM), as it was illustrated in Figure 1. Thus, the first question is how to put together these elementary objects to form a larger one, what we call "Elementary alternatives".

Identification of Elementary alternatives

An elementary alternative corresponds to: a subset of rows of the project's DMM with a particular setting for the remuneration type and the selection mode (see section 2), and a specific temporal cut. To identify the elementary alternatives, we propose to proceed by

two steps. The first one is to assemble the rows of the DMM into what we will call “row blocks” (see example on Figure 2). However, we should carefully choose the rows that must be combined because some combinations are technically not possible.

Project Scope of Work		Basic Engineering (BE)	Detailed Engineering (DE)	Procurement (P)	Construction (C)	Transport & Installation (T&I)	Commissioning (Com)
Object 1	Elementary Object A						
	Elementary Object B						
Object 2	Elementary Object C	Row Block assembling the Elementary Objects B and C					
Object 3	Elementary Object D						
	Elementary Object E						

Figure 2. Objects assemblies into Row blocks

To do that, the proposal is to use three drivers identified based on different studies on the design of each elementary object. The drivers are: the number of contractors able to realize the elementary objects as a block; the technical compatibility between the objects; the pre-project studies compatibility. For instance, it is unsuitable to assemble elementary objects where the design is uncertain with others for which it is not the case.

The information regarding the three drivers can be summarized through a DMM for the first one, and two DSMs for the two others. For instance, in Figure 3, the presence of 1 for the line B and the column CTR1, of the list of contractors table, means that we have a contractor CTR1 able to realize the elementary object B. if not enough contractors are able to do different objects, it may be too risky to group them. For instance, 3 contractors are able to do A and B, which is enough to have competition, while only CTR4 is able to do B and D (risks associated with single sourcing, like over cost, no backup, etc.).

PreProject	A	B	C	D	E
A	1	1	1	0	1
B	1	1	1	1	0
C	1	1	1	0	0
D	0	1	0	1	1
E	1	0	0	1	1

Technique	A	B	C	D	E
A	1	1	1	0	0
B	1	1	1	1	0
C	1	1	1	0	0
D	0	1	0	1	1
E	0	0	0	1	1

CTR	CTR1	CTR2	CTR3	CTR4	CTR5	CTR6
A	0	1	1	1	1	0
B	1	1	0	1	1	0
C	1	1	1	1	0	0
D	0	0	1	1	0	1
E	0	1	1	1	0	1

Figure 3. Inputs of the Row blocks identification procedure

Considering DSMs, and DMM illustrated in Figure 3, we have the following row blocks: A, B, C, D, E, {A, B}, {A, C}, {B, C}, {A, B, C}, {D, E}.

The second step is to identify for each row block their temporal cut, corresponding to a subset of columns of the DMM matrix, and to choose both a remuneration type and a selection mode (see Section 2). To do this, we rely on a list of drivers, namely: size of the scope, schedule criticality, risk of temporal interfaces, basic engineering uncertainty, construction uncertainty, scope uncertainty, and suppliers’ competition. Each one of them is represented by a qualitative scale. For instance, the uncertainty of the scope can have three values: small, average or high. The identification of possible contractual configuration reflects the experience of the company in upstream projects. Thus, as it is illustrated in Figure 4, the elementary alternatives are identified after having specified for each row blocks the evaluations on the drivers. We note that a cross (x) in the table means that the information is not required to propose an elementary alternative.

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Row blocks	Inputs - 1st Decision Tree				Inputs - 2nd Decision Tree						Final Elementary Alternatives
	BE Uncertainty	BE Competition	Exec. Phases Uncertainty	Exec. Phases Competition	Size of the Scope	Scope Uncertainty	Schedule Criticality	Risk Interfaces	Construction Uncertainty	Suppliers' Competition	Contractual Configuration
A	small	yes	x	x	small	Small	no	no	x	yes	Call for Tender EP+PC Lump Sum
B	small	yes	x	x	small	Small	no	no	x	yes	Call for Tender EP+PC Lump Sum
C	small	yes	x	x	small	Small	no	no	x	yes	Call for Tender EP+PC Lump Sum
D	Large	yes	no	yes	x	x	x	x	x	x	Design Competition EPC Reimbursable
E	Large	yes	no	yes	x	x	x	x	x	x	Design Competition EPC Reimbursable
{A, B}	small	yes	x	x	Medium	Small	no	no	x	yes	Call for Tender EP+PC Lump Sum
{A, C}	small	yes	x	x	Medium	Medium	no	no	x	yes	Call for Tender EP+PC Unit Rate
{B, C}	small	yes	x	x	Medium	Small	yes	no	x	yes	Call for Tender EPC Lump Sum
{A, B, C}	small	yes	x	x	Large	Medium	x	x	x	yes	Call for Tender EPC Unit Rate
{D,E}	Large	yes	no	yes	x	x	x	x	x	x	Design Competition EPC Reimbursable

Figure 4. Contractual configurations identification procedure applied on a fictitious example

Estimation of Elementary alternatives

In this step the performance of each resulting option is estimated. We propose to measure the performance of an alternative according to four criteria: the cost (for multi-billion projects, choosing a contractual strategy over another may save several million dollars), the schedule (delivering projects in time is a key performance index to a project, knowing that, the longer is the realization time, the greater are the cost expense and the sales loss), the cost vulnerability, and the schedule vulnerability (the occurrence of risks may induce some cost and schedule creep). An example of a performance table for a set of alternatives is presented in Figure 5. In this paper, we will not discuss how the estimations are obtained; we just note that it may include information, data and estimation provided from different sources and stakeholders of the decision process.

Elementary Alternatives	Cost Estimate	Schedule Estimate	Cost Vulnerability	Schedule Vulnerability
A -> CFT EP+PC LS	1000	40,0	2	3
B -> CFT EP+PC LS	400	17,0	1	1
C -> CFT EP+PC LS	700	31,0	1	2
{A, B} -> CFT EP+PC LS	1394	40,0	2	3
{A, C} -> CFT EP+PC UR	1689	41,0	3	3
{B, C} -> CFT EPC LS	1096	32,0	2	2
{A, B, C} -> CFT EPC UR	2097	41,5	3	3

1 Slightly Vulnerable

2 Moderately Vulnerable

3 Vulnerable

4 Very Vulnerable

Figure 5. Elementary Alternative estimation on a fictitious example

In a classical evaluation model, after the estimation phase, the performances are used to discriminate between the different options to keep the most relevant ones. In our context, such performances are used to evaluate larger alternatives. The idea is to try to not lose potentially interesting candidates for building on a latter phase relevant CS.

3.2 2nd level: identification, estimation and evaluation of Intermediary alternatives using DMMs and DSMs

The intermediary level stage consists of the same identification and estimation steps, plus an evaluation step (not detailed here).

Identification of Intermediary alternatives

Intermediary alternatives (IA) correspond to the combination of several elementary alternatives within a specific perimeter. This perimeter constitutes an area named "Intermediary breakdown", representing limited areas that do not overlap. For instance, in Figure 6, we have two intermediary breakdowns, IB₁ and IB₂. The first one includes objects A, B and C, and the second one includes objects D and E. Intuitively, one can see

that the overlapping is prevented by the fact that there is no possible assembly between two objects (Elementary objects D and C for instance).

Project Scope of Work		Basic Engineering (BE)	Detailed Engineering (DE)	Procurement (P)	Construction (C)	Transport & Installation (T&I)	Commissioning (Com)
Object 1	Elementary Object A	Intermediary Breakdown IB1					
	Elementary Object B						
Object 2	Elementary Object C						
	Elementary Object D						
Object 3	Elementary Object E	Intermediary Breakdown IB2					
	Elementary Object F						

Figure 6. Cutting the DMM of project scope into Intermediary breakdown

Moreover, within each intermediary breakdown IB_i , different alternatives $IA_{i,j}$ are identified: in IB_1 four IA are distinguished, and in IB_2 we have two IA (see Figure 7).

	IA1,1	IA1,2	IA1,3	IA1,4		IA2,1	IA2,2
A -> CFT E+P+C LS	1	1	0	0	D -> DC EPC R	1	0
B -> CFT E+P+C LS	1	0	1	0		E -> DC EPC R	1
C -> CFT E+P+C LS	1	0	0	1	[D, E] -> DC EPC R	0	1
[A, B] -> CFT EP+C LS	0	0	0	1			
[A, C] -> CFT EP+C UR	0	0	1	0			
[B, C] -> CFT EPC LS	0	1	0	0			
[A, B, C] -> CFT EPC UR	0	0	0	0			

Figure 7. Intermediary alternatives identification on a fictitious example

Estimation of Intermediary alternatives

In this step, IA are estimated, using elementary alternatives and interfaces estimates.

Estimation of Elementary alternatives interfaces. The interface risk can be translated into some additional cost and delay or even more vulnerability regarding the cost and the schedule. Thus, we propose to assess each couple of elementary alternatives of a given IA according to our four criteria. Figure 8 presents such estimations on our running example. We do not detail in this paper how these estimates are obtained.

Cost Interfaces	A ->	B ->	C ->	[A, B] ->	[A, C] ->	[B, C] ->	[A, B, C] ->
A -> CFT E+P+C LS		6	10				14
B -> CFT E+P+C LS			5		10		
C -> CFT E+P+C LS				12			
[A, B] -> CFT EP+C LS							
[A, C] -> CFT EP+C UR							
[B, C] -> CFT EPC LS							
[A, B, C] -> CFT EPC UR							

Sched Interfaces	A ->	B ->	C ->	[A, B] ->	[A, C] ->	[B, C] ->	[A, B, C] ->
A -> CFT E+P+C LS		0,5	0,75				1,25
B -> CFT E+P+C LS			0,5		0,75		
C -> CFT E+P+C LS				1			
[A, B] -> CFT EP+C LS							
[A, C] -> CFT EP+C UR							
[B, C] -> CFT EPC LS							
[A, B, C] -> CFT EPC UR							

Cost Vuln. Interf	A ->	B ->	C ->	[A, B] ->	[A, C] ->	[B, C] ->	[A, B, C] ->
A -> CFT E+P+C LS		2	2				3
B -> CFT E+P+C LS			1		2		
C -> CFT E+P+C LS				2			
[A, B] -> CFT EP+C LS							
[A, C] -> CFT EP+C UR							
[B, C] -> CFT EPC LS							
[A, B, C] -> CFT EPC UR							

Sched Vuln. Inter	A ->	B ->	C ->	[A, B] ->	[A, C] ->	[B, C] ->	[A, B, C] ->
A -> CFT E+P+C LS		3	3				3
B -> CFT E+P+C LS			2		3		
C -> CFT E+P+C LS				3			
[A, B] -> CFT EP+C LS							
[A, C] -> CFT EP+C UR							
[B, C] -> CFT EPC LS							
[A, B, C] -> CFT EPC UR							

Figure 8. Estimation of Elementary alternatives interfaces of IB1

Estimation of Intermediary alternatives. Aggregation functions have been defined for each of the 4 criteria. We use the sum for the cost, and the max for the other ones.

Evaluation of Intermediary alternatives

For intermediary alternatives evaluation, a multi-criteria sorting methodology is proposed, for which the alternatives are screened out depending on some parameters not

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described here. The step allows to keep a relevant set of IA, for each intermediary breakdown. These alternatives will serve to identify potential contractual strategies (CS).

3.3 3rd level: identification, estimation and evaluation of contractual strategy alternatives using DMMs and DSMs

The third level concerns the construction of CS alternatives, which corresponds to the combination of IA in order to cover the complete project scope. More precisely, to form a CS, one should select exactly one IA per intermediary breakdown while checking that the obtained set of IA is compatible with each other. It is explained in what follows.

Identification of Contractual Strategy alternatives

Elimination of incompatible Intermediary alternatives pairs. The selection of exactly one alternative per breakdown allows constituting a feasible CS. However, some IA may not be compatible. The incompatibility can be explained by the following reasons: a large number of interfaces to manage; a risk escalation due to risky interfaces; a too large scope given to a single contractor. The proposal is to use a DSM for each dimension where the evaluation can be: +1 for very compatible, 0 for feasible or -1 for incompatible (see Figure 9). With such a scale, the pair (IA_{1,4} ; IA_{2,2}) is excluded.

Number of Interfaces		IB ₁		IB ₂	
		IA _{1,2}	IA _{1,4}	IA _{2,1}	IA _{2,2}
IB ₁	IA _{1,2}			0	0
	IA _{1,4}			0	1
IB ₂	IA _{2,1}	0	0		
	IA _{2,2}	0	1		

Risks Interfaces		IB ₁		IB ₂	
		IA _{1,2}	IA _{1,4}	IA _{2,1}	IA _{2,2}
IB ₁	IA _{1,2}			0	1
	IA _{1,4}			0	1
IB ₂	IA _{2,1}	0	0		
	IA _{2,2}	1	1		

Large Scopes		IB ₁		IB ₂	
		IA _{1,2}	IA _{1,4}	IA _{2,1}	IA _{2,2}
IB ₁	IA _{1,2}			1	0
	IA _{1,4}			0	-1
IB ₂	IA _{2,1}	1	0		
	IA _{2,2}	0	-1		

> Elimination of the Couple (IA_{1,4} ; IA_{2,2})

Figure 9. Elimination of incompatible Intermediary alternatives couples

From this screening phase, three possible CS alternatives have been produced (see Figure 10) based on the combination of three pairs of compatible IA.

CS1		Life Cycle	
IB _{1,2}	A	CFT E+P+C LS	
	B	CFT EPC LS	
	C	DC EPC R	
IB _{2,1}	D	DC EPC R	
	E	DC EPC R	

CS2		Life Cycle	
IB _{1,4}	A	CFT EPC UR	
	B	CFT EPC UR	
	C	CFT EPC UR	
IB _{2,2}	D	DC EPC R	
	E	DC EPC R	

CS3		Life Cycle	
IB _{1,2}	A	CFT E+P+C LS	
	B	CFT EPC LS	
	C	CFT EPC LS	
IB _{2,2}	D	DC EPC R	
	E	DC EPC R	

Figure 10. Identification of Contractual Strategy alternatives on a fictitious example

Estimation of Contractual Strategies alternatives

The next step in the process is to estimate the CS alternatives, which is similar to the one used for IA. Inputs are the estimates of intermediary alternatives on the four criteria, and the DSMs corresponding to the estimation of interfaces between those IA.

Estimation of Intermediary alternatives interfaces. Similarly to the previous level, the interfaces between IA can generate extra cost, delays and vulnerability.

Estimation of contractual Strategies Alternatives. It is done using the same aggregation functions as for the 2nd level.

Evaluation of Contractual Strategy alternatives (not detailed here)

This last step intends to come up with a CS proposal. CS alternatives are first classified into categories, using MR Sort (Bouyssou and Marchant, 2007). Then, alternatives in the best category are ranked from the best to the worst, using S-RMP (Rolland, 2013).

4 Conclusions and Perspectives

This research work aims to provide a decision aiding process for selecting a contractual strategy in the oil and gas industry. The challenge is twofold: 1) there are a large number of possible low-level alternatives (contracts and contracts combinations) to form CS alternatives; and 2) the performance of CS alternatives depends on criteria from different scales and natures, which are difficult to compare and aggregate. This problem, to our knowledge, has not been treated in the literature. Thus, our aim was, on the one hand, to propose a structured methodology to face the difficulties encountered by the industry in the CS definition and selection process. This methodology proposes to identify low level alternatives from a set of drivers, to reduce the set of contracts possibilities, and then to split the scope into breakdowns to reduce the number of contracts combinations. The alternatives are then estimated and evaluated on the basis of the usual cost and schedule criteria, but also on their vulnerability due to risk occurrence. At the end, the most efficient CS can be proposed, allowing to optimize at best the quality of the structure of the future execution of the upstream development project. On the other hand, through our approach we have tried to bring some answers to some problems highlighted by the literature (see for instance (Ikhinmwin, 2004), namely: (i) the CS selection processes are too lengthy and perspective, (ii) the risk of selecting a suboptimal CS is very high, and (iii) the companies tends to prefer Lump sum contract. Indeed, (i) the designed decision aiding allows to target a set of drivers in order to efficiently converge to a relevant set of alternatives, (ii) the methodology aims to identify, estimate, and compare alternatives to come up with a justifiable contractual strategy proposal, and (iii) we recommend Lump sum contracts only in the case of low scope uncertainty (which is one of the identified drivers), as cost and schedule estimates are more accurate.

This work is also the opportunity to draw some perspectives. Indeed, oil and gas upstream projects are multidimensional and complex at different temporalities. Other dimensions can be dealt with similar scientific approaches, either before CS selection (selection of a technical object while defining architecture, or definition of local content actions), or afterwards (selection of contractors once the CS is designed). Later, it would be interesting to construct a generic tool allowing interaction between all dimensions, to see the impact of decisions taken in one dimension on others, and appreciate the consequences on the whole process.

5 References

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- Aboushiwa, M.A., Bower, D., 2000. Exploring Promoter Briefing on the Procurement and Selection of Contract Strategy Offering the Best Value for Money. University of Manchester (UMIST), Ph. D. Thesis.
- Beer, S., 1959. What has cybernetics to do with operational research? *Operational Research Quarterly*, 10 (1), pp. 1-21.
- Bouyssou, D., Marchant, T., 2007. An axiomatic approach to non compensatory sorting methods in MCDM, II: More than two categories. *European Journal of Operational Research*, 178(1), pp. 246–276.
- Browning, T.R., Fricke E., Negele H., 2006. Key concepts in modeling product development processes. *Systems Engineering*, 9(2), pp. 104-128.
- Chen, L., Ding, Z., Li, S., 2005. A Formal Two-Phase Method for Decomposition of Complex Design Problems. *Journal of Mechanical Design*, 127(2), pp. 184-195.
- Danilovic, M., Browning, T.A., 2004. Formal approach for domain mapping matrices (DMM) to complement design structuring matrices (DSM). In: *Proceedings of the 6th international design structure matrix(DSM) workshop* - Cambridge, UK.
- Danilovic, M., 2006. Bring your supplier into your project- Managing the design of work packages in product development. *Journal of Purchasing and Supply Management*, 12(5), pp. 246 - 257.
- Danilovic, M., Browning, T.R., 2007. Managing complex product development projects with Design Structure Matrices and Domain Mapping Matrices. *International Journal of Project Management*, 25(3), pp. 300 – 314.
- Dhanushkodi, U., 2012. Contract Strategy for Construction Projects. Dissertation for MSc degree in Construction Project Management, Faculty of Engineering and Physical Sciences, University of Manchester.
- Easterbrook, S., 1991. Handling conflict between domain descriptions with computer-supported negotiation. *Knowledge Acquisition*, 3(3), pp. 255-289.
- Elbeltagi, E., 2009. *Lecture Notes On Construction Project Management*, Chapter 2: Contract Strategy, pp. 19-41, Mansoura University, Egypt.
- Eppinger, S.D., Browning, T.R., 2012. *Design Structure Matrix Methods and Applications*, MIT Press, Cambridge.
- Grice, M., Kimball, N., Sangal N., 2014. Applying the Lessons of Matrix Representation to Box Diagrams. 16th International DSM conference: Risk and Change management in complex systems, pp. 3-12.
- Haughan, G.T., 2002. *Effective Work Breakdown Structure*. Management concepts, Vienna, Virginia.
- Ikhinmwin, C.I., 2014. Structured contract strategies for capital and operations expenditure projects in the oil and gas industry (Doctoral dissertation, Queensland University of Technology).
- Olsen, B.E., Haughland, S.A., Karlsen, E., Husey, G.J., 2005. Governance of Complex Procurements in the Oil and Gas Industry. *Journal of Purchasing and Supply Management*, 11(1), pp. 1 - 13.
- Perry, J.G., 1985. The development of contract strategies for construction projects. University of Manchester, Institute of Science and Technology, Ph.D. Thesis.
- Smith, N.J., 1995. *Engineering Project Management*. Blackwell.
- Steward, D.V., 2013. The Design Structure System: a Method for Managing the Design of Complex System. *IEEE Transactions on Engineering Management*, 28(3), pp.71-74.
- Rolland, A., 2013. Reference-based preferences aggregation procedures in multi-criteria decision making. *European Journal of Operational Research*, 225(3), pp. 479-486.
- Tsoukiàs, A., 2008. From decision theory to decision aiding methodology. *European Journal of Operational Research*, 187(1), pp. 138–161.
- Vesay, A.C., 1991. *A Project Delivery Selection System*. Pennsylvania State University, Department of Architectural Engineering, Technical Report No. 26.