Project Supply Chain Management

From Agile to Lean

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by

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‘The fact that Alexander [the Great] so capably directed [the warfare’s] operation that logistics scarcely seems to have affected any of his strategic decisions. ... Supply was indeed the basis of Alexander’s strategy’.

‘Alexander where able to overcome these [logistics] obstacles where other armies had failed because of his superior abilities in gathering intelligence, planning, preparation, and organisation’

(Engels 1978, pp.119 & 123).

Preface

This thesis marks the end of a long research journey, with as in most projects, many unforeseen elements that have impacted and changed the approach of the research. Now at the end it is though fruitful to look back and acknowledge the process, as well as all support and help from colleagues and friends, without which this research would never have been possible.

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I would also like to thank all the people working in or related to the oil and gas supply chain that I have had contact with through this research, no name mentioned and no one forgotten. They have shared much knowledge and given me insight into an interesting and challenging context. Thank you.

Finally, many thanks goes to you Grete, for your support and understanding during this period.

Trondheim, November, 2002.

Bjørn Egil Asbjørnslett

Summary

Background

More than forty years has passed since the start of the North Sea oil and gas developments. On the managerial side of the projects there have been large cost overruns, project planning and control measures developed to avoid these, initiatives to improve the industry's competitiveness in the North Sea, as well as measures to improve the supply chains contribution in the projects. We have seen a focus first and foremost on the CAPEX side of the projects, which still is the public measure of a 'project's' success as seen in medias coverage. However, the operation side of the project has been given extended focus, especially through life-cycle cost measures, and life cycle value measures trying to balance out the CAPEX, OPEX and income sides of the project to obtain the most commercial value enhancement from each project. At the same time there has been an increasing focus on the core business among the project demand and supply chain actors in this industry as in most other industries.

Our belief is that this necessitates an enhanced focus on the project demand and supply chains of the industry, both for the projects development and operations phases. A question is whether the project demand and supply chain developments are approached appropriately according to the characteristics of the industry's project context?

Research topic

This research commenced with an initial assignment of '*looking into logistics and logistics management in the project context and as part of project management'*. The project context addressed here is that of the oil and gas industry, i.e. the development and operation of an object where the production by that object generate income for the owner(s) of the oil and gas reserves, while taking part in development and operations of the object generate business for the supply chain actors.

The focus on logistics and supply chain management in most industries is as means for improving the competitiveness of the industry or companies. This is the same for the oil and gas industry. Therefore, an approach to supply chain management in the project context of the oil and gas industry should aim to address logistics' contribution to industrial competitiveness in the oil and gas industry.

The objective of this thesis is to bring a contribution to the project management of large-scale development and operation projects from concepts and thoughts within logistics and supply chain management. The objective is to develop and outline supply chain management within the project-oriented context as a particular and conscious knowledge area of project management. Through developing a concept that approaches projects and project management from a logistics and supply chain management perspective, and through outlining what is important/specific for logistics and supply chain management within the project context. The objective is as such related to developing conceptual and methodological frameworks that may be used as basis for specific developments and application in specific industrial and project-oriented

contexts. The objective is as such not to develop and give specific solutions to specific problems.

Perspective for addressing the research topic

The *added value* of logistics and supply chain management in general is found within the logistical mission elements, namely the supply chain cost and service position achieved through the 'best' alignment of supply and demand. Then to approach logistics and supply chain management within the project context, we have three conditions that our perspective rests on;

- The *project* as the *business opportunity*.
- The *supply chain* as the *competitive entity*.
- *Competitiveness through logistics and supply chain management*, focused on alignment of supply and demand.

The project is regarded as a business opportunity, where each actor will make business out of it and gain from participating in it. It is also assumed that a project will not be realised if it is not possible to make business out of it, i.e. it is not a realisable business opportunity. Though, technology, competence, capability and capacity of the supply chain actors organised into the specific project supply chain construction, is what may make the project available to realise as a business opportunity. Therefore the project supply chain may be regarded as the competitive entity. Competitiveness or value enhancement for the project, through the supply chain is assumed to be achieved through logistics and supply chain management, specifically through the logistics aim of alignment of supply and demand.

Scientific approach

The approach taken in this research follows Arbnor and Bjerke's (1997) *system approach*. They say that the systems approach is related to *determining the type* of a system, by characterising and categorising the object under study, in our case the 'system type' of logistics and supply chain management in the project context of the oil and gas industry;

Following Arbnor et al.'s definition of the systems approach our aim of this study is;

√ *To determine* the type of the system (from a logistics point of view)

√ *To describe* the system (from a logistics point of view)

√ *To guide* in approaching how we see the system (from a logistics point of view).

The scientific approach to this research is based on theoretical studies and open sources of information, interviews with representatives from the industry, and participation in meetings and workshops related to the research topic.

Theoretical platform

Our theoretical platform is based on theory from the domains of project management, logistics and supply chain management, manufacturing theory, and theory related to vulnerability and robustness.

From the project management theory we have focused on the aspects of the project, such as the project context, the differing characteristics of the project life cycle, and the element of uncertainty in projects. Further the theoretical focus has been on the choices that has to be made in the project processes of determining 'what to do', i.e. the scope of work of the project, and 'how to do it', i.e. the projects development and execution model, and how these set different alternatives for approaching a project. We explore three different strategies for undertaking a project development, as well as establish a project atlas that may be used to explain and understand the choices of developing a project along different routes from front-end to operations.

From logistics and supply chain management theory we focus on the difference between supply chain management and demand chain management, as two similar concepts, but with strong resemblance with the two main phases, development and operations, of the project life cycle. Uncertainty is addressed related to the processes of demand and supply, and with the concepts of resilience and robustness to address the service aspect of the supply chains. From manufacturing theory we borrow the concepts of lean and agile, to address what should guide organisational processes in the different phases of the project life cycle.

Within logistics and supply chain management most of the conducted research and development have focused on repetitive and continuous types of industries and businesses. There is a difference between the repetitive context and the project context with respect to logistics and supply chain management. Through a literature review of earlier approaches to logistics in different project contexts, we found no one that addressed how the logistics and supply chain management concepts apply to the different needs of large-scale development projects throughout the project phases, development and operations, and the differing characteristics of these two phases, the one-of-a-kind development phase, and the repetitive operations phase.

Main findings and conclusions

Technology development is regarded as the most contributing factor for further improvements in the Norwegian oil and gas industry. With respect to demand and supply chain management in this project context a question is how new technology or technology developments shall be taken into new project developments? The old principle was that technology development was conducted as part of the project development, while the contemporary principle is that technology development shall be conducted between project, and be ready to use for new project developments.

The challenge of the oil and gas supply chain in this setting is two-fold. First it is the ability to be able to support and take advantage of innovations and technological development that may keep up the competitiveness of the oil and gas region. The other is related to managing risk and thereby keeping the most 'optimal' execution time. Both are aimed at competitiveness, and were among the focus areas for the NORSOK initiative. Competitiveness has to be achieved through inter-organisational capabilities and capacities, where the project specific demand and supply chains has to be competitive both in enabling use of innovative technologies, and without extending the development time, and this should be made manageable in a planned and controlled way. This is given in the table below.

Challenge	Description
Innovations and technology development **[Cost and income impact on value]**	Being able to develop relationships in the industry demand/supply chains that enables and sustains the initiation and use of innovations and technology development.
Project development execution time **[Time impact on value]**	Being able to establish extended project organisations that are able to execute the project development in a 'correct' scheduled time, and in a controlled manner.

Pre-NORSOK, technology development came to a large extent through a broad base of small and medium sized enterprises, SME's, working tightly to the technological problem core and the operator. This could be regarded as a 'rich' supply chain approach. In the same era the approach was to have the project demand, i.e. scope of work, specified in detail before the supply chain was committed to the project. We have called this stage two of the development history of the Norwegian petroleum industry.

Then, with NORSOK came the third stage of the development of the Norwegian petroleum industry. It was a need for improved competitiveness, through reduced project development CAPEX and execution time. Some of the answers to this challenge was a reduced number suppliers, i.e. a lean supply chain approach, with more responsibility for project object development placed with contractors, and committing the supply chain earlier into the project, at a time when the project is less defined.

In other words, we may say that in stage two the focus was on closing the project through strict project planning and control means, especially before committing the supply chain, but having a multitude of potential supply chains (and thereby technology) to develop from. Then in stage three we may say that the project is opened up, especially to the contribution of the supply chain and even when committing the supply chain, but the portfolio of supply chains to develop from is reduced due to lean supply developments. This benefited the execution time, but at the sacrifice of the (potential) opportunity value of alternative technology. In summary we may say that;

Stage 2; Approach a **closed project**, with a **rich (open) supply chain**.

Stage 3; Approach an **open project**, with a **lean (closed) supply chain**.

The consequence may be that when opening up the demand processes, concurrently with applying lean supply, as in stage three, one may see that technology development in is danger of being lost, with its potential value enhancement contribution. At the same time the concurrent execution process, with a lean supply chain seeks to manage the time element of the value enhancement process in a controlled manner. However, if project value enhancement from both technology (cost and income), as well as time shall become an opportunity, then one may seek to combine the approaches of stage two and three. Combining the steps from stage two and three could e.g. for a stage four mean to;

Stage 4: Approach an **open project**, with a **rich (open) supply chain**.

Approach a **closed project** with a **lean (closed) supply chain**.

This means that new project planning and control concepts and means should be established that enables to up-keep and manage the option of a rich and open supply chain for an open project setting, though still keeping manageable control of the time processes of the project development and execution. We have called this opportunity seeking and value enhancing project strategies.

To develop a demand and supply chain management concept for this challenge we have focused on the characteristics of five aspects of the two main project phases. The project context focused on here is primarily characterised by being a unique business opportunity, with two distinct phases, development and operation, that again are unique with respect to the characteristics that describe the supply chains and processes. The first characteristic is the project life cycle, stating the importance of being aware of the *differences in characteristics* between the two phases, development and operations. The second characteristic is the supply chain focus, driven by the *targeted, one-of-a-kind* demand/supply in the development phase, versus the *repetitive* demand/supply in the operations phase. Then the third characteristic is the logistics drivers, or whether the main driver of the supply chains should be *demand or supply* in the development phase versus the operations phase respectively. Then come the organisational processes, characterised by *agile* characteristics in the development phase and *lean* characteristics in the operations phase. The final characteristic is then related to the service quality, an important logistics mission, focusing on *resilience* in the development phase and *robustness* in the operations phase. These are presented in the table below.

Aspect	**Characteristics**	
1. The project life cycle	Development	Operations
2. The supply chain focus	One-of-a-kind	Repetitive
3. Logistics drivers	Demand chain management	Supply chain management
4. Organisational processes	Agile	Lean
5. Service quality	Resilient	Robust

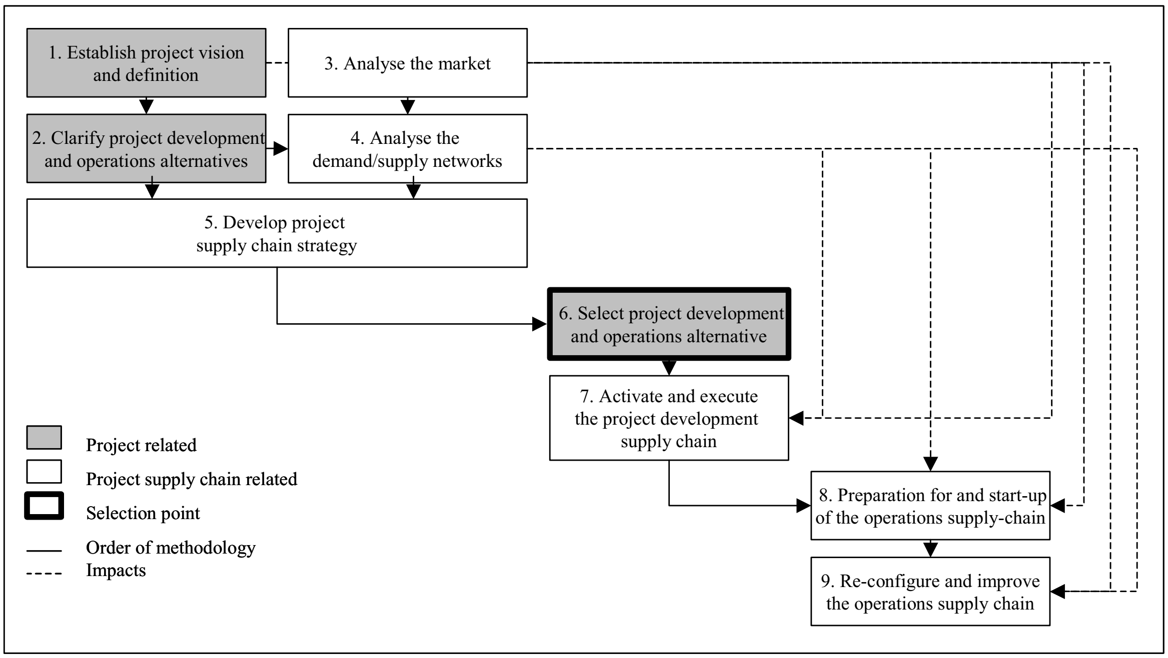
The development phase is a phase were the project and the project object is to be developed, i.e. the aim is to define and specify the *demand* that in sum through the fabrication and construction activities will become the project object. Therefore we have chosen to emphasise *demand chain management* specifically for the development phase. We have used the term *agile* to point to the importance of seeking and evaluating opportunities that could bring value enhancement to the project. The project development context is also defined by a high degree of uncertainty so that opportunities as well as risks will emerge, necessitating an *agile* approach either explicitly or implicitly. The term *resilient* is also used to reflect the uncertainty in the development phase, and when uncertainty mature, the demand/supply chains has to be able to ‘get back on track’, i.e. be resilient, to aim for the final objective.

The terms *supply, lean,* and *robust* is what we mean should characterise the operations phase of the project life cycle. The operations context is one of repetitiveness, keeping focus on the supply so that the whole ‘machinery’ goes like ‘clockwork’. This is the ultimate basis for *lean* thinking where not only the potential for waste reduction could be discovered through incremental rounds of continuous improvement, but also making the whole supply operations more *robust* through revealing elements that could be a risk factor. We have used the term *supply* specifically for the operations phase because it is a repetitive supply operation. The demand is already defined and the supply chains should be *robust* so that they do not contribute to disturbing the production. The term robust is used specifically to indicate that although the supply chains should be lean, that should never compromise their service quality, because a stop in the revenue generation of the production by the project object in most cases far outweighs the incremental supply cost.

We then have a demand and supply chain management concept that ‘obey’ the logistics objectives of alignment of supply and demand. That takes account of the specialities of the project context’s development and operations phases, and is aimed at value enhancement for the project as a business opportunity realised through the project supply chain as a competitive entity throughout the lifecycle of the project. That is the concept of project supply chain management, PSCM, presented in the table below.

Principles	**Characteristics**	
The *project* as the *business opportunity*	Development	Operations
The *supply chain* as the *competitive entity*	One-of-a-kind	Repetitive
Competitiveness through logistics and supply chain management, focused on alignment of supply and demand in the project context	Demand chain management	Supply Chain Management
	Agile	Lean
	Resilient	Robust

To support the PSCM concept we have developed methodological guidelines for project supply chain management as we have approached it. The intention with the guidelines is that they shall be a guide to address the questions that is important with respect to the context and the characteristics of the demand and supply chains that are approached, as well as the mission of those demand and supply chains. When approaching project-oriented demand and supply chains one have to take both the specific context of the project as well as the supply chain approach into account. The PSCM guidelines are based on nine steps that follow the project from initiation to revision of the operations supply chain, as presented in the table below.



The PSCM concept and methodological guidelines has been developed to meet challenges of the project demand and supply chain context, as described by industrial actors. However, we have in this research not been able to apply and demonstrate neither the concept nor the guidelines in relation to real cases. This is a drawback of this research, and has to be left for further studies.

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1. Introduction

1.1 Historical background

The oil and gas industry in the North Sea has a history that stretches about forty years back. When it commenced, tremendous technical, organisational and managerial challenges lay in front to be able to undertake the development and exploitation of the hydrocarbon reserves that were located below the seabed. However, although there were tremendous challenges and risks involved, the financial opportunities were very large[1]. The 'price' or CAPEX[2] cost, of developing and installing the first offshore facilities were regarded as 'enormous' and the cost estimates had to be increased several times, leading to considerable budget overruns. Though, the oil price was so high that the payment period needed to pay off the CAPEX costs was short.

1.1.1 Forty years of development in the North Sea.

Hetland (1999) [3] has made a reflection over the developments within project execution and project management practice that has developed since the first North Sea offshore oil and gas developments began and such projects emerged. Table 1 gives a summary of these developments.

In Table 1 there are three events that should be given further attention. The first event is the Moe report[4] (Moe, 1980) that among others concluded that the cost control of the first generation offshore development projects had come out of control. The result was that project planning and control was tightened up, leaving 'closed' projects where every party in the project knows what to do and how to do it, as they are told in detail. This development is by Hetland (1999) referred to as the start of using strategies focusing to gain control over and manage tightly all risks, so that the project meets its cost and schedule targets, without addressing whether these targets have room for improvement. The type of risk reducing strategies as were developed in this stage of the project management development is still active today, and contribute constructively in their kind of project context.

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[1] For an interesting description of the early phases of the development of the Norwegian oil and gas industry see Stinchcombe *et al*. (1985).

[2] CAPEX = Capital expenditure, the investment cost for developing the facilities.

[3] The content in this sub-chapter is a short summary of some reflections made by Dr. Per Willy Hetland (Hetland 1999) on the historical development with respect to project and contract management developments that has been seen throughout forty years of oil and gas developments in the North Sea.

[4] The Moe Report = 'Kostnadsanalysen norsk kontinentalsokkel' (Moe, 1980).

Table 1.1. Project management challenges and practices – North Sea capital projects.

STAGE 1		1965 – 80
Major challenge:		Keep CAPEX escalation under control
Results:		Major cost overruns in Norway and in the UK
THE MOE REPORT		1980
Conclusions:		176% cost overrun (average 1st generation projects).
Recommendations:		Detailed definitions, tight change control.
STAGE 2		1975 – 90
Major challenge:		Making the recommendations in the Moe report work.
Initiatives,	Shell:	CTR-catalogues (tell contractor what to do).
	Conoco:	FEL, Front End Loading.
	Mobil:	Incentives (contractor control his own costs).
Results:		Generally good.
STAGE 3		1990 – 2000
Major challenge:		Reduce costs by 40%
Initiatives,	UK:	CRINE.
	Norway:	NORSOK.
Results,	UK:	Generally good, some disappointing.
	Norway:	Some good, generally disappointing.
THE KAASEN REPORT		1999
Conclusion:		27% cost overrun (average of 13 projects).
Recommendations:		'Continue the NORSOK process'.
STAGE 4		2000 -
Major challenge:		Keep life-cycle cost reductions under control.
		Enhanced life-cycle value through the project supply chain.
Initiatives,	UK:	Crine Network -> Logic[5].
	Norway:	Kon-Kraft[6].

[5] Logic – Leading Oil and Gas Companies Competitiveness (www.logic-oil.com).
[6] Kon-Kraft – www.olf.no/konkraft/.

The second event is what in Hetland's outline is referred to as stage 3. In the early nineties the oil and gas industry was in a downturn with few development projects in the pipeline. The whole industry was on low speed, and the main question was about the *competitiveness* of the North Sea continental shelves. To address and improve this situation and the competitiveness of the oil and gas industries based around the North Sea some national initiatives were established. First the British CRINE initiative was formed, then the Norwegian NORSOK initiative (www.nts.no/norsok/). Both were cross-industry initiatives, aimed at improving the industry competitiveness to bring the continental shelves to a competitive level, and this is reflected in the initiatives names, 'Cost Reduction Initiative for the New Era' or CRINE, and 'norsk sokkels konkurranseposisjon' ('the competitive standing of the Norwegian continental shelf') or NORSOK.

Both the CRINE and the NORSOK initiatives set tough ambitions for their achievements to come. They were both going to achieve substantial reductions both in CAPEX cost expenditure and in project execution time. Improvement targets were high, on the British side they were not made 'tangible', as the improvements were said to be substantial, while on the Norwegian side it was 'promised' improvements in the range of 40-50%.

'The main target for NORSOK was to achieve improvements in work processes and external conditions that would make the Norwegian Continental Shelf competitive compared to other petroleum producing countries. Two important sub-goals were especially emphasized;

- √ A reduction in time and cost consumption with 40-50% within the end of 1998, compared with best practice in 1993.
- √ Maintain the leading position in health, environment and safety work.

[Seven topics with work groups] were established to achieve these targets. [The seven topics were] cost analysis and target figures, standardisation, the relationship between operator and supplier, documentation and information technology, base- and logistics, HES, and external conditions' (Kaasen 1999, p.20).

In table 1.2 we have listed some important changes that the NORSOK process lead to, as presented by Kaasen (1999, pp.20-22), changes that have direct effect on the project supply chain.

Table 1.2. Some of the main changes resulting from the NORSOK process.

Structures and roles	A new project execution model where the operators to a larger extent procure complete products, and that these products increasingly are openly described based on functional requirements for function and performance. This means that the contractor to a larger extent must take the full responsibility for engineering and execution of a larger part of the development. As the contractor in this model has taken over tasks and responsibilities prior handled by the operator, this has lead to a real demand for adjustment and learning in the project supply chain, e.g. project planning and control, detailed design, and interface control.

New project execution model/shorter development time	The old, sequential execution model is replaced with a more concurrent model, including the main phases of the development, reservoir planning, design and construction of the production facilities, drilling, and the overall decision process. The project supply chain is also involved earlier in this model. This has the effect that the supply chain may contribute with its knowledge and competence early on, but also that it is activated at a stage where the definition of the project is still in an early phase, which may give rise to challenges with respect to contractual relations.
Diversity in co-operative relations	The requirement for shorter development times and a new execution model has developed co-operative relations in two dimensions. One focus on more long term engagement between contractor and suppliers, this is often seen in the increase in frame contracts and agreements. The other focus on more committed engagement in customer and supplier relationships, e.g. through integrated execution (e.g. operator/ contractor/ supplier integrated teams), alliances, or joint ventures. The development of committed engagement needs forms of contractual incentives, and further development of contractual models. The use of frame contracts and agreements is intended to make ordering of standard components more cost effective over several project, as well as standardisation and cost efficiency in operations.
New risk-picture for contractor	The new structures and roles of the contractor, together with the new execution model have collectively made up a new risk-picture for the contractor. Although the contractor has increased his risk exposure, the operator still owns the ultimate risk, and as such the risk management should be a joint effort from both stakeholders.
NORSOK standards	A common set of industry standards were developed and used (to a varying degree, often with operator specific additions). The NORSOK standards replaces (to a certain degree) the operator specific standards, with a set of common standards. The specifications in the NORSOK standards are functional for some areas, and detailed for others. The focus on Norwegion, i.e. NORSOK, standards, is an element that has been ‘criticized’ by the British industry, as they don’t see the benefit of having national industry standards in an international industry, when there are international standards available.[7]
Legislation	A change made in the legislation through the Petroleum Law is that the licensee may enter into substantial contractual obligations or start fabrication or construction before approval of PDO. The contractual obligations are entered into at the licensee’s own risk. This has made possible shorter development time, and has become a much applied practice. A possible drawback on this is that contractual obligations are made on a weak engineering (demand) basis, leading to changes and cost escalation.

[7] Comment given in interview with Olav Andenæs, after a meeting with British CRINE representatives.

When the results started to emerge one saw that improvements had been made, but were the improvements as good as expected? On the British side they saw results that was better than what had been achieved in earlier, comparable projects, while on the Norwegian side one saw that improvements had been made, but not in the scale, at least with respect to costs, as was 'promised'. For many within the oil and gas industry, both on the operator and contractor side the results of the CRINE and Norsok initiatives were *perceived to be*; on the British side; '*generally good, but some disappointing*', and on the Norwegian side; '*some good, but generally disappointing*'[8]. This could of course be a source of different opinion, but should rather be perceived as the importance in understanding between setting quantitative benchmarks versus the process to achieve radical changes. The difference in 'benchmarks' used to reach these conclusions, were on the British side that they were going to achieve substantial improvements compared to earlier development projects, while on the Norwegian side that they were going to achieve tangible improvements in the range of 40-50%.

In the Norwegian Public Study 1999:11 (Kaasen, 1999), they give the following summarising comment with respect to the results of the NORSOK process, versus the CRINE process (translated by the author);

'Based on the comparisons made between the two periods [projects developed pre or post 1994] regarding costs and development time, we see a **considerable improvement**. The improvements have though not been of the magnitude that was estimated as NORSOK's targets of 40-50% reduction in time and costs spent, but the improvement must though be said to be **substantial**. Comparisons with British projects and the latest cost estimates for projects on the Norwegian Continental Shelf, indicates that a major share of the cost increases is a result of too ambitious targets, rather than of bad project execution. Maybe was even the ambitious targets a mean for reaching the improvements seen. … The British project are on the same level both cost and schedule wise as the Norwegian projects of the same period' (Kaasen 1999, pp.81-2).

The second event lead to the third event, which is related to the Norwegian industry. The third event came in February 1999 when a committee appointed by the Norwegian Ministry of Oil and Energy published a report regarding cost overruns in projects executed in the 1990's on the Norwegian continental shelf (Kaasen 1999). The report states that on average 13 later development projects related to the Norwegian continental shelf had a cost overrun of 27%. The budgeted basis that the cost overrun was calculated from was the figures stated in the government approved plan for Development and Operation, PDO, which had discounted the 40%-50% cost improvements 'promised' through the Norsok initiative. However, the report concludes also that;

'Although the study, according to its mandate, has concentrated to shed light on and consider the cost overruns for the projects approved in the period 1994-98, it is reason to remind that;

√ The figures analysed show that the 13 projects have on the whole had a significant cost reduction [costs per production capacity or per weight unit] and reduced development time compared to pre 1994 projects.

[8] This was summarised by Per Willy Hetland at a workshop by the 'European institute of advanced project and contract management', after a long discussion between representatives from the industry both on the British and Norwegian side.

√ It is indication that the results achieved on the Norwegian Continental Shelf is comparable with the results achieved on the British Continental Shelf in the same period.

The results are achieved by that the actors in the industry together set ambitious targets with respect to cost and development time. New solutions for development were being used as well as new means and incentives in execution. The targets gave the incentives for renewal that were necessary to achieve substantial improvement' (Kaasen 1999, p.94).

Some of the reasons for the cost overruns [final cost control estimate versus budgeted (PDO) CAPEX] as well as further areas for improvements listed in the study (Kaasen 1999) are given in table 1.3.

Table 1.3. Main areas for further improvements post-NORSOK.

Five main areas to be focused	**Sub-elements**
Attitude and cooperation	Basic change in attitude; Greater openness, less positioning. The stakeholders should collaborate about contractual risk management.
Better quality early	The projects should be developed so far that development elements may be estimated with sufficient degree of safety before PDO approval. The estimates should be based on a more thorough evaluation of remaining risk elements. Estimation of drilling and completion must be given a more secure basis. Efforts should be made to visualize and deal with strains regarding HES.
Decision processes in development projects	It should be clarified which formal and real function the PDO[9] shall have in the decision process. The committee recommends that the criteria for revision of the PDO is clarified.
Support further improvements	Establish a basic fundament for continuous improvements. Further develop work processes and competence based on learning from executed development projects. Challenge established practices. Invest in development of competitive solutions.
Level of activity	The stakeholders should pay greater attention to the consequences that start up of new development project will have for the level of activity in the industry.

[9] PDO = Plan for Development and Operations.

The focus is aimed at continuing and refining the processes started with the Norsok initiatives, i.e. focusing on continuous improvements. To answer these challenges a ‘revised’ Norwegian initiative has been established named ‘Kon-Kraft’. Kon-Kraft (www.olf.no/konkraft) involves companies from the whole range of the Norwegian oil and gas industry value chain. There are four main initiatives (sub-projects) in Kon-Kraft; (i) how to involve the [supply] industry earlier in the project development life-cycle, (ii) industry collaboration on the Norwegian continental shelf, (iii) internationalisation through foreign companies present on the Norwegian continental shelf, and (iv) collaboration in the value chain. In the UK the government supported work of the CRINE Network has been brought over to the industry funded organisation LOGIC (www.logic-oil.com), ‘that will work with companies throughout the industry to stimulate collaboration and radically improve competitiveness’. The main initiatives of LOGIC are related to collaboration about wells and drilling, supply chain management and e-Business.

As both the Kon-Kraft and LOGIC initiatives address the challenges for the future, they comprise among others how to best utilise and benefit from the supply chain actors and processes throughout the life-cycle of the project object.

1.1.2 Development, operations and the supply chain focus

To develop and operate the offshore facilities that exploit the hydrocarbon resources from the continental shelf and processes them for further distribution, the owner(s) of the facilities, represented by the petroleum company acting as Operator, have to procure external resources, competence and services. The ‘chain’ of companies that is necessary to bring forward the goods and services required may be referred to as a *supply chain*. The supply chain processes and interaction among the supply chain actors was raised as issues both in the Norsok Collaboration Panel (NORSOK, 1998) and in the Kaasen report (Kaasen, 1999). Both addressed that this was an issue that should be given increased emphasis.

A supply chain is needed both for the development of the facilities as well as keeping the facilities in operation. The costs of developing and operating the facilities are to a large extent procured costs, i.e. costs inherent in the supply chains. The costs materialised through the development supply chain are referred to as capital expenditures, CAPEX, while the costs of the operations supply chain may be referred to as operational expenditures, OPEX. The *development* and *operations* supply chains may be used to refer to a two-parted supply chain scheme for the project object. The two-parted supply chain scheme reflects that one supply chain is needed for the project object development, while another supply chain is needed for the operations of the project object, as outlined in figure 1.

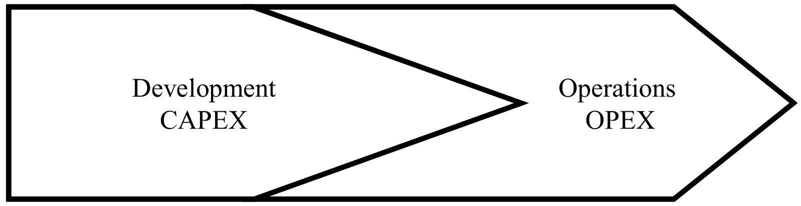

Figure 1.1. A two-parted CAPEX and OPEX supply chain perspective.

A two-parted approach to the supply chain for the project context as presented in Figure 1.1 may be related to the developments in *business focus* that has emerged in project and contract management. In figure 1.2 a four-staged approach is outlined. The development in business focus has commenced from a single focus on the investment cost of developing the project object. Then the operation costs came into focus through life-cycle cost approaches. Though, it was not possible to fully leave out the development cost focus under the cover of improved life-cycle cost, and to get a balance between CAPEX and OPEX focus life cycle value approaches came forward. With strong fluctuations in oil prices, and a capital market with many alternative opportunities to invest, the oil and gas industry now has to focus on business competitiveness with the supply chain as one mean to extract value as a competitive entity.

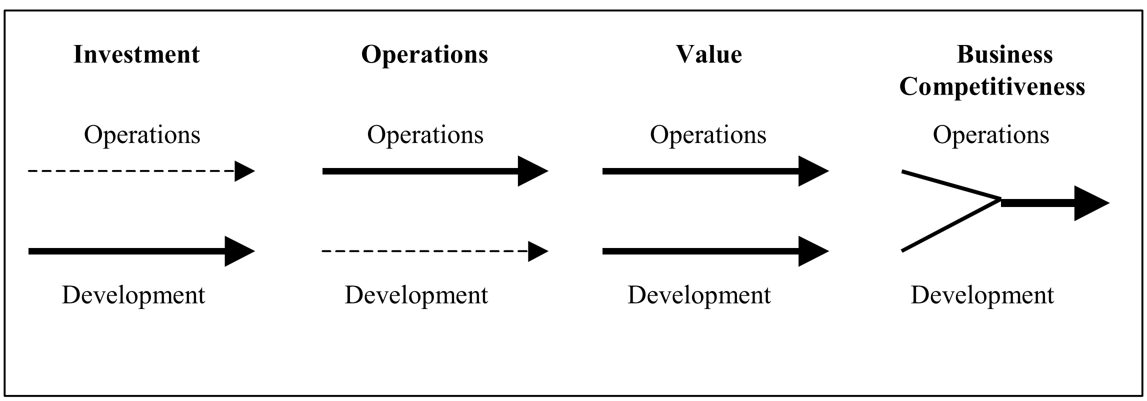

Figure 1.2. The developments in business focus from investment to business competitiveness.

Investment

The first or initial business focus is the investment of developing the facilities. With the investment of developing the facilities as the business focus it is the investment 'price' of realising the project object that is in focus. As shown in Figure 2 it is the investment 'cost position' of the development supply chain that is in focus, the operations supply chain is not regarded as a business related issue. We have tried to emphasise this through highlighting the development supply chain (thick), while de-emphasising the operations supply chain (dotted). The business focus is related to realising a facility that meets the requirements at a best (lowest) possible CAPEX, within the given time limits, through a prescriptive and controlled process. This may be related to stage 2 in Table 1. The message in stage 2 was that the price had been escalating, and had to be brought under control.

Operations

The second type of business focus is ‘operations’, or the life cycle cost of developing and operating the project object. In a life-cycle perspective both the development and operations costs throughout the life-cycle of the object shall be taken into consideration. Though, in such a perspective there may be easy to shift focus to more or less exclusively addressing operations aspects and costs, and emphasising the operations chain and even use this as an ‘excuse’ to cover escalations in CAPEX. This is illustrated through the dotted line of the development supply chain and the thick line of the operations supply chain in Figure 2.

Value

The third business focus put equal emphasis on both the development supply chain as well as the supply chain for operations. The business focus has moved towards ‘life cycle value’, addressing the supply chains for the two phases equally. The perspective is still that of the operator, in that what is addressed is life-cycle value for the operator of the project over the life-time of the project object, i.e the net present value of the project. The emphasis for the operator is strong both with respect to the development supply chain, and the operations supply chain. The actors in the supply chains of the two phases are still ‘separated’. The value oriented business type, focusing on value enhancement, sets the project as the *business opportunity*, from which value should be enhanced for the owners of the business opportunity.

Business competitiveness

The last business type reflects the aspect of competitiveness. This type extends that of the value focus presented above, and moves on to focus on the chain of actors that creates value and consumes cost and time. As such this business type reflects that the supply chains for development and operations should merge. This means that the upper-tier supply chain actors in the development phase ‘convert’ to become actors in the operations supply chain, and that this conversion is intended and planned already from the initiation of the project and reflected in the approach to project organisation, execution and incentive mechanisms. Given such a perspective the contractors and suppliers become part in not only developing the project object, but also in operating it, and gaining remuneration based on the production by the project object. The business focus has now become a ‘*business opportunity*’ not only for the operator, but also for the supply chain actors. The underlying concept is that of competitiveness, with the project and the facilities, or the project object, as the business opportunity or entity, and with the supply chain(s) for development and operations as the *‘competitive entity*’.

The four stages outlined above may now be brought together. From an approach to business focus limited to focus on the initial investment in the product that is used to exploit and process the well-stream of oil and gas the focus has developed seeing the project object as a part in a life-cycle perspective of being competitive and generating value. The development and operations supply chains has to be balanced in a cost and value perspective, and these supply chains constitute the competitive entity which establish the competitive position of the project. As such we may say that the supply chain and thereby supply chain management are issues that should be of interest for the oil and gas industry, in developing competitiveness. Before we proceed with outlining supply chain management in the project context of the oil and gas industry and the outline of this thesis, let us briefly re-visit the two competitiveness initiatives for the oil and gas industry referred to in stage three in Table 1.

1.2 The Future

The imperative for projects of this kind is *business*. That is the reason for investing money to finance the CAPEX and partly OPEX costs for developing and commence operations. For the Operator it is about being able to exploit and make a profit out of selling the oil and gas. The oil price is set in the international marketplace, and is more or less given for the operators except for different contractual terms for selling that to some degree hedges short- and medium-term fluctuations in price development. To develop and operate, sometimes marginal, oil and gas fields are very capital intensive. For the supply chain actors the business lies in developing the facilities and supporting the operations of the Operator's facilities. The shared challenge for both operators and supply chain actors is to be part of, develop and manage competitive supply chains for the project context of development and operations, and thereby strengthen business for all. Much of the strategic imperative behind the drive towards the supply chain management approach in general is that the supply chain is regarded as the '*competitive unit*'.

'Integrated supply chain management implements a co-ordinated total supply or value chain from determination of external customer needs through product/service development, manufacturing/operations and internal/external distribution, including first, second and third tiers customers/suppliers. The objective is to provide the highest customer service and satisfaction levels and *make the most effective use of the competencies of all organisations* in the supply chain. *The supply chain, versus the single business unit, is positioned as the competitive unit.*' (Frayer *et al.* CLM 1997, pp.346-7).

That is the same for the oil and gas industry, and may be seen underlying the CRINE and NORSOK initiatives. Stage two of the CRINE initiative, CRINE Network, are directly addressing the importance of a holistic view of the supply chain and how to apply supply chain management to the context of the North Sea oil and gas industry.

If one were to draw a scenario for the future it may be built on the trends and developments as laid out by the references given above;

- Business value enhancement orientation.

- Value through projects.

- The project as a business opportunity.
- The supply chain as the competitive entity.
- Logistics and supply chain management as one issue for competitiveness.

This thesis is built on the *belief of this scenario*. As this is *one out of several scenarios*, that will reflect the assumptions and limitations of this thesis.

1.3 Outline

This thesis is built up of three parts, and eight chapters. Part one, setting the scene, outlines the background, topic, objectives and approach taken in the research presented in this thesis. Part two, theoretical background, outlines aspects within projects, project management, logistics and supply chain management, as a basis for the developments and concepts presented in this thesis. Part three, project supply chain management, presents different sides of the project supply chain management concept that is the main message of this thesis. Figure 7 presents the outline of the thesis.

Part I – Setting the scene

Chapter one has set the scene for the topic of this thesis through outlining different perspectives on the developments in the business regimes of the type of projects that is found within the offshore oil and gas industry. CRINE and NORSOK is central in this development, and especially the attention that both give to the importance of the supply chain and its inherent inter-organisational processes.

Chapter two presents the topic of the research to a fuller extent. The problem addressed is outlined, together with objectives and the contribution of this thesis. Finally assumptions and limitations are presented, and the scientific approach that lay behind the research presented in this thesis.

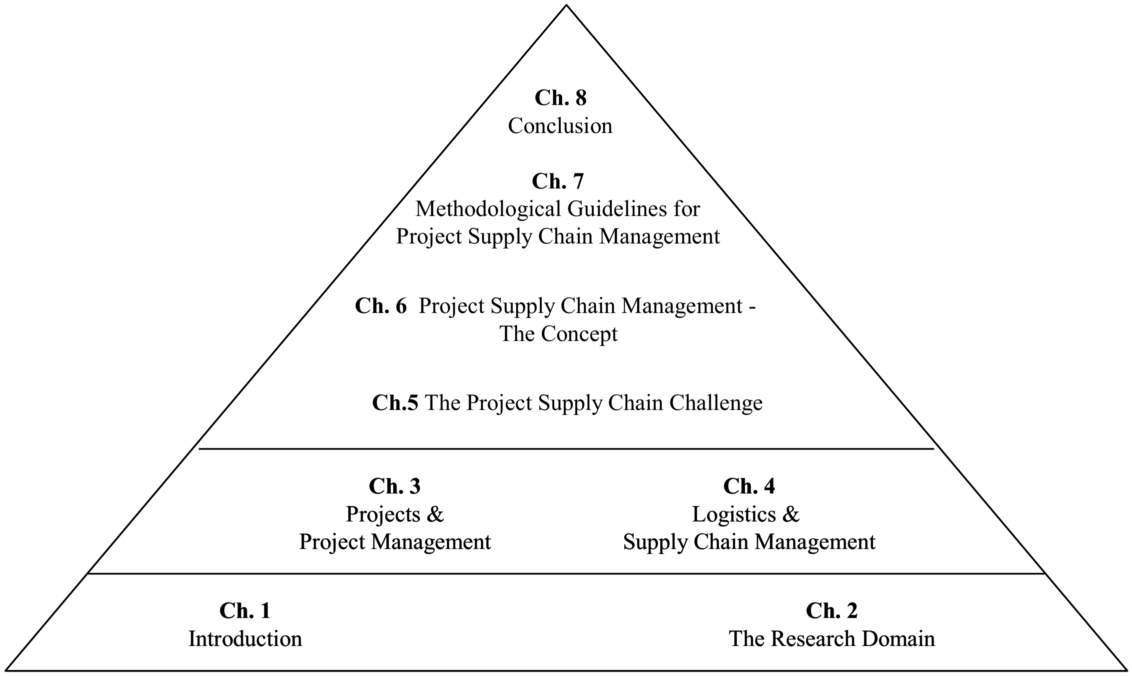

Figure 1.3. Outline of the thesis.

Part II – Theoretical background

Chapter three outlines aspects of projects and project management. The emphasis is laid on the differences of projects, their inherent uncertainty and complexity, and the impact this has on approaches to project management.

Chapter four outlines aspects of logistics and supply chain management. First an outline of the development within logistics and supply chain management is given. Uncertainty within logistics and the supply chain is presented, linking it to the demand and supply side of the supply chain, and to the uncertainties of the project context. Then some concepts borrowed from the manufacturing domain are visited, before chapter three and four is brought together towards logistics and supply chain management in the project context.

Part III – Project Supply Chain Management

The third part of the thesis is written with project executives, project managers, people involved in project core teams (operator), and integrated teams (operator, contractor and/or supplier(s)), as well as people involved and/or interested in procurement, logistics and supply chain management in mind. This part is also the main part or contribution of this thesis, as it set out to outline and develop a conceptual basis and some methodological guidelines for logistics and supply chain management as an approach in the project context of large-scale development and construction projects, including the operations of the project object, and the project management of such projects.

Chapter five outlines the project supply chain challenge in the oil and gas industry. Initially the business context is elaborated a bit further than in this chapter. Then the supply chain actors in the intra- and inter-organisational perspective of the project supply chain context are outlined. finally the challenge of the oil and gas demand and supply chain is outlined as we see it here.

Chapter six outlines the concept of project supply chain management, to give company and project executives a new frame of mind to use to address the undertaking of large-scale development and construction projects. First some principles from the project context are outlined. Then some characteristics of project supply chain management is outlined and discussed, before the project supply chain management concept is outlined and defined.

Chapter seven outlines some methodological guidelines for supply chain management, SCM, and SCM analysis in the project context. The methodological guidelines is set to follow the life cycle of a project, from vision and initiation, to the operations supply chain and revisions of that.

Finally chapter eight concludes and discuss the work presented. The validity of the result is discussed, whether the proposed concept is something new or just ‘old wine in a new bottle’, seen against the objectives of this thesis. Finally the usefulness of this work is discussed.

2. The research domain

2.1 The research topic

'The fact that Alexander [the Great] so capably directed its [the warfare's] operation that logistics scarcely seems to have affected any of his strategic decisions … supply was indeed the basis of Alexander's strategy. … Alexander was able to overcome these [logistics] obstacles where other armies had failed because of his superior abilities in gathering intelligence, planning, preparation, and organisation' (Engels 1978, pp.119 & 123).

To successfully execute his warfare operations and reach his objectives Alexander the Great knew that he had to draw and rely on resources outside his own 'organisation'. These external resources had again to be different based on the situation he and his army were in, and he had to take this into account prior to execution. Projects are, as warfare, unique endeavours with a given start and finish, objective-oriented, of significant size, value and complexity, under time pressure to complete, developed and executed based on inter-organisational capabilities, capacity and integration. If the supply chains were fundamental for Alexander's successes, then it could bear success as well in the project context to use the supply chain perspective as an approach.

Both logistics management and project management are managerial topics that have gained increased attention in later years. The project approach is often referred to as the future way of organising work, while the supply chain is approached as the competitive entity of the future. Neither logistics nor projects are new inventions. Logistics have been central to human settlement and especially warfare since ancient times. Alexander the Great used logistics directly as a central aspect in strategic and tactical planning of his warfare, and did not move until his logistical resources were in place to support his fighting resources (Engels 1978). Projects have also been undertaken since ancient times, since building the first city wall of Jerico 9000 B.C, although the term project management has emerged after the 2nd World War (Hetland 1998). The question then is whether it would be constructive to bring the two together?

This thesis outline and describe the development of a concept named '*project supply chain management*'. The background for this work was an initial assignment of **'looking into logistics and logistics management in the project context and as part of project management'.** The project context addressed here is that of the oil and gas industry, i.e. developing and operating an object where the production by that object generate income for the owner(s) of the oil and gas reserves, while taking part in developing and operations of the object generate business for the supply chain actors.

Within logistics and supply chain management most of the conducted research and development have focused on repetitive and continuous types of industries and businesses. There is a difference between the repetitive context and the project context with respect to logistics and supply chain management, as for the latter the following apply;

- √ One of a kind product and supply chain, that must concurrently develop inter-organisational competence.

√ Long lead items lock-in the design.

√ Long time frame from initial design to construction, often with many design changes.

√ Most value is engineered into the project in its early phases.

√ High cost consumption over a rather short period of time, where missing material give rise to high quality costs.

√ Few opportunities for continuous development.

√ Complexity in product and organization.

√ Technological developments that must be integrated into solutions already established or to be established through project development.

We may use the order penetration point to visualise, as in Figure 2.1, how the project context comprises the whole cycle, as compared to most repetitive industries. The project context is represented by the 'one-of-a-kind production' context.

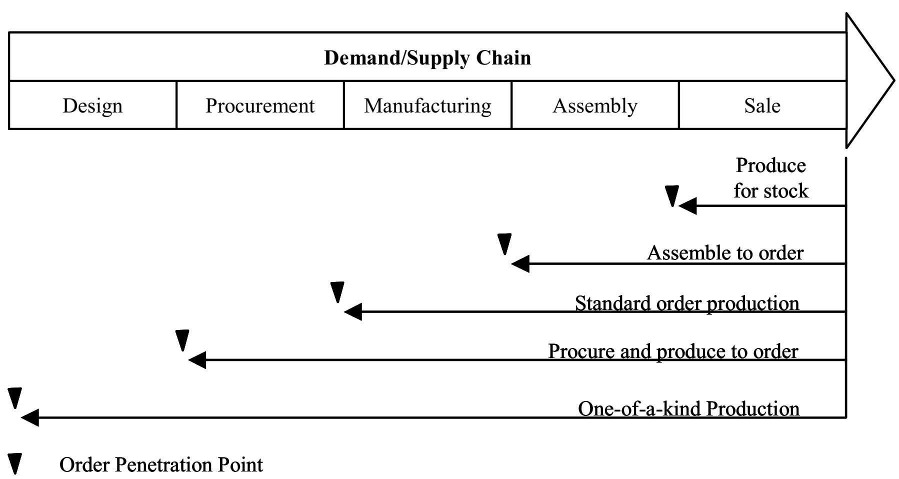

Figure 2.1. The order penetration point's intervention in the demand/supply chain (Rolstadås, 1997-B).

Of the research and approaches to logistics and supply chain management in the construction or project context no references is found that try to conceptualise and describe the key characteristics of logistics and supply chain management in the project context. As the project context described above is both a special type of business situation, as well as characterised by differing characteristics throughout its life cycle that will influence the management of the supply chain processes, logistics and supply chain management should be worthwhile to examine for this context.

The focus on logistics and supply chain management in most industries is as means for improving the competitiveness of the industry or companies. This is the same for the oil and gas industry. Therefore, an approach to supply chain management in the project context of the oil and gas industry should aim to address logistics' contribution to industrial competitiveness in the oil and gas industry. **This means, the problem of this research is to show how concepts and principles of logistics and supply chain management, may be applied to address competitiveness in the project context of the oil and gas industry.**

The problem, or rather the challenge, related to the oil and gas supply chain, that states the requirements of logistics concepts for this context is further explained in chapter five.

2.2 Contributions and objectives

The aim of the different domains of management is to create *value* beyond what would have been created without a given management approach. As such the aim of the concept of project supply chain management is to show how logistics and supply chain management may contribute to enhance the value that project management have on developing and operating the object which the project is established for. The *added value* of logistics and supply chain management in general is found within the logistical mission elements, namely the supply chain cost (or maybe more appropriate; value) and service position achieved through the **'best' alignment of supply and demand**.

The contribution of this thesis may be seen in relation to the three elements that CRINE Network (1998) addressed as aims for their supply chain management initiative. The three aims of CRINE's supply chain management initiative were (CRINE 1998): (i) Awareness and potential contribution, (ii) Assessment of SCM status in the British oil & gas industry, and (iii) Delivery of means and training. The relation between this research and CRINE's SCM initiative may be presented as in Table 2.1.

Table 2.1. CRINE's supply chain management initiative versus project supply chain management as outlined in this thesis.

CRINE *Supply Chain Management Initiative*	**This thesis;** *'Project Supply Chain Management'*
Awareness and potential contribution	Project Supply Chain Management – The Concept; Chapter 6.
Assessment	Earlier Approaches; Chapter 4.5.1. The Project Supply Chain Challenge; Chapter 5.
Delivery of means and training	Project Supply Chain Management – Methodological Guidelines; Chapter 7.

The contribution of this research is both wide and narrow. Wide in the sense that it contributes to applying knowledge from the field of logistics and supply chain management to the field of project management. Narrow or specific in the sense that it outlines what should be the core focus (or most characteristic) for logistics and supply chain management within the project context and project management of the oil and gas industry. The 'wide contribution' is presented through the conceptual development in chapter six, while the 'narrow contribution' is presented through the methodological guidelines for analysis in chapter seven. **The project supply chain management concept and methodological guidelines should as such be regarded as the original contribution of this thesis.**

Not only project management, but also logistics and supply chain management may gain from this work. Logistics and supply chain management become more project- and network-oriented and -dependent, as businesses need to focus on establishing specific supply chains for specific customers and as the move towards core competence and the use of contracting develops. The ability to plan, establish, manage and close temporary supply chains as a way to conduct business will therefore become more important. This research may help to build knowledge about that.

The objective of this thesis is to bring a contribution to project management of large-scale development and operation projects from concepts and thoughts within logistics and supply chain management. The objective is to outline supply chain management within the project-oriented context as a particular and conscious knowledge area of project management. Through developing a concept that approaches projects and project management from a logistics and supply chain management perspective, and through outlining what is important/specific for logistics and supply chain management within the project context. Therefore the objective of this thesis may be summarised to;

- **Develop** principles, concepts and a framework of logistics and supply chain management in the project context.
- **Demonstrate** these principles and concepts through theoretical and empirical examples.
- **Apply** these principles and concepts, through methodological guidelines for analysis.

The objective is as such related to developing conceptual and methodological frameworks that may be used as basis for specific developments and application in specific industrial and project-oriented contexts. The objective is as such not to develop and give specific solutions to specific problems.

To support the main objective to *'develop, demonstrate, and apply'* principles and concepts within the area studied, the following part objectives may be formulated;

- Determine if there exists present work or approaches that are suitable to use with respect to developing and proposing the use of logistics and supply chain management within the project-oriented context of the oil & gas industry, through a survey of existing research on project management and supply chain management.

- Determine competitive aspects or elements of logistics and supply chain management that are more important than others to relate to and use within the project context as found in the oil & gas industry.

- Structure and adapt existing theory as a guidance to practical use – formulate a concept (or 'frame of mind') and develop methodological guidelines for an approach to logistics and supply chain management within the project context of the oil & gas industry.

The concept of project supply chain management presented is developed to outline key describing characteristics of logistics and supply chain management within the project context. Although this is not a complete approach to undertake the project management of large-scale construction projects it may contribute to enhance the awareness and understanding for the importance of the extended 'procurement' function, moving from procurement to project supply chain management, PSCM.

As a part of developing the concept one should aim at defining what the specific focus of supply chain management should be within the project context. For instance the five aspects that could be agreed to be the most important and characteristic for supply chain management within the project-oriented context. An example of such a focus may be found in an analysis methodology used for analysing supply chains for car manufacturers (Schneider *et al*., 1994). This methodology focus on finding critical elements within the supply chains with respect to important objectives of key customers, and whether these supply chains are robust with respect to up-keeping their mission under different circumstances. As such the focus of this methodology (for lean car manufacturing supply chains) is *robustness*[10]. A similar focus point for a PSCM methodology should be established through this research.

2.3 Assumptions and limitations

Supply chain management is concerned with integrating, aligning and managing the inter-organisational supply chain regarded as the competitive entity, included internal integration in each single company that is part of a given supply chain. The aspect of the supply chain as the competitive entity and supply chain management as the managerial aspects related to such chains, means that supply chain management will comprise a large number of issues and thereby a large number of alternative and possible approaches[11]. In this thesis the approach or focus is 'logistics and supply chain

[10] Robustness may be defined as 'a system's ability to resist an accidental event and return to do its intended mission and retain the same stable situation as it had before the accidental event' (Asbjørnslett *et al*. 1999).

[11] See Stock (199x) for a broad description of theories that relate to logistics. Stock (op cit.) tries to establish a broad view of logistics to make it clear that 'logistics is … a boundary-spanning activity' (*op cit*., p.184). He does so by evaluating more than 50 theories to see how they may contribute to logistics.

management within the project context'. The main *assumptions* that underlie this thesis may be presented as the three elements of;

- The *project* as the *business opportunity*.
- The *supply chain* as the *competitive entity*.
- *Competitiveness through logistics and supply chain management*, focused on alignment of supply and demand.

The project is regarded as a business opportunity, where each actor will make business out of it and gain from participating in it. It is also assumed that a project will not be realised if it is not possible to make business out of it, i.e. it is not a realisable business opportunity. Though, technology, competence, capability and capacity of the supply chain actors organised into the specific project supply chain construction, is what may make the project available to realise as a business opportunity. Therefore the project supply chain may be regarded as the competitive entity. Competitiveness or value enhancement for the project, through the supply chain is assumed to be achieved through logistics and supply chain management, specifically through the logistics aim at alignment of supply and demand.

The last assumption element may also be regarded as the main limitation of this thesis. Logistics and supply chain management is a broad field of knowledge, with several possible approaches. Limiting the perspective here to 'alignment of demand and supply' is therefore a limitation. The project itself and the project context may also be regarded as many different constructions, as well as be found in many different industries, as well as both in the private and public sector. The type of projects aimed at in this thesis is projects as represented by field development projects in the oil and gas industry, i.e. a project object that is developed and operated to exploit oil and gas resources located offshore.

2.4 Scientific approach

2.4.1 Initial approach and changes

In the early phase of this research the intention was to use a set of three case studies as the basis for the research. The intention was to make descriptive case studies as described by Yin (1994), describing the supply chains of the projects and the management of them. The three cases and the corresponding project-oriented supply chains and supply chain actors were selected from three different offshore development projects. Three projects (cases) were initially chosen due to the long duration of offshore petroleum development projects. Two of the projects to be used were

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This is a honourable effort aiming at strengthening logistics both for scholars and practitioners. If viewed by a person external to the logistics domain it may be seen as an attempt to make logistics an all-embracing domain of management, which may be seen as a destructive attempt both for the logistics management domain as well as the relationships between different perspectives on management.

combinations of modifications and developments tied in to existing offshore infrastructure. The third project was a complete development project. The two modification projects were, for this research, similar in scope-of-work, but in two different phases of their lifecycle. The first was in the planning phase and the supply chains were not yet fully developed and initiated, while the other was in the execution phase, where most of the supply chains were initiated and in operation.

Initially, in January 1997, contact was established with a petroleum company to explore whether they found interest in the topic of the research, to check whether they had projects that could be used as cases for empirical research of the topic, and if it would be possible to get access to do research within these projects. Due to reorganisation and people changing positions in the petroleum company, it took a year from the initial contact to a meeting was arranged with the central procurement and supply chain department of the petroleum company. This was in January 1998. Based on this meeting the three projects to be used as cases were established. Due to a large workload on the project teams and progress demands in the projects it took four months from this meeting, to the initial contact with the first project in May 1998.

After this initial meeting with the first case project, interest for the research was established in another part of the petroleum company. They wanted to extend the study, and have a group of consultants working in parallel and together with the research. We saw this as an opportunity to get a better basis for the research and agreed to this. This also led to a revision of some of the initial research questions, as well as an extension of the research area to be covered.

Then from June to December 1998 a set of meetings and interviews were held with the petroleum company's project teams for each project, as well as the joint project teams of the petroleum company and the main contractor of each project. The time schedule of these meetings and interviews became quite long due to a full agenda for these project teams. The aim of these meetings and interviews was to establish understanding in the projects for the research, and to establish initial information about the projects and their supply chains. During these meetings and interviews we obtained some basic information, as well as individual comments with respect to logistics and supply chain management in petroleum development projects in general. Then, at the end of 1998 we had established a good basis for starting more thorough analysis of specific elements within the project's supply chains.

In the same period, the price of oil had fallen, and the license that covered the cost of the consultants and the travelling expenditures was asking questions about the relevance of this project for them as a license. As these project teams were located at five geographically different locations, financial support for travelling expenditures was important to be able to undertake the studies. The result was that this research project had to be terminated, at the point in time when a good basis was established for specific studies, but without having the necessary material to develop good descriptive case studies. Another point worth mentioning is that the workload on the project teams made it hard to get appointments and sufficient time for the research. This is an understandable situation seen from the priorities of the project organisations, but with a negative impact on our research.

The question was then how to proceed, based on non-complete case material, but with the good basis understanding it had given? One alternative would have been to conclude the cases as they were, but this was not regarded as a satisfactory solution due to the insufficient material. Another alternative could be to take a conceptual orientation and approach to the research topic, and a third alternative could be to find other cases. It was decided to follow the second alternative, a conceptual orientation to the research topic, and in parallel search for opportunities to find other opportunities for case studies.

Based on a relation to a project management institue, Epci[12], we found that it could be possible to take a higher-level and more general conceptual approach to the topic. And through their network find material of relevance to the research. In September 1998, the CRINE Network, the British parallel to NORSOK, started up their supply chain management initiative, 'Supply Chain Management in the UK Oil and Gas Sector'. This was also an initiative that could be followed as a source of information. CRINE network were positive to send written material, but it was not possible to get a direct relation to their initiative. Several other attempts were also made towards engineering companies to be allowed to come into some of their projects as a research case setting. We were able to get high-level contacts and interviews, but they were not interested in 'opening up' on-going projects for casework. This was mainly due to the workload and time pressure on the project teams.

The research was therefore continued based on the conceptual orientation, and when the conceptual development was developed it was 'put on hold', to see whether it was possible to get a case to test the conceptual material.

As a follow up to NORSOK, a Norwegian initiative was established in year 2000 and named KONKRAFT. When this initiative came up we took contact with the KONKRAFT secretariat to present the conceptual development we had made, and check whether it could be an opening for testing these developments through activities in KONKRAFT. This contact was up-kept through 2000 and 2001. It was interest and positive feedback on the conceptual developments, but the stakeholders in KONKRAFT wanted the developments to be based on internal resources in the participating companies, not through external resources.

As a summary, we decided medio 2002 to sum up the conceptual developments made and present them in this thesis. The approach to this study as it resulted is described below.

2.4.2 Chosen approach

Supply chain management and this research belong to the field of *applied science*, i.e. research aimed at the practical applicability of the results;

[12] Ecpi, the European Institute of Advanced Project and Contract Management.

‘Applied science is activity of original character to gain new knowledge and insight, primarily aimed at certain practical goals and applications’ (as defined by the OECD, in NOU 1988, p.181, translated from Norwegian).

The approach taken in this research follows Arbnor and Bjerke’s (1997) *system approach*. They say that the systems approach is related to *determining the type* of a system, by characterising and categorising the object under study, in our case the ‘system type’ of logistics and supply chain management in the project context of the oil and gas industry;

‘In [the case of the systems approach], however, the researchers/consultants/investigators do not begin by trying to come up with an interesting and testable suggestion for a producer-product connection (equivalent to formulating a hypothesis in the analytical approach), but instead try to determine the type (of a system). This means attempting to *categorise the object under study* in terms of, say, complexity, age, degree of openness, type of environment, and so on. The type of system present will determine such aspects as where to seek inspiration from other creators of knowledge and the design of the rest of the study: to describe, to determine a relation, to forecast, and to guide’ (Arbnor et al. 1997, p.149-150).

Arbnor et al. presents three approaches for creating business knowledge. The analytical, systems and actors approach, moving from the more ‘objective’, quantifiable analytical approach, to the subjective and intentionally influenced actors approach. The systems approach’s place among these is presented in table 2.2.

Table 2.2. Arbnor and Bjerke’s three methodological approaches in relation to paradigmatic categories (from Arbnor et al., p.44).

1	**2**	**3**	**4**	5	6
Reality as a concrete and conformable law from a structure independent of the observer	Reality as a concrete determining process	Reality as mutually dependent fields of information	Reality as a world of symbolic discourse	Reality as a social construction	Reality as a manifestation of human intentionality
The ANALYTICAL Approach					
	The SYSTEMS Approach				
				The ACTORS Approach	

The differences in approaches to studies of business knowledge is also commented by Andersen et al. (1992). Andersen et al. differentiate between two types of processes, a rational process and a learning process (see table 2.3). We regard our research to be part of a learning process.

Table 2.3. Two idealistic approaches of the research process (Andersen *et al.* 1992, translated by author).

	Rational Process	**Learning Process**
Goal	Clear, defined in advance	Tentatively formulated in advance
Goal Function	Establishing the frames of the research, excludes "noise", may be changed marginally	Heuristic mean, commences research and discovery, can be changed
Theory, Models, Concepts	Established and made operational in advance	Adaptive, plastic
Process dominated by	Calculation and evaluation	Inspiration and evaluation
The process' function	A mean to answer the questions raised in advance	A mean to 'force' knowledge out of the field, and develop research competence
The researcher's learning process	Perfection within the frames of a paradigm	Development of a personal method for production of knowledge between two cultures, learning about the borders of a paradigm
The researcher's self-perception	Distant observer, expert	Existentialist, craftsman

Related to the methodics of the systems approach, Arbnor et al. states that;

'Success is associated with imagination, alertness, and awareness when facing the complex reality postulated by this approach' (Arbnor et al. 1997, p.294).

Following Arbnor et al.'s definition of the systems approach our aim of this study is;

√ *To determine* the type of the system (from a logistics point of view)

√ *To describe* the system (from a logistics point of view)

√ *To guide* in approaching how we see the system (from a logistics point of view).

Through our assumptions[13] we may say that we have taken what Arbnor et al. names a '*goal-means orientation*' in our research. This means that the goal for both the study and the system *should* be stated at an early stage in the study. We say 'should' because this is an iterative process, as also was experienced through the research. What was stated early was that the contribution of logistics and supply chain management in the

[13] Our three assumption were; (i) The *project* as the *business opportunity, (ii)* The *supply chain* as the *competitive entity, and (iii) Competitiveness through logistics and supply chain management*, focused on alignment of supply and demand.

project context of the oil and gas industry should be improved competitiveness, as this is the contribution that is sought from the same in other contexts. The goal of the study was also stated early on, but as we learnt through the study process, the means for reaching that goal had to be changed during the study. Further, our research followed the main headings of Arbnor et al.'s description of a system study to determine relations, describe and to guide.

'Systems analysis is conducted using traditional data collecting techniques that are adapted to the specific study situation and made into methods via methodical procedures; that is by using secondary material, direct observations [e.g. case studies], and interviews' (op cit p. 302).

As explained above, the process that the research takes, may often be influenced by situations in the study context, and may therefore have to be altered during the research process. This may lead to revised and other goals and levels of the research. Table 2.4 give a short outline of how our research developed due to the changes that were necessary to make when the cases fell out, seen in relation to Arbnor et al.'s plan for a study to determine relations.

Table 2.4. Arbnor et al.'s plan for a system study that determines relations, with comments from this actual research.

System study plan	**Comments from actual research**[14]
Formulating possible finality relations	This is by A&B said to be developed in an iterative way through direct 'dialogue' with the system(s) under study. The way that was developed in our study is outlined below; **(1)** The first contact with the system was with a strategic adviser from an Operator company, and that gave a strategic focus on the role of the supply chain and supply chain management as an approach for improvements for an Operator. As this did not lead to any formal continuation of the study, this was kept as part of the background material of the study. **(2)** Then for the second contact with the system, the focus was on the importance to secure the supply of goods for the construction of the project object, not to delay the scheduled progress of the development project. This may be regarded as a project planning and control perspective. **(7)** When the case studies had to be terminated, we had learnt that; √ Technology development is the main driver for value enhancement in future projects. √ Changes are an important element to control in the demand/supply processes of the development phase of the project, and that the changes come late in the development process. Then we started to work with the value perspective of the demand and demand chain processes in the development, especially through the importance of technology and the impact of changes. This may be regarded as a project

[14] The numbers show the relations in progress of the study, and the development of the focus of the study. To understand the development of the study, the reader should follow the numbers, i.e. not reading the table from top to bottom, but in stead follow the number indication.

	management perspective. Further for the operations phase of the project we started to gather information and knowledge from secondary sources, as well as from other studies external to this study.
Planning the continuation	**(3)** Based on this and an extension of a study, a set of case studies was established. Three case studies was made available, all three with different characteristics as projects, that could shed light to different elements of the problem complex. The case studies was developed as descriptive case studies along the prescriptions of Yin (1994), and supported by aspects from Dyer et al. (1991), Eisenhardt (1989 A & B, 1991), Flyvbjerg (1991), Leonard-Barton (1990) and Merriam (1994). **(8)** We now had some information from three unfinished case studies, but for the rest of the study we had to rely on second hand material, and interviews when we where able to get such. In summary we had to take a higher magnifying level on our study.
Designing methods for collecting data	**(4)** These case studies started with interviews with actors from the operators project teams, and the operator/contractor integrated project teams, as well as interviews with personnel from contractors. It was also planned to have interviews and follow-up with a set of sub-contractors and suppliers. It was also developed a method and format for collecting information about the project (case) specific supply chains, and the logistics processes involved **(9)** The methods now had to turn to a more theoretical analysis and development of a system construction that focused on the characteristics and the high level problem complex of the system, and how these were theoretically to be met by logistics and supply chain management theory.
Collecting data	**(5)** Data were collected to a certain extent from some of the actors in the cases, but due to external circumstances that influenced the financing of these case studies, they had to stop when the understanding of the sub-systems started to grow, as well as the contact and relations with the actors had been established.
Are you satisfied as a creator of knowledge?	**(6)** Then the question was whether we as researcher were satisfied with the data and knowledge gathered this far? We were not! We had not enough data to call the started case studies for real case studies. We had not been able in the time available to map the demand and supply chain of the cases, and far from having a material that was sufficient for data analyses and being able to go further into detailed studies of aspects of special interest or importance. Though, we had learnt some, and were able to review and revise our finality relations. **(10)** Without having been able to test the results of our system analysis and theoretical construction and check the validity of this, there is still uneasy to be satisfied as a creator of knowledge. Arbnor et al. call it the expert variant, when a theoretical solution is developed, without the researcher being in place to check out the practical validity of the results. This is especially so for the development phase of the project life cycle.
Coding and arranging data	**(11)** The data material from the case studies where not sufficient, and therefore no data analysis were conducted based on that material.
Controlling finality	**(12)** We have not been able to control the finality relations for the development phase of the project life-cycle. Though, from a theoretical point of view we have this far not seen any aspect that should tell otherwise, given the preconditions of the result, i.e. the results are context or system specific. For the operations phase

	of the project life-cycle we have gathered information from secondary material, as well as from studies external to this study, and these other studies have confirmed our proposed theoretical results.
Reporting	**(13)** This thesis is the final reporting of this study.

Then, let us go back to the objectives of this research;

- **Develop** principles, concepts and a framework of logistics and supply chain management in the project context.
- **Demonstrate** these principles and concepts through theoretical and empirical examples.
- **Apply** these principles and concepts, through methodological guidelines for analysis.

To address these objectives we have taken a 'goal-means orientation' as described by Arbnor et al. and as presented in figure 2.2.

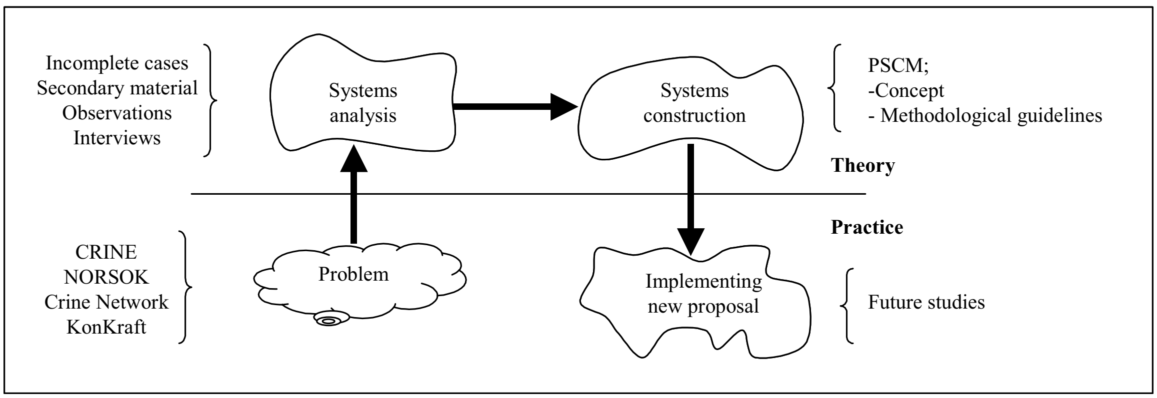

Figure 2.2. The 'goal-means orientation' of the study (revised from Arbnor & Bjerke*, 1997,* p.302).

We started with a specific problem statement for the oil and gas industry. This problem description is given in chapter five. Based on this problem statement we have done a systems analysis based on input from secondary material, observations, as well as participation in meetings and interviews with actors related to the problem complex in the oil and gas industry. Based on this we have proposed a system construction through a theoretical concept and methodological guidelines for what we have named 'project supply chain management'. As the case studies terminated and it has not been able to test out the theoretical solutions fully in practice, we have a study that is mostly theoretical, in some areas on the philosophical side, but that seeks to answer how we perceive a theoretical answer to the problem complex of supply chain management focusing on the logistical side of the oil and gas industry. Therefore, we believe that the scientific approach taken in this thesis is in line with the systems approach from Arbnor and Bjerke.

Now, let us turn the attention to part two and the theoretical background for this thesis. First, projects and project management is addressed in chapter three, then logistics and supply chain management in chapter four.

3. Projects and project management

3.1 Introduction

Project management is a domain of management knowledge and theory that has emerged after the term project started to be used consciously about different forms of objective oriented endeavours of a temporary character. As such projects will be different, especially in the context surrounding and the aspects underlying the project. Though there may be project processes and project management processes that are similar across a range of projects, and that may seem very similar in a project execution perspective, there may be more interesting differences to find in the more strategic aspects of projects and project management. This is especially so as the logistics and supply chain management perspective to the project context taken in this thesis, may be seen as a deliberate, strategic choice with respect to approach to projects and project management. This chapter seeks to outline aspects and elements related to projects and project management that is perceived to be of relevance for logistics and supply chain management within the project context. The aim is to outline some differences of projects and the approach to them that influence logistics and supply chain management as an approach to project management.

3.2 The development of project management

The project as an object of management goes back to the time period 9000 B.C. as we referred to in chapter two. However the conscious treatment of project management as a specific topic arose later in time. One author, Morris (1994) says that the historical developments of project management emerged between the 1930s and 1950s, and to be closely related to;

- ‘the developments of system engineering in the US defence/aerospace industry and to engineering management in the process engineering industries,
- developments in modern management theory, particularly in organisation design and team building, and
- the evolution of the computer, on which project management’s planning and control systems are now generally run’ (Morris 1994, p.2).

Though, project management is an area that touches onto many aspects and as such has to take account of developments in general that will influence the project context and the management of project;

‘Despite its long development, the concepts and techniques of project management now available to the general practitioner, however advanced and specific they may be, are often inadequate to the overall task of managing projects successfully. … [T]he successful accomplishment of a project may well require attention to a range of factors not treated by the traditional project management literature. Design and technology management, …,and *even contract strategy and administration*[15]: all these are frequently ignored in the professional and academic writings and teachings of today's project management' (Morris 1994, p.2).

Project management is based on an approach to or a perspective of what a project is. A critical part of an approach's usefulness to model the project, or the 'reality', is its ability to enable the analyst or researcher to 'move into' the 'reality' to address and create a better understanding of critical details per se, without loosing the details place in the totality. As the models of the reality will be simplified representations of the reality this is an important point to remember. The different approaches or perspectives taken towards project management will, as Morris states, necessitate that concepts, methodologies and techniques from several other 'sources' of knowledge is brought into and adapted to the project context and the project management domain. The contemporary understanding of projects and project management is represented by a multitude of different approaches and perspectives. Gareis (1999, in Hetland 2000) group these into three main areas;

1. *'The traditional project management approach* – mainly task-oriented and related to planning and control of activities.

2. *The organisation theory project management approach* – mainly actor-oriented, focusing specifically on the project as temporary organisations.

3. *The systemic constructivistic project management approach* – distinctly moving the focus from what a project *is* to what we want a project to *be*. We are intentional in choosing the project as way of working because we believe this will give a better result than if we had used another way of working' (Hetland 2000, p. 1.1-18).

A professional project management organisation working within the first area of project management understanding is the Project Management Institute, PMI. Some of PMI's approaches will be further outlined and discussed below. The approach to projects and project management developed in this thesis follows the lines of the third area above. Though, we believe that this area comprises the preceding two, and as such they should be regarded as a basis to develop upon, and for this thesis, especially the organisation theory project management approach, seeing the project as a temporary organisation or more specifically a temporary business opportunity. This is again an intentionally made choice.

3.3 Definitions of project

The term project has been given many, and different definitions. Table 3.1 presents some definitions of the term project.

[15] As an example of a subject that falls within the logistics and supply chain management approach of this thesis.

Table 3.1. Some definitions of the term project.

Source	Definition
Project 2000 (1998)	An effort that has character of being a one-time undertaking, with given objectives and limited scope of work, that is executed within time and cost limits.
PMI (1996)	A project is a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all similar products and services.
Harrison (1992)	'[The project] is a discrete undertaking, that is, it has a start and a finish. It has finite objectives, often including time, cost, and performance goals. [The project] is of significant size, value, and complexity, and is under time pressure for completion. [The project] involves the *integration across organisational boundaries* of groups, departments, organisational units and companies. '

The definitions of projects presented in Table 3.1 shows that a project may be perceived in many ways. Common for most is the notion about the temporary aspect. It needs temporarily to pull together and group resources from different professions, and often from different 'parent' organisations. It is objective-oriented, and intentionally chosen. Finally it may be of varying complexity and scope. Though, the definitions listed do not mention the life cycle of the project. The life-cycle is only referred to as a 'time-limit' or a 'definite end', but what defines the end of a project? Is it e.g. the end of the development phase in a oil and gas field development project, i.e. when the project object is handed over to operations and operations commences? Or is it for the same type of projects the point in time when the project object is 'abandoned' and the production and value flow from the reservoirs is stopped? The first end point reflects the intention in the project definitions above, the classical development activity of a project managed within the project planning and control scope. The latter end point reflects the project as a value generating entity, where both the investment, or enabling, part (development) and revenue generation (operations) is part of the project life cycle.

Therefore, of the definitions above e.g. Project 2000's and PMI's are examples of good definitions for the project development phase, and Harrison's definition further points to the scope and complexity, and the need for inter-organisational integration. Though, to cover the complete life cycle of the project as a business opportunity, these definitions have to be extended. There is no aim in this thesis to propose a new project definition, but at this point state that the definitions above have to be extended to comprise the business opportunity context of the project, e.g. as in an oil field development comprising both the development and operations of the project object.

3.4 Aspects of projects

Below four aspects of projects and project management are outlined. The aspects are not meant to be generic for all projects, but are aspects that should be understood as a basis for the approach developed in this thesis. The four aspects are the project context, the project object, the project life cycle, and the uncertainty within projects.

3.4.1 The project context

The project context is what makes projects' a special managerial object. Turner (1993) sets projects into an environment and a context. Turner says that:

'A project is not an island; the work is not done for its own sake, although traditional approaches to project management often treat it as such. The project exists within a context. I should say that, …, I differentiate between the project's environment and its context. The environment is a *physical* concept. It is the neighbourhood in which the facility is built. The context is an *abstract* concept, but includes the environment. It is the complete economic, human social and ecosystem in which the project exists.

The context has three primary elements; (i) projects and corporate strategy, (ii) the parties involved, and (iii) strategic management of projects' (Turner 1993, p.18)

The Project Management Institute, (PMI 1996), states that the project context comprises the topics of;

'Projects and project management operate in an environment broader than that of the project itself. … The topics included here are; (i) Project Phases, and Project Life Cycle, (ii) Project Stakeholders, (iii) Organisational Influences, (iv) Key General Management Skills, and (v) Socio-economic Influences (PMI 1996, p.11)'.

We can see that both Turner and PMI let the context comprise general and strategic management topics and skills. Hetland[16] states that the project context comprises;

'(i) *Business practice*; 'arms-length', co-operation, collaboration, co-opetition, (ii) *Culture*; e.g. Norwegian – short front end, many changes, versus Japanese – long front end, few ('no') changes, and (iii) *Other project specific contextual issues*, e.g. Physical location, Political issues, Financing, and Resourcing'.

We can see that Hetland sees 'physical location' as a project-specific contextual issue, while Turner sees that as a project's environment. A part of a project's context will therefore be the trends that are influencing the development of execution models and related elements. Therefore, part of the context are the developments that are related to making use of concepts, models and methodologies from other knowledge areas. One such influential factor is the emphasis and developments of logistics and supply chain management that is made use of in continuous and repetitive processes and industries.

How the project context is defined and delineated may be an intentional choice, as described in the system constructivistic project management approach. The project context as it is to be understood in this thesis is;

[16] Based on a presentation by and discussion with Hetland in 1999.

- *The project as a business opportunity for the project supply chain actors, and*
- *The project supply chains as the entity to make the project competitive.*

Development projects of the kind that is found in the oil and gas industry need large financial resources to be realised, i.e. they may be regarded as being part of a generic class of investment projects. Financial resources are often scarce, and each development project must compete against other projects, and firms within the oil and gas industry for financial funds. In addition the oil and gas industry has to compete against other types of industries, which may give better or more secure returns on the financial funds invested. Therefore the project context addressed here is that of the project as a business opportunity, with the project's supply chain and the management thereof as the competitive entity, both in development and operations.

3.4.2 The project object

As some definitions of the term project states, a project is aimed at bringing by a 'unique product or service'. If we look at offshore field development projects we may say that they both are product and service oriented. The ultimate product the project develops is the oil and gas to be sold in the marketplace. These oil and gas derivatives may also be regarded as a 'service', e.g. as part of the gas-supply agreements to the European continent, i.e. an energy supply-service. A part of the field development project itself is the development of the infrastructure that enables the exploitation of the oil and gas resources at a competitive cost. This infrastructure may be regarded as the project object.

At this point it is important to separate the project from the project object. The *project* is the whole setting concerned with exploiting and gaining value from a business opportunity. The *project object* is the infrastructure that shall make it possible to exploit, process, refine and distribute the oil and gas resources from the reservoir, through it stages of refining, to the marketplace. The project is concerned with value or financial benefit, the project object is related to the revenue, i.e. production capacity, regularity and recovery rate, and cost side, CAPEX and OPEX, of the value equation. This distinction between the project and the project object is important, as the project seen from the side of an operator is, as a business opportunity, not completed before the project object is removed. Seen from the side of the actors in the project supply chain, their involvement in the project may be limited to a certain phase or a set of phases of the project life cycle. With respect to the logistics and supply chain approach to this project context, the project object, comprising both its development and operations, is the focus of the approach.

Table 3.2 and 3.3 below show the cost estimate and cost distribution for six reference project developed in relation to the Norwegian Continental Shelf in the late 1990's. The names of the projects are hidden due to confidentiality.

Table 3.2. Cost accounts for some reference projects developed in relation to the Norwegian Continental Shelf in the late 1990's (figures in mill. NOK).

	Projects						
	A	**B**	**C**	**D**	**E**	**F**	**Average**
Management	942	104	322	179	314	957	470
Engineering and procurement	2 031	207	674	211	976	2 438	1 090
Material deliveries	4 225	547	2 564	1 463	1 337	9 247	3 231
Construction	6 448	758	2 274	441	1 226	5 989	2 856
Operations	509	149	320	252	78	477	298
Unit work activities	0	0	10	0	995	0	168
General	-191	29	2	0	-90	0	-42
SUM	**13 964**	**1 794**	**6 166**	**2 546**	**4 836**	**19 108**	**8 069**

Table 3.3. Percentual cost distribution for some reference projects developed in relation to the Norwegian Continental Shelf in the late 1990's.

	Projects						
	A	**B**	**C**	**D**	**E**	**F**	**Average**
Management	7	6	5	7	6	5	6
Engineering and procurement	15	12	11	8	20	13	14
Material deliveries	30	30	42	57	28	48	40
Construction	46	42	37	17	25	31	35
Operations	4	8	5	10	2	2	4
Unit work activities	0	0	0	0	21	0	2
General	-1	2	0	0	-2	0	-1
SUM	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Wee see that on average approximately seven out of eight billion NOK's are related to the EPC element of the project object. That is almost ninety percent of the total cost account for the project object. Engineering, which is heading the demand process for procurements and material deliveries, as well as construction requirements, consumes fourteen percent of the project object cost accounts, to initiate supply consuming forty percent of the cost accounts, and construction activities consuming thirty-five percent of the cost accounts. In other words, for every 1.000 NOK spent for external supplies and construction, 187 NOK's have to be spent for engineering and procurement activities to define, initiate and follow-up.

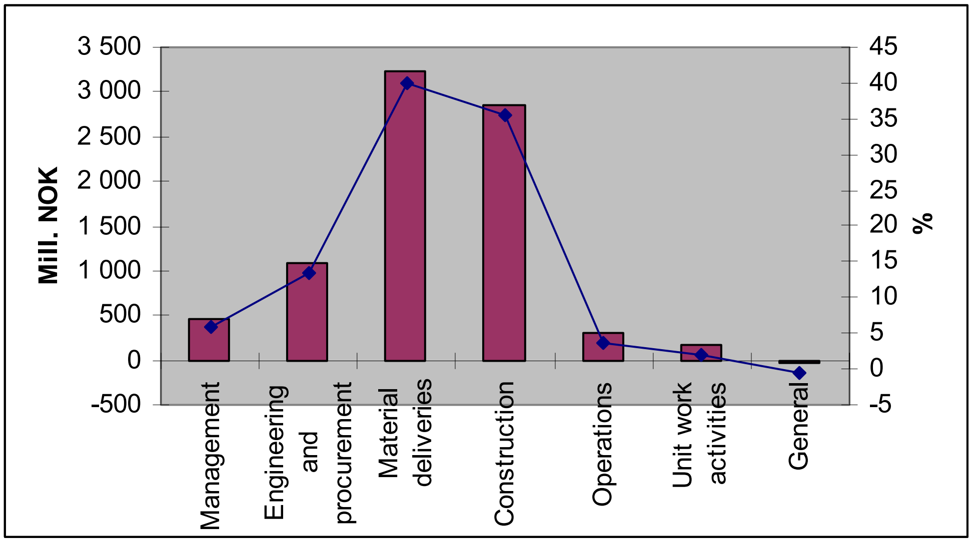

Figure 3.1. Average cost and cost distribution for some reference projects.

3.4.3 The project life-cycle

The life cycle of a project should be elaborated further than as the development of the project object. The life cycle of a project may be regarded in several ways. PMI have defined;

'the project life cycle as a collection of phases whose number and names are determined by the control needs of the performing organisation' (PMI 1996, p.vii).

This approach to the project life cycle is much related to a view of projects that see them as developing and 'physically' creating a unique product or service. The project life cycle may also be seen as the life cycle of an object, from 'birth' to 'death', as discussed above regarding the definitions of projects. Especially the development projects of the oil and gas industry were the project object is the 'cornerstone', as the 'enabling tool' for revenue generation. This may be seen as a process consisting of four major steps as outlined in Table 3.4.

This four-step approach to the project life cycle is also compatible with the first definition, as it may be that all these four steps are necessary for the 'control needs of the performing organisation'. All these four steps have influence on the financial objectives of the project, both for the owner and the contractors and suppliers. For the project owner, CAPEX is involved in step one, two and four, while the revenue generation is 'limited' to step three. For the contractors, revenue is generated primarily in steps one and two, but also for some in step three, although in a smaller scale. For the suppliers the revenue is generated in steps two and three, dependent on their involvement in either object realisation or supporting 'consumables' for object utilisation.

Table 3.4. The project life cycle.

Project life-cycle stages	**Description**
Project *development*	The front-end phase, up to the point in time when the project has been defined and evaluated as a project, and the project basis been examined thoroughly and developed so far as to start the specific development of the project object i.e. 'up to big spending'.[17]
Project *object development*	The main investment phase of the project, including, detail engineering, procurement, fabrication, construction and commissioning of the project object. Up to the point when the responsibility of the project object is handed over to operations.
Project object *utilisation*	Operations of the project object to produce the oil and gas resources.
Termination of the project.	Closure of the project, including investments in removal of the project object after the operations of the oil and gas resources has come to an end.

In general, for a logistics and supply chain approach, *the life cycle of the project object* is in this thesis focused on two main phases. The first main phase comprises the development phases of the project and the project object, comprising every sub-phase up to the project object is ready for hand-over to operations. The second main phase is the operations of the project object. The role of the supply chains in these two phases is in the development phase to contribute with competence, technology and resources to enable and realise, i.e. design, specify, produce and fabricate parts, and construct the project object, then in the operations phase the role of the supply chains is to enable, support and secure the operations of the project object.

The two phases of the project life cycle are important as the logistics and supply chain management approach to the two phases should be guided by distinctively different characteristics. This will be elaborated through developing the project supply chain management concept in chapter six.

[17] For a further discussion of the challenges of the project front end, see appendix D.

3.4.4 Projects means uncertainty

As we saw from the definitions of projects above they are characterised as ‘one-time undertakings’, ‘unique’, and ‘of special character’;

‘The principal identifying characteristic of a project is its *novelty*. It is a step into the unknown, fraught with risk and uncertainty. No two projects are exactly alike, and even a repeated project will differ in one or more commercial, administrative, or physical aspect from its predecessor’ (Lock 1992, pp.2-3).

The larger the project is, both in scope of work, geographical distribution, and organisation, and the more stakeholders involved in the project, the number of factors that will influence the project increases. The globalisation of business, and therewith the spread of potential project actors and stakeholders, lead to a geographically dispersed supply network involved in a project, supplying for and to the project object. This increases the basis of uncertainty and complexity in the project. With a logistics and supply chain management approach to projects and project management uncertainty and complexity of both the project product, the extended project organisation or the project supply chain, as well as the related processes necessitate to be dealt with.

Uncertainty in projects

As stated above, a project is an endeavour characterised by uncertainty. Uncertainty is on the top level related to the value of the business *opportunity* to be exploited and the *risk* to the financial and resource commitments needed to exploit the business opportunity. This two-sided picture of uncertainty, balancing business opportunity and risk, is essential for understanding supply chain management in the project-oriented context addressed in this thesis. The reason for this is the project supply chain actors’ influence both on the opportunity as well as the risk side of the inherent project uncertainty. Further, the uncertainty both evolves through and have to be dealt with by the supply chain actors. As such the uncertainty picture may be presented as in Table 3.5 below.

Table 3.5. Uncertainty management means balancing opportunities and risks along the project supply chain.

Uncertainty	
Opportunity	**Risk**
Check project challenges with respect to consequences in the sense that the conditions are arranged to exploit opportunities – to increase the value of the project.	Reduce and control to be within an acceptable risk exposure for the project.
Risk and reward shared among the project supply chain actors based on willingness and ability to bear.	

Uncertainty originates due to whether *data* is known or unknown or whether the *state* is closed or open. This is presented in Table 3.6 as a suggested taxonomy (Hetland 1999).

Table 3.6. The nature of uncertainty. Suggested taxonomy (Hetland 1999 (A)).

		STATE	
		Closed	**Open**
DATA	**Known**	Deterministically uncertainty	Variability
	Un-known	Lack of information	Undetermined uncertainty

The importance of the content in Table 3.6 is not the taxonomy itself, rather to understand the sources of uncertainty, and how the types of uncertainty may be approached and dealt with for the best of the project. Another quote that is related to data as a source of uncertainty is;

'Uncertainty is given by the difference between the information that is necessary to make a reliable decision and the information that is available' (Project 2000, 1998).

A common source of this type of uncertainty is engineering decisions taken on an early information basis, leading to changes that again may lead to alterations in the project supply chains, e.g. termination of one supply chain and activation of another.

Uncertainty has to be dealt with actively, and that has given rise to uncertainty management as a specific topic within project management. Though, the most important aspect related to uncertainty is that it is treated consciously and proactively, it should not be allowed to just 'happen';

'Our success derived from deliberate front end planning – not from good luck randomly drawn from possible future states of nature. We were lucky in the sense that we were not hit by randomly drawn states of seriously bad luck' (Heyerdahl 1999).

As stated above, uncertainty management should be deliberate and start early in the project, or even before one has defined a project, i.e. in the front-end phase. It should be part of 'good management', not left to 'luck', i.e. bad management. As such the approach to uncertainty management should be developed and established already in the front-end phase.

In figure 3.2, this is presented through three different approaches to treatment of uncertainty in front end planning in a project; *no*, *traditional* and *proactive*. No front end planning may be regarded as what happens in a Monte Carlo simulation. The future contains thousands of different outcomes, and in each draw in the Monte Carlo simulation a state is 'picked' that may either represent good or bad luck with respect to the parameter in focus. Underlying is the assumption that there is *no active management involvement that will influence the outcome*. Then there is the traditional approach to front end planning, or 'the accountants scenario'. This approach is characterised by risk reduction, trying to reduce the number of possible outcomes as much as possible, so that one ultimately is left with one option. In relation to the project space that will be described below, we have a 'closed' project. By following the 'accountants scenario' one seeks to eliminate possible risks, but at the same time one forego potential opportunities. The question then is whether this is good, value enhancing management? The third and final approach to front end planning try to 'play' proactively on the uncertainty inherent in the project, as a business opportunity, both to 'eliminate states of seriously bad luck', as well as 'add value' through 'added states of good management'. Then we are down to what management is about, creating value beyond what would have been created if management was not active. The case here is that management emphasises the ability to proactively exploit uncertainty as a source of value enhancement, not just a source of risks to protect against.

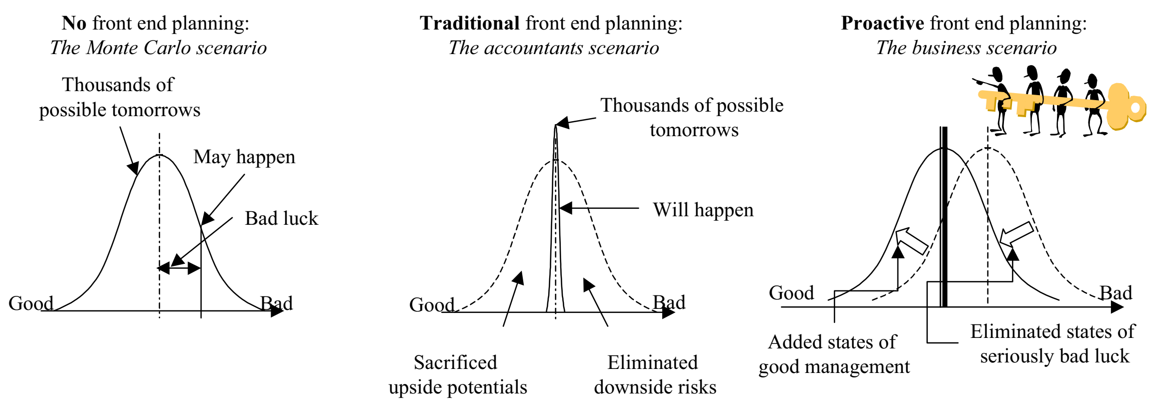

Figure 3.2. The approach to uncertainty management starts in the front-end phase[18].

But projects are not static, stationary constructs. Project are more like 'moving targets'. This should be reflected in a dynamic development of uncertainty management in the project;

'Projects are born and developed under a high degree of uncertainty. A project may be planned with realistic targets and assumptions, and one can establish time schedules and cost estimates based on experience, knowledge and available information. But, the project develops continuously due to increased knowledge and insight that is won through the planning processes' (Husby *et al*. 1999).

Therefore the uncertainty management process established in the front-end have to be dynamic, in addition to being proactive. But, uncertainty management comes at a cost, and future opportunities and actions has to be weighed against historic commitments;

'The significance of uncertainty for a decision situation depends on the cost of reversing a commitment once made, the volatility of the environment, and the sensitivity of benefits to the occurrence of the unpredicted' (Rosenhead 1989, p.194).

[18] Summary from 'Front End Opportunities' workshop, Epci, 10-11 March 1999, see Appendix D.

This is especially important for supply chain management, as the uncertainty when commitments have been made down through the supply chain may have consequences for the whole supply chain, and in the worst case even lead to termination of a whole supply chain.

Uncertainty and the project supply chain

Husby *et al*. (1999, p.14) regarded uncertainty management to cover; '*exploiting opportunities, reducing risk, accepting uncertainty, and transfer of uncertainty*'. This is the same as we presented in the introduction to uncertainty and in Table 3.6, except for the last aspect, transfer of uncertainty. Regarding this aspect there may be raised a question with respect to where to transfer given uncertainty? Should it be transferred from the project owner to a project contractor or supplier, or vice versa? Or should it be kept within the actors of the project supply chain, and distributed and dealt with among them? Distributed and dealt with in such a way that the uncertainty is *transferred among the project supply chain actors in a best possible way for dealing with the uncertainty*, both with respect to exploiting opportunities and reducing risks or the consequence of them within the project supply chain actors as a whole. However, as Husby *et al*. (1999, pp.122-3) states, uncertainty is ultimately owned by the project owner, though the uncertainty may be handled by the project supply chain as a whole, or by parts of it;

'Uncertainty costs; Uncertainty in a project does not change after a contract is signed; Uncertainty should be reflected in the actors' objectives and limits; Uncertainty may be a competitive advantage; Uncertainty is ultimately owned by the client'.

Changes are related to technical risk. Changes comes both from that complete information is not available, or through that degrees of freedom' have been transferred down the supply chain. Degrees of freedom may be transferred (delegated), e.g. via functional specifications, which moves the 'ownership of freedom' to choose a specific technology or solution from the operator to the contractor, as long as it meets the functional specifications set by the operator. However, the operator still has the final responsibility, and financial consequences of changes in degrees of freedom must be born by the operator as principal. Therefore;

'Risk may be divided in two:

- <u>technical risk</u> where decisions about technological choices affects a large scope of entities, and together with the fact that nobody have full overview of the product, then this will influence the

- <u>financial risk</u>' (OA 990614).

An example of coping with uncertainty through the project supply chain in the development phase of a project is taken from *Nerefco*, a restructuring project of a petrochemical plant in the Netherlands. The project was owned and financed by British Petroleum (65%) and Texaco (35%). The project was executed as an alliance project between the owners, hereafter referred to as Nerefco, and the two contractors Raytheon and Fabricom (participated with two divisions) and suppliers. The starting point was that the project did not have 'robust' financials, and therefore had to show cost effective strategies and execution. It did also have construction challenges as it was complex restructuring that was going to take place within an already existing plant. The competence of the fabrication and construction contractor would therefore be essential. To be able to keep the shut-down of production to a minimum the project had to have a short installation schedule. These factors gave rise to several uncertainty factors.

To cope with these uncertainty factors an alliance contract was developed and agreed to between the owners and the contractors and suppliers. As part of the alliance agreement, a financial risk/reward incentive was developed. The risk/reward shares was distributed among the project supply chain actors in relation to their impact on the solution, and their willingness and ability to bear the risk. From the vendor side the engineering, fabrication and construction contractors participated, and the supplier of one of the main equipment-modules. The risk/reward shares of each partner in the project supply chain is given in Table 3.7.

Table 3.7. Nerefco alliance project; Alliance partners – under-run shares.

Partner	Nerefco	Raytheon	Fabricom (M)	Fabricom (E&I)	NBM	**Total**
Share	35%	25%	23%	6%	11%	**100%**

We see from table 3.7 that the owners carry only 35% of the risk/reward incentive within the alliance contract, while the contractors and one supplier carry 65%. Though, this distribution does need some explanation, which is based on Figure 3.3.

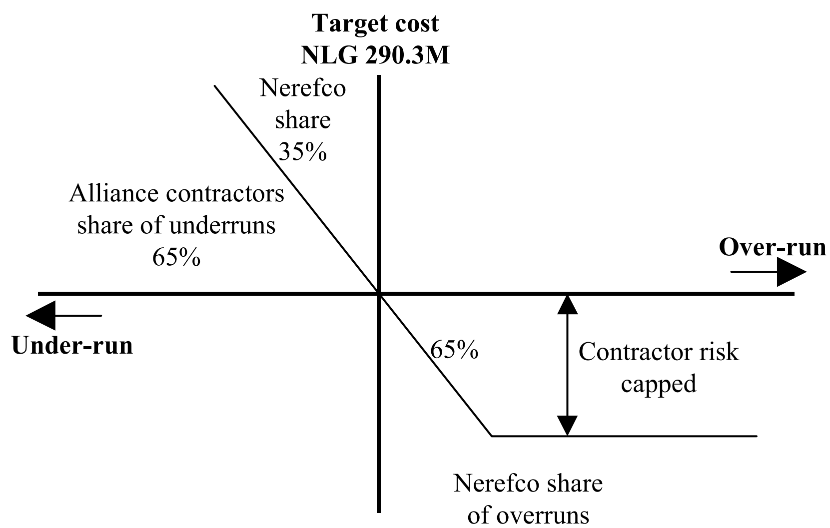

Figure 3.3. Sharing of financial risk/reward among the Nerefco alliance partners.

Figure 3.3 shows the distribution of incentive between the project owners and the contractors/supplier. The basis for the incentive is a target cost on CAPEX, set to NLG 290.3 million. This was a target set based on cost estimation after a sufficient degree of information and information confidence had been established in the project. With respect to the resulting cost position after the project was completed (CAPEX account) it could either be higher or lower than the target cost. If the final project cost accounts showed an under-run versus the target cost, the cost differential would be shared with 35% to the owners and 65% to the contractors/supplier. That means that if the owner, contractors and suppliers are able to develop the project using less money than the target cost, the contractors and the supplier in the incentive contract will earn 65% of that under-run, and the owners will save 35% of the under-run. If on the contrary there is an over-run, the contractors and the supplier in the incentive contract will have to cover 65% of the additional cost, up to a certain amount over-run. If the over-run exceeds a fixed amount above the target cost the contractors and supplier will only cover 65% of that fixed amount, i.e. the contractors' upside risk is 'capped'. The remaining over-run has to be covered by the owners. This is in accordance with the ability to bear risk, and thereby the willingness to try new approaches in dealing with the project supply chain to seek additional value, and thereby be able to make the project financially viable.

3.5 Project processes

Project processes may be regarded in several ways. One way is to try to define them along the project timeline, and towards the different functions and activities involved in project and project management work. Another is to try to approach them a bit more broadly, in researching the underlying uncertainty involved in 'what to do' and 'how to do' it in a project. Below we will give examples of two approaches along these two lines.

3.5.1 PMI's project processes and knowledge areas

The Project Management Institute, PMI, is one of the larger international interest organisations for developing project management as a body of knowledge and as a profession. To help create understanding for the process of managing projects, as well as the functional areas involved, PMI has developed a set of project management processes and knowledge areas.

With respect to project processes, PMI separates between *project management processes*, '…describing and organising the work of the project' (PMI 1996) and *product-oriented processes*, '… specifying and creating the project product[19]' (op cit.). A supply chain management approach may be seen as a part of the product-oriented processes, as it is focused towards the product of the project, but should also be seen as a project management process, as it is a way of 'describing and organising the work of the project'. The duality of the product-oriented processes versus the project

[19] The term 'project product' used by PMI is the same as the term 'project object' used in this thesis.

management processes is an interesting one. This duality becomes even more interesting and important as uncertainty with respect to 'what to do' and 'how to do it', i.e. uncertainty in the product oriented processes, has to be combined with different, or targeted, project management processes. This is further described below, in the description of the project space and the differences in approach to project strategy and execution.

PMI's project management processes are 'phase-oriented' and grouped into five phase-related groups; *initiating*, *planning*, *executing*, *controlling*, and *closing* processes. These processes are further oriented towards the development phase of the project object, not taking the operations phase and the life-cycle perspective of the project object into account. The initiating processes act as '*commitment achievers'*, i.e., their role is to commit actors to their involvement in the project. The planning processes are concerned with the *means and ends* of the project, i.e. defining and specifying the 'what to do' and 'how to do it' elements of the development project. The executing processes focus on the execution of the *project plan*, with *corrections* made by the controlling processes. Linking the project oriented supply chain is part of the executing processes. The controlling processes are aimed at identification of variances between actual and planned performance. Change control is part of the controlling processes. The objective of the closing processes are to *close-out* contracts with external project supply chain actors, as well as *nest up* all information to formalise the completion of a project phase or the whole project.

Within the project processes there will be functional activities related to PMI's nine project management *knowledge areas*. These knowledge areas comprise the functional management elements for development of *project integration, scope, time, cost, quality, human resources, communications, risk* and *procurement management*.

The product-oriented processes are related to the 'what's' and 'how's' of 'what to do' and 'how to do it' in developing the project object. Below we will present another more overriding approach to the product-oriented processes, though not as broadly recognised as the work of PMI, it address some interesting aspects especially regarding the inherent uncertainty in the processes.

3.5.2 What's and how's

Projects are different with respect to their degree of specification of '*what to do*' and '*how to do*' it. Obeng (1996) proposes four generic categories to explain and group projects based on these two parameters. The four categories are differentiated by the knowledge or familiarity about the 'what' and 'how' endeavours of the project, and each category is given a descriptive name; *Painted by Numbers, Going on a Quest, Making a Movie, and Lost in the Fog.*

In the first instance you have full familiarity and knowledge about both what to do and how to do it. This is the first category 'painted by *numbers*', characterised by 'knowing'. One know what, i.e. the project object, or result, and know how, i.e. the tasks to be performed to reach the desired end. Uncertainty is involved, but that is on the level of uncertainty in specific scope of work, schedule or cost for specific tasks. The 'painted by numbers' category is characteristic of the project planning and control situation. Then in the next category 'going on a *quest*', you know what to achieve, e.g. exploiting some oil and gas resources located under the seabed in an offshore environment, but you don't know how to exploit them, i.e. the conceptual and technological basis to be used is not known. This category may be suitable for the early stages of complex development and construction projects, especially when new, advanced technology has to be developed or tried out. The third category 'making a *movie*' takes advantage of familiarity or knowledge about a way to, or the process of realising something, you know how, but you don't know what business potential it may be applied to. The name of the category implies that this may be seen as making a movie, i.e. you know how a movie is created, but you don't know what kind of movie it will be. This category may also be used for actors that seek business opportunities where their own competence or technology may be applied. The final category 'lost in the *fog*' may both be seen as the ultimate opportunity where all possibilities are open to you, but also as the opposite characterised by that you 'don't know where you are, and not where you are going', i.e. you are lost in the fog. An example of the first is that you have in your possession some money that you want to develop further, and where you yourself have to act as the agent for finding a business opportunity, going from 'don't know what' to 'know what'. Then when you know what, you have to establish the way of realising or exploiting the business opportunity and the 'organisation' to do it, i.e. move from 'don't know how' to 'know how'.

Table 3.8. Obeng's four project categories.

Project category	Know what?	Know how?	Closed or open?
Painted by ***numbers***	Yes	Yes	Closed project
Going on a ***quest***	Yes	No	
Making a ***movie***	No	Yes	Open projects
Lost in the ***fog***	No	No	

Hetland (Epci 1999-B) has defined Obeng's four project categories as a '*project space*', consisting of 'open' projects and 'closed' projects. Related to Obeng's four categories, Hetland (*op cit.*) defines projects in category one as *closed* projects, while he defines projects in category two to four as *open* projects. Few projects may completely be put into one of the four categories, but the degree of openness will be greater the more one moves from a project characterised by category one, towards category four. The difference between open and closed projects is found in the projects inherent degree of uncertainty. A closed project has few loose ends and may be quantified and measured by numbers for its means and objectives. Open projects on the other hand have a large degree of uncertainty that have to be dealt with both to be able to pursue opportunities still not closed and manage inherent risks. Figure 3.4 presents the 'project space', comprising Obeng's four project categories.

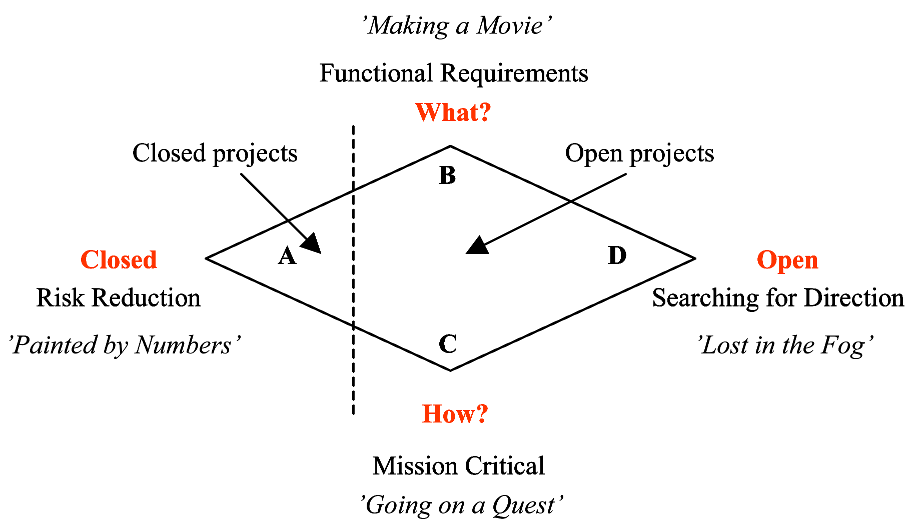

Figure 3.4. The project space.

In stead of using Obeng's figurative category names, Hetland proposes to use names as indicated in Figure 3.4 and Table 3.9.

Table 3.9. Obeng's categories, with Hetland's suggested naming.

Obeng	**Hetland**	**Comment**
Painted by numbers	Risk reduction	Reduce risks, leave opportunities un-examined. The project planning and control context.
Making a movie	Functional requirements	The contractor are open to suggest and use how to best solve the needs (what?) of the client. Technological development driven.
Going on a quest	Mission critical	Project execution process development. The value lies in the project management processes directing the search, because 'the journey is the mission'.
Lost in the fog	Searching for direction	Is this the really the right concept to follow? Is there another business that could be more worth while to pursue? E.g. total change of technological development concept, that could be e.g. from platform concepts, to sub-sea developments and down-hole processing.

Projects of a given type may move within the project space, e.g. due to involvement of new technology or new organisational constructions chosen deliberately to pursue opportunities inherent in an open 'approach', resulting that the project context is more characterised by uncertainty. An example of such a move within the project space may be taken from the construction industry, as described by the British Department of Trade and Industry, DTI;

'The traditional model of construction views the construction process as the purchase of a product governed by legal contracts. This provides a small level of uncertainty about project ends, but uncertainty about the means by which it is implemented is passed on to contractors and sub-contractors as risk. … However, when projects are more complex and uncertain … The construction process is described more like a prototyping operation where the needs and means are continually negotiated' (DTI 1998, p.22).

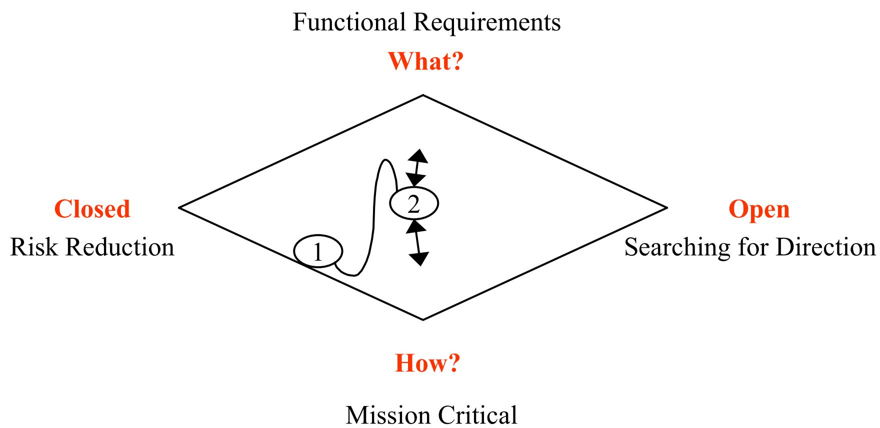

Figure 3.5. Construction projects moves within the project space as they become more complex.

This quotation show that the projects in the construction industry move within the project space as the projects becomes more complex. First the projects are a bit into the open area as they have an element of going on a *quest* within them. They know what ('this provides a small level of uncertainty about project ends', position 1 in Figure 3.5), although there are some uncertainties with respect to how it shall be implemented. As the construction projects become more complex and the construction process become more prototyping based, the projects move within the project space from the closed domain, towards the open domain adding on elements of 'don't know what' (adding elements from 'making a movie') and 'don't know how' (position 2 in Figure 3.5). A project will also be more and more closed as it develops throughout its life-cycle, from development to termination, e.g. as showed in Figure 3.6 below.

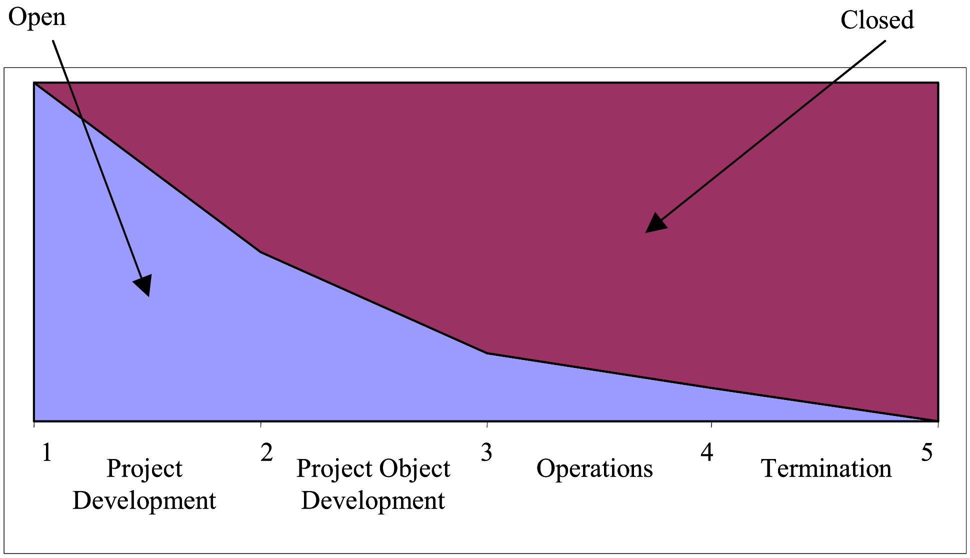

Figure 3.6. Project's degree of openness throughout the project phases.

By itself, Obeng's project categories contributes to developing a basis from which one may better start to understand the interaction between product-oriented processes and project management processes, as defined by PMI, under the influence of degree and form of uncertainty. This will be further outlined below.

3.6 Differences from strategy to operations

There are several alternatives to choose as an approach to develop a project. There are different strategies, tactics, as well as operational forms. Below we will first address some differences with respect to project strategy, contract strategy and procurement strategy. Then an 'project atlas' is outlined, and approached as a tactical issue with respect to applying different types of strategies to outline the project 'route' from start of the front end, to completed development.

3.6.1 Strategies are different

As stated above one of the most used and understood perspectives on projects is the development and construction of a unique product or service. This perspective shows the temporary or finite nature of the projects organisational construction. Organising to undertake a project of the category treated in this thesis is dependent on the internal competence and capacity of the operator. Behind the organisation of the project lie the business strategy (that among other establishes the company internal competence 'profile') and the *project strategy*, i.e. the strategy about realising the business opportunity. The project strategy will lay the guidelines for establishing the project organisation, 'brought together' through *contract strategies*, and *procurement* *strategies*. Besides from the project execution phase of realising the project object, these strategies may or will directly or indirectly have relevance for the object utilisation phase, i.e. the operations of the project object. Project organisation is important as the supply chains and the management of them is to a large part dependent on the project's organisational construction. The life cycle aspect has also an important influence on how the organisational issues should be approached.

Some say that there is a need to change how we perceive and approach the management of large, complex development projects;

'We are currently facing the need for major shifts in the way we run complex capital projects, which are "complex inter-organisational business processes" of a finite nature. The traditional focus on costs and discrete contracts are no longer adequate to deliver profitable developments. These parameters need to be replaced by life cycle costs (or life cycle value) – i.e. we are more interested in the total costs of construction and operation rather than piecemeal costs as such. Detailed specifications are being replaced by functional requirements – i.e. we are buying performance rather than hardware. Contractors and suppliers are considered as potential partners, not as crooks – i.e. the contract terms are used as constructive tools and not as destructive weapons. Vendors are contracted earlier, far before comprehensive scope definitions can and should be produced' (Hetland, 1999-B).

As part of developing new approaches to project strategies, Epci[20] proposed three different types of project strategy approaches; (i) *risk reducing*, (ii) *opportunity seeking*, and (iii) *value enhancing*. These three types were used as an approach to see what actors from project-oriented industries meant when addressing project strategy[21]. When a group of representatives from the oil and gas industry were asked which of these types of project strategy that best reflected their own approach, most of them stated that the risk reducing type was the most common, though several pointed to the value enhancing type as a concept that was sought e.g. through alliance contracts and incentive contracts. Within this lies a difference between what is felt needed, due to 'old arm-length' transactional principal/agent relationships, versus what was believed to be the best form for enhancing value through project work. When asked what types of measures they believed were necessary to move towards more value enhancing project strategies, the answers may be summarised into three points;

- ✓ *Linking inter-organisational* value enhancement with *intra-organisational* profitability and risk.
- ✓ *Transparent* measures along supply chain to ensure that actors and stakeholders targets and objectives are clear, visible and understood.
- ✓ *Dynamic* measurements that reflects changing needs over time.

Value enhancement has to be shared, i.e. the inherent risk and profitability in a project has to be shared among the project supply chain actors for them to be focused on value-enhancement for the project as an inter-organisational business opportunity, e.g. as in the Nerefco case described above. The issue of transparency into the project supply chain came also up (this is also an important part of all logistics and supply chain

[20] Epci, the European Institute for Advanced Project and Contract Management.

[21] These three approaches to project strategy were used in an Epci workshop to address project and contract strategy. The questionnaire used for the workshop and a summary of the responses can be found in Appendix E.

management). Then the project issue of dynamics came up, to meet the dynamic context of project, not least due to their inherent uncertainty which trigger the need for dynamic measures. All these remarks are related to project supply chain relationships, and thereby a project's contract strategy.

'Contracts are used to procure people, plant, equipment, materials and services. Contracts are therefore fundamental to the management of almost all engineering projects. The type of contract should be selected only after consideration of the nature of the parties to the project, the project objectives and the equitable allocation of duties, responsibilities and risk. [This chapter] outlines the main components of the process used to determine how the project will be procured, usually referred to as the contract strategy' (Smith 1995, p.188).

As it comprises 'the processes used to determine how the project will be procured', the contract strategy may be regarded as 'a tool' for establishing and managing the project's inter-organisational supply chain. As such the mission of the contract strategy may be regarded as 'an enabler to align and optimise inter-organisational value enhancement and intra-organisational profitability given inherent opportunities and risks'. Related to the input from the industry, they meant that the contract strategy should support the project objectives through;

- ✓ Complementing the project supply chain with the project objectives.
- ✓ Reduce imbalances along the project supply chain.
- ✓ Align and commit the supply chain to deliver.
- ✓ Increase the likelihood of project success.

The choice of contract strategy is in large dependent on to which extent what's and how's of the project is defined, as outlined in the project space, i.e. the knowledge and experience with respect to what to be done and how it is to be done, and the contextual influence on this. When asked about the relationship between the project strategies and contract strategies the answers from the industry may be grouped into the following;

- ✓ Well defined what's and how's lead to risk reducing strategies, well suited for securing delivery in accordance with promises. Fixed price type of strategies, lump sum, with strong risk transfer motivation between actors is characteristic.
- ✓ Less defined what's and how's may open up for creativity and utilising the full potential of the project supply chain, especially in opportunity seeking contexts.
- ✓ Value enhancement strategies will have to utilise risk reduction and opportunity seeking strategies targeted in parts and phases of the project.

Therefore, the project strategy has to be aligned with the procurement strategy and contract strategy, and it has to be known to all the actors in the project supply chain. Below we will outline an approach or a 'tool' that may be used to develop a project strategy, the project atlas.

3.6.2 The Project Atlas

The objectives of the project stakeholders may be seen in relation to the ambition levels of the industry and the actors. One may say that there are four different ambition levels involved in an approach to a project. The first being *status quo*, i.e. approaching the project as one has approached projects previously. Secondly, *continuous improvement*, i.e. try to improve on the 'what's' and 'how's' previously used. The third is *radical change*, i.e. one tries more or less completely new approaches to the what's and how's earlier used. And finally the fourth, *quo vadis*, i.e. one question what one does.

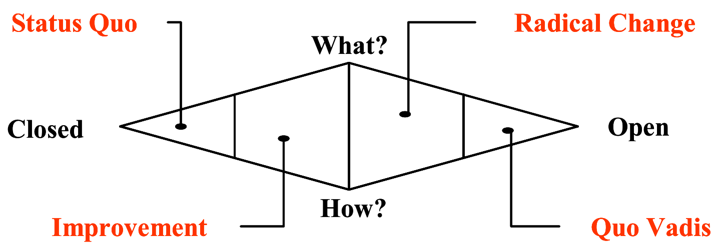

Figure 3.7. Different project strategies and the project space.

The level of ambition increases, e.g. due to market or industry pressure, as one moves from the retaining 'status quo' towards the 'quo vadis' situation. The latter one could for this discussion be left out as it often may involve a complete strategic shift, e.g. shifting the line of industry one is involved in. As one shifts ambition levels one may also need to change the approach one takes to the management of a project, as it leads to new 'what's' and 'how's' previously 'unknown' or unfamiliar. This means that one has to acknowledge that there is a need for different project strategies. As a start we may relate four different project strategies to each of the four ambition levels above. The 'status quo' situation may be termed A-type of project strategies, 'improvement' B-type project strategies, 'radical change' C-type project strategies, and 'quo vadis' D-type project strategies. These four different project strategies are related to the degree of openness in the 'what' and 'how' characteristics of the project space. Based on the project space and these four different types of project strategies, Epci has started working on a 'project atlas', to try to establish a 'tool' for 'navigation' from project strategies and further into contract and procurement strategies. The 'project atlas' is shown in Figure 3.8, and shows how the project strategies take different 'form' dependent on the clearness or unclearness of the project objectives 'what's' and the project processes 'how's'.

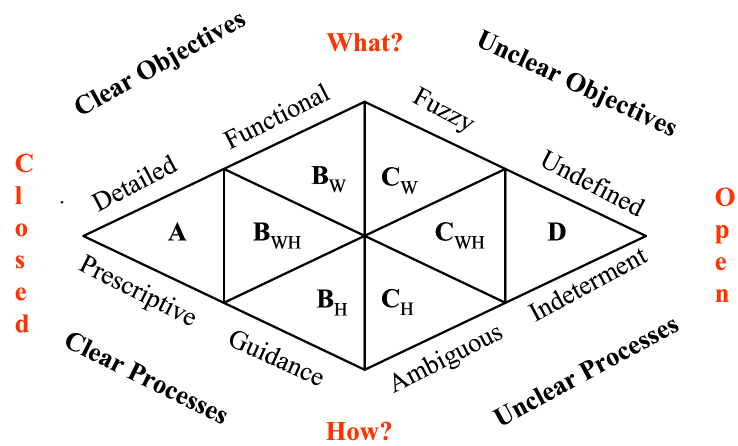

Figure 3.8. The Epci Project Atlas.

Let us now look into the different project strategy types and their segments, as they are proposed in the project atlas. The *A-type* of project strategies are characterised by clear specifications with no or very small room for seeking opportunities. As such the A-type of strategy is a risk reducing type of strategy often copying previously used concepts and methods. The *B-type* of project strategies is as the A-type characterised by clear objectives and processes. There has though been opened up a bit, in that the objectives have become functional in stead of detailed, and the processes are meant to be of guidance in stead of prescriptive. The B-type of strategies may again be divided further into three groups, B_W, B_{WH}, and B_H, dependent on the degree of openness in objectives or processes. B_W is characterised by that one is able to choose how to do it (i.e. one knows how to do) as the what to do is given as functional specifications. The room for improvement is through challenge prevailing work processes to continuously develop to stay competitive. Moving from B_W to B_{WH} is characterised by opening up on the functional specifications that defines the 'what's' of the project object, while slightly starting to define (preferable or competitive) work processes. Still there is room for challenging the prevailing work processes, but the trend is moving towards improving the current work processes. Moving further to B_H leaves more room for challenging the functional specifications of the project objectives, but tightens up the work processes to be applied, using a guidance approach. An example could be to follow the principles that CRINE Network has established, in the supply chain management initiative. Approaching the *C-type* of strategies we move into the unclear area characterised by fuzziness and ambiguity. Further dividing the C-type of strategies into C_W, C_{WH}, and C_H, we moves from challenging the fundamental statements and objectives of the project, through to taking technological step changes in applying next generation technology. Finally the *D-type* of strategies is completely open in that the objectives are undefined and the processes to be applied are undetermined.

The project atlas and the different project strategy segments may now be used to outline a tactical approach to project execution, i.e. the different routes that may be chosen through execution.

3.6.3 Routes are different

From a business opportunity is identified, via project initiation and development, through to the project object is completed and set into operations there are a number of alternative routes that may be pursued to complete that process. Common for all routes is that they will be within the confines of the project strategies comprised by the project atlas. If we leave out the D-type strategies, as they are mostly found in the phase searching for a business opportunity, we have the three strategies A, B and C left. Therefore, the choice of a route through the development phase of the project is what links the project development strategy with the execution of the project development phase. The strategy may be seen as the basis underlying the approach to a route.

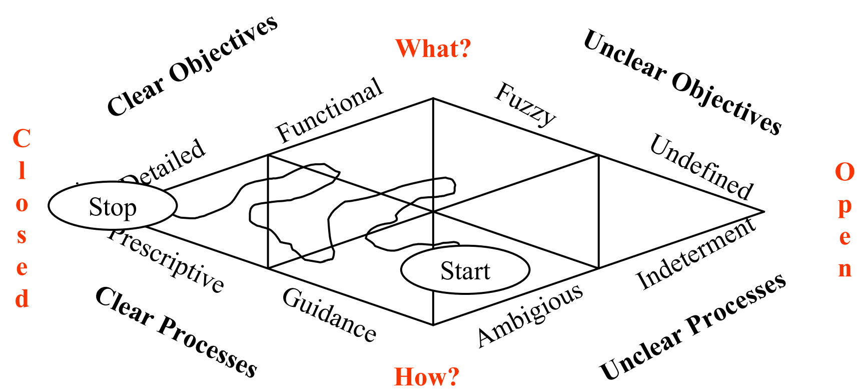

Figure 3.9. A route moving through several categories of the project atlas.

From the '*start*' point of the project development to the '*stop*' point, that for the type of projects addressed in this thesis, i.e. oil and gas development projects, may be defined as the point where the project object is set into operations, there may be several routes to pursue, dependent on the ambitions of the project or project stakeholders. The start point will most probably be located somewhere within the B or C region of the 'project atlas', as what may become a project in its origin as a business idea or opportunity is related with a large portion of uncertainty. At the 'stop' point when most of the degrees of freedom have been set, the project will ultimately have been brought into a phase of order, i.e. closed, and the degrees of freedom still open is there to bring elements of flexibility into the operations of the project object. As such we may say that all routes will move from the 'open' part of the project atlas to the 'closed' part of the project atlas, where the elements still 'open' are defined to be so within given limits. We could alternatively present this as a matrix orientation, where one axis follows the timeline from 'start' to 'stop', and the other axis goes from 'open' to 'closed' in the project space, or from disorder to order. This is presented in Figure 3.10 below.

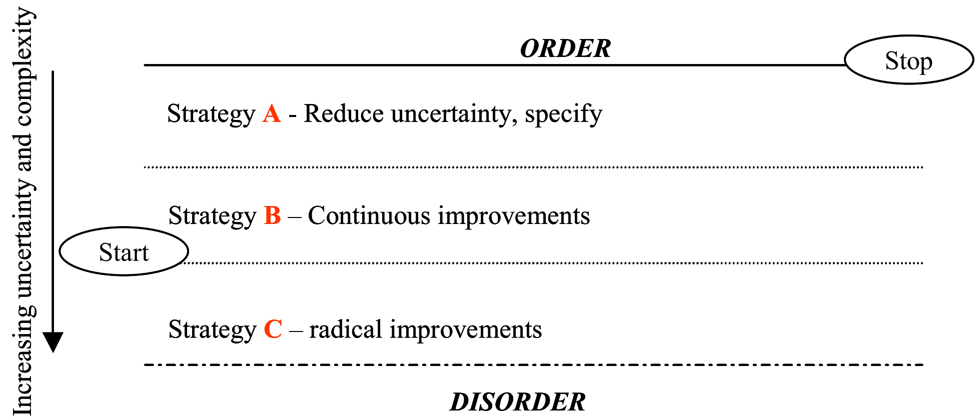

Figure 3.10. A to C strategies between order and disorder.

If we look closer into three different routes we may say that they relate to three different strategies. We may say that the routes start in the B_W category, and ends in the A category.

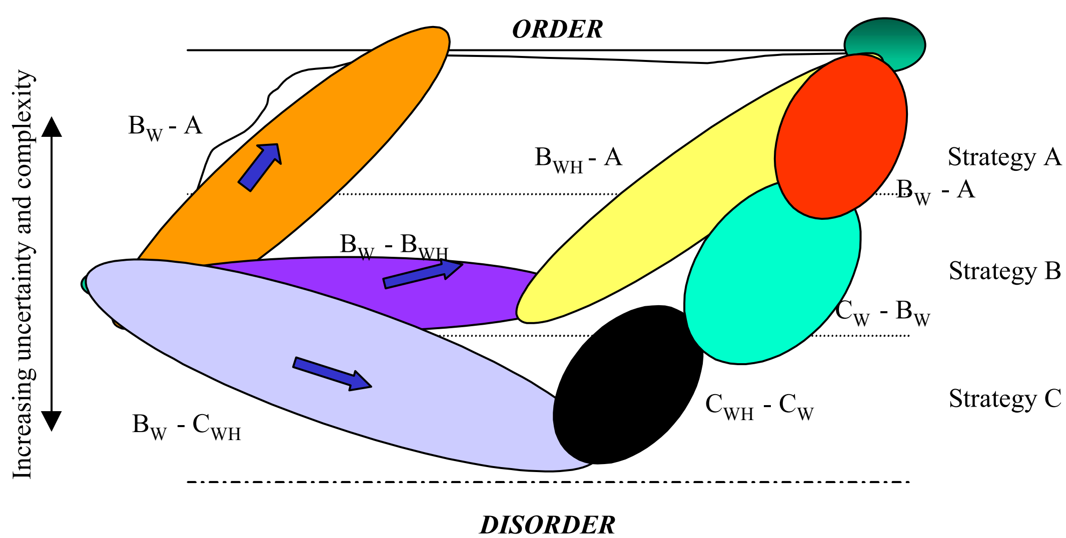

Figure 3.11. Three different routes from initiation to completion (1).

The first may be seen as the risk reducing type of route, seeking to exploit, or copy, concepts, products and processes previously used. The main aspect in this route is to 'close' the project as fast as possible, i.e. bringing it to a 'painted by numbers' type of project as soon as possible, and thereafter using A-type strategies. The second route requires that the degrees of freedom are opened up to explore possible approaches, through improving the current work processes, i.e. moving to B_{WH}, before closing the project and exploiting A-type strategies. The third route goes further than the second route in opening up the degrees of freedom. From the start point, the route searches into the 'radical improvement' area, first generally (C_{WH}) then trying to challenge or reformulate the objectives or the specifics of the objective of the project. Then the routes start closing the project, through returning to the segment it started, i.e. see what has been learnt from relaxing the requirements or limits of the project (the tour into the C-segments), before closing the project completely and moving into the A-segment.

The three routes could also be represented in the project atlas, as in Figure 3.12 below.

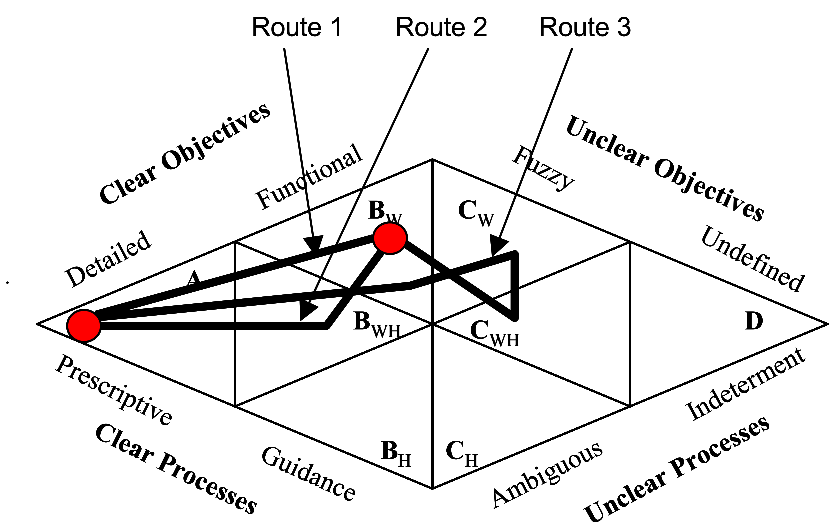

Figure 3.12. Three different routes from initiation to completion (2).

The different project strategies and the different routes outlined are an important aspect when approaching projects from the supply chain and supply chain management perspective. The different strategies applied and the routes that are outlined, will impact the demand and supply chains that is necessary to realise the project. This will again impact the contractual relationships to be developed in the project supply chains. These are one of the factors that differentiate project-oriented supply chains and supply chain management from the context of the continuous industry and operations. This will be further developed through the agile concept outlined in chapter four, and brought together in the project supply chain management concept in chapter six.

4. Logistics and supply chain management.

4.1 Introduction

In the last chapter projects and project management were outlined and discussed. In this chapter the focus is turned towards the other aspect of this thesis, the developments of logistics and supply chain management. First the theoretical developments of logistics and supply chain management as a domain of managerial knowledge are outlined and discussed. Then uncertainty as it emerges and is handled in logistics and supply chain management is addressed. Two aspects of manufacturing management theory are then described and discussed as they are seen as relevant for logistics and supply chain management in the project-oriented context of developing and operating a project object. Finally the previous parts of this chapter and the last chapter on projects and project management are brought together to approach supply chain management in the project context.

4.2 Logistics and Supply chain management

Logistics management may simply stated be said to be the *managerial practice about bringing something or someone that is needed from the place where it origins to the place where it is needed, when and in the form it is needed*. The term itself originates from military operations, together with the related terms procurement and supply.[22]

Logistics; '(1) *the aspect of military science dealing with the procurement, maintenance, and transportation of military material, facilities, and personnel*, or (2) *the handling of the details of an operation*'.

Procure '(1) *to get possession of: obtain by particular care and effort*, (2) *bring about*';

Supply: '(1) *to provide for*, (2) *to make available for use*, (3) *the act or process of filling a want or need*'.

Documentation of one of history's first uses of logistics management as a strategic driving force is given by Engels (1978) in his description of Alexander the Great and how Alexander planned and conducted his warfare, in the time period 340-323 B.C. Even earlier than Alexander the Great Sun Tzu a Chinese General, 500 B.C., wrote a collection of essays named 'The Art of War'[23]. 'The Art of War' has come to be recognised as the oldest military treatise outlining warfare strategy, and does also contain aspects of logistics and logistics management. Creveld (1977) gives another reference to logistics role in warfare, in a later, but longer historical time-perspective. As part of later military warfare, Pagonis (1992) gives us insight into the role of logistics and logistics management in the Gulf War often referred to as the largest logistics operation in history taking the time-frame into account.

[22] As defined in the Encyclopædia Britannica.
[23] See e.g. http://pubweb.ucdavis.edu/Documents/ROTC/suntzu/szbook1.htm.

Commercial use of many of the concepts and methodologies developed within military applications of logistics goes often under the name of *logistics engineering*. Logistics engineering takes a maintenance or operability focus in its approach to logistics. A definition of logistics engineering is given by the Society of Logistics Engineers, SOLE (www.sole.org);

'*[Logistics engineering is] the area of support management used throughout the life of the product or system to efficiently utilise resources assuring the adequate consideration of logistics elements during all phases of the life cycle so that timely influence on the system assures an effective approach to resources expenditure*' (www.sole.org).

The other main branch within logistics is named '*business logistics*'. Business logistics focuses more broadly on the whole supply chain from the initial source to the final consumer and the elements that have to be managed to secure a correct flow along these chains to meet service and cost requirements. One definition of business logistics is given by the Council of Logistics Management, CLM (www.clm1.org);

'*Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customer requirements*' (www.clm1.org).

The *mission* of logistics is on the upper-most level *service* and *total-cost* (Bowersox *et al*. 1997, pp.8-13).[24] The service element is related to *availability*, *operational performance*, and *reliability*. All three aimed at the ability of getting an object into a place where it is needed, when it is needed, given that internal and/or external elements may impact the supply chain and disturb or threaten its ability to meet its service requirements. The total cost element is related to all costs accrued up through the supply chain, from 'point of origin to final point of consumption'. That means the costs necessary to bring the object from its raw material bases through its development stages and finally into the 'hands of the customer' or ready for final 'consumption'. The total cost aspect focuses specifically on elements that may be improved through a holistic approach to the supply chains. Finally there must be a balance between service and total costs, given the needs and requirements to be fulfilled.

'The challenge is to balance service expectations and cost expenditures in a manner that achieves business objectives' (Bowersox *et al.* 1997, p.9).

The contribution and recognition of the importance of managing the external supply chain has been known and acknowledged all since the days of Alexander the Great (Engels 1978). As a management topic logistics got foothold after the Second World War. The period up to the 1970's was characterised by logistics functions, e.g. physical distribution, warehousing, and purchasing. Then in the 1970's and 1980's the focus became optimisation of the balance of customer service and operations cost, often addressed as materials management. The focus was still on internal functions that was 'optimised' within their boundaries, e.g. through the use of quantitative calculations for predicting optimum stock levels. The next logistical period that emerges in the 1980's commenced with the focus towards internal integration between company internal

[24] '[T]he logistics of an enterprise is an integrated effort aimed at helping create customer value at the lowest total cost' (Bowersox *et al*. 1997, p.8).

functions, as well as the move to integrate, or synchronise, inbound activities with outbound activities. In this period the integrated logistics concept emerges, which integrates internal activities from the supplier interface to the customer interface around the two flows of material and information[25]. The information flow is the holder/carrier of requirements and demand, originating in the customer interface, to pull the value-added materials flow from the supplier interface, through the organisation and up to the customer interface. The 1980's were as such characterised by internal integration, integrating internal functions related to the logistics flow, as well as the integration of the flows of material and information as two mutually dependent flows.

Then in the 1990's the focus on integration continued, but now the focus was broader, taking external elements into account, extending the holistic focus to embody both customers and suppliers as part of the managerial context. The flow aspects was also extended as in addition to the flows of material and information, the flows of *services* and *funds* became important elements of the logistical flow.

Table 4.1 outlines the developments of logistics management up till now, as well as suggests a scenario for further development of the logistics management domain.

Table 4.1. Development of logistics' concepts.[26]

Stage	**1**	**2**	**3**	**4**	**5**
Timeframe	To 1960s	1970s-1980s	1980s-1990s	1990s-2000	2000 -
Concept	Warehousing and Transportation	Total Cost Management	Integrated Logistics Management	Supply Chain Management/ Demand Chain Management	Context dependency
Management focus	Operations performance	Optimising operations cost & customer service	Tactics/ Strategies Logistics planning	Supply Chain Visions, Objectives & Goals	Supply Chain Context Mastering flexibility and uncertainty Interconnectedness & Dependency
Competitive aspect			Internal competitiveness	Supply chain competitiveness	Supply network competitiveness.
Organisational design	Decentralised functions	Centralised functions	Integration of logistics functions around logistical flows	Partnering, "Virtual" organisation, Market co-evolution	Co-opetition e-linkages in the network

[25] See e.g. the article 'Materials logistics management' by Bowersox *et al.* in Christopher (1992), pp.38-48.

[26] This table is a revised and extended version of Ross 1998, p.78.

			flows	Outsourcing	Insourcing
Logistical flows	Material	Material (Information)	Material Information	Material Information Services Funds	Information Funds Services Material

The specifics of this development is further outlined below where the developments from *logistics functions,* through *logistics engineering, logistics management*, *integrated logistics*, *supply chain management and integrated supply chain management*, up to *demand chain management* and *extended or virtual enterprises* are described.

4.2.1 Logistics functions

To bring goods from the 'point of origin' to the 'point of consumption' there is a need for transportation. The demand for goods from one 'point of origin' may be geographically distributed over a wide area. To cover the demand that arises in one area within the timeframe available before the demand disappears, the transportation time from the 'point of origin' to the 'point of consumption' has to be less than the timeframe of the demand. If the transportation time is longer than this, then a new 'point of origin' has to be located closer to the potential demand area, so that the transportation time becomes shorter than the timeframe of the demand. This new 'point of origin' may be a warehouse located to be better able to service the customers, i.e. cover the demand. Thereby a chain of transportation and warehousing is established between the initial 'point of origin' for the goods and the final 'point of consumption'. This may be referred to as a physical distribution chain and the management of it may be referred to as it is done in the definition of *physical distribution management* given by the American Marketing Association in 1948:

'*The movement and handling of goods from the point of production to the point of consumption or use*' (Robeson 1994, p.4).

Already in this early phase the 'work of logistics', as described by Bowersox (1997), are seen to emerge. The 'work of logistics' are defined as the five elements of (1) network design, (2) information, (3) transportation, (4) inventory, and (5) warehousing, material handling, and packaging.

Except from physical distribution the work of logistics comprises the management of materials that are needed to produce or construct the goods. This is often referred to as materials management[27]. Now we see two 'schools' of logistics emerge. First the intra-organisational focus, focused at the flow of information and goods related to the manufacturing of goods, often termed material and production planning and control or materials management. Secondly, the flow of information and goods between organisations, or inter-organisational, i.e. inbound and outbound transportation focusing on the transportation aspects, or physical distribution management. Table 4.2 gives an overview of how the logistical functions may be grouped into materials management and physical distribution management, and finally into logistics management.

Table 4.2. From logistics functions to logistics management (from Ross 1998, p.26).

1	Purchasing	Receiving	Manu-facturing	Ware-housing	Trans-portation	Demand forecasting
	Inventory mgmt.	Material handling	Value added processing	Finished goods inventory	Supply channel mgmt.	Order processing/ services
2	Materials Management			Physical Distribution Management		
3	Logistics management					

Before we move on to the 'all-embracing' logistics management, we shall look into logistics engineering.

4.2.2 Logistics Engineering

As described in the historical retrospect of the reliance on logistics, its origins may be found within the military context, and later came to be developed and known as logistics engineering. A well-known textbook within the area of logistics engineering is '*Logistics Engineering and Management*' written by Benjamin Blanchard (1992).

'*Logistics engineering is defined by the Society of Logistics Engineers, SOLE, as 'the art of science and management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans, and operations*' (Blanchard 1992, p.4).

Logistics engineering is different from the business or industrial logistics approach in that it focuses on continued operations of a piece of equipment or a system and how this is prepared for in the design process of the system. As such logistics engineering is more concerned with analysis of the system (facilities) capabilities per se, and not so much the analysis of the supply chains – from point-of-origin to point-of-consumption – bringing forward the necessary support. There is also a focus today within e.g. the

[27] Materials management may also refer to the wider domain of logistics management as presented later. This view is especially distinctive in the school of thoughts that emerged in the Nordic countries, see e.g. Persson *et al*. 1993.

defence organisations to use and rely more on commercial items, more or less freely available in the marketplace, and less on specifically designed items only to be used in defence equipment or facilities. The background for this being the cost position of using a specific, proprietary supply chain for defence material, versus a supply chain based on open-market goods and services. This may also be seen in what is emphasised in what Blanchard (1992) refers to as the 'language of logistics'[28]. As the 'language of logistics' comprise a large number of elements a dedicated, proprietary supply chain will need its own resources for all elements, in stead of having the opportunity to base and rely on resources shared with a number of other application areas. This may improve on both cost and service factors. The downside may be increased vulnerability for the supply chain as part of defence operations, but that is part of the analysis to address and evaluate.

The system or facilities is the point-of-consumption or 'consumer' in the logistics engineering approach. The demand side of logistics engineering is to a large extent given in the design process of the facilities, and one may also say that the demand side (the demand for support to make the facilities operate and do their mission) is the core focus of logistics engineering. Of the two logistical mission elements, service and total cost, logistics engineering focus on both taking the given service level required by the mission of the system or facilities as a basis requirement. The service level shall secure the uptime of the system or facilities. The required service-level is given and logistics engineering must focus on how to make the logistics support cost-effective. The emphasis on maintaining continuous operations and the required service of the support 'structure' is by Blanchard's (1992) referred to as 'measures [or factors] of logistics' where also the order of the factors should be noted[29]. First one should be able to rely on it (reliability), then be able to fix it and continue operations (maintainability). Total cost in the logistics engineering approach is seen in the *life-cycle perspective* while business logistics sees it in a supply chain perspective throughout the actors in the supply chain. Balancing investments, i.e. design of facilities, against operational cost is therefore at the core of logistics engineering.

4.2.3 Logistics management/ Integrated logistics

The *mission* of logistics management is related to two elements. First is the *service* element that addresses the alignment of demand and supply, i.e., to have supply available to fulfil a given demand within a pre-defined time. The other is *cost*, i.e., the

[28] Blanchard (1992) names the following twenty areas to be part of the 'language' of logistics: (1) systems engineering, (2) concurrent engineering, (3) logistics support, (4) integrated logistics support, (5) logistics engineering, (6) logistics support analysis, (7) reliability, (8) maintainability, (9) maintenance, (10) maintenance level, (11) maintenance concept, (12) maintenance plan, (13) total productive maintenance, (14) supportability, (15) human factors, (16) producibility, (17) total quality management, (18) system effectiveness, (19) life-cycle cost, and (20) cost effectiveness.

[29] Blanchard (1992, pp.26-93) give the following list of measures or factors of logistics: (1) reliability, (2) maintainability, (3) supply support, (4) test and support equipment, (5) organisational, (6) facility, (7) transportation and handling, (8) software, (9) availability, (10) economic, and (11) effectiveness factors.

total cost position of obtaining the alignment of demand and supply throughout the whole supply chain. Thus, supply chain management is concerned with matching demand and supply in the most cost-effective way, taking a holistic view of the supply chain from 'point-of-origin' to 'point-of-consumption'.

Logistics management is based on the interdependent logistical flows of material and information. The duality of the material and information flows is in the logistical theory known as the *integrated logistics* concept[30]. Among the information and material flows the information flow is the driver and the one to focus on if one is to improve the supply chain dramatically. It is often said that 'the flow of material can not be better then the flow of information'. This may be true, but the flow of materials is though the one needed to understand to start creating knowledge. The flow of information may be a supply chain in itself, e.g. in the supply chains of the financial services where the 'flow of material' or the products, which are financial derivatives, are in themselves information or virtual/intangible objects.[31]

As was shown in Table 4.2 above, logistics management comprises materials management and physical distribution management. Thereby logistics management connects the inbound side with the outbound side of the company, and integration is a key subject in logistics management and integrated logistics. The core of the integration is to align the inbound side of the company with the outbound side as cost-effective as possible to meet service requirements. The means to obtain this is intra-organisational integration along the logistical flows, i.e. the flows of material and information, and integration of the logistical flows themselves. Integrated logistics is then a concept by itself, as it presents the core of the logistical thought in aligning both resources and flows towards the mission of serving a stated need with a given level of service in a cost effective way.

As the use of information technology and broad world wide networks increases, there becomes a need to make the information flow more 'transparent' so that it is easier for the actors along the supply chain to make use of information to enhance the physical supply chain. Transparency of information has raised the possibilities and challenges within logistics management to a new level. The emergence of 'e-'type of solutions is an example of this.

4.2.4 Supply chain management / Integrated SCM

Supply chain management extends logistics management to comprise *external integration of logistics oriented processes* among several individual companies and organisations that as a whole make up the total supply chain from point of origin to

[30] See e.g. Bowersox *et al.* 1996, pp.33-40.

[31] Financial systems are referred to by Meister (1991) as an example of idealised logistics systems. 'Financial institutions may seem like odd man out in this company [distribution systems], but systems such as banks and the stock market essentially *store* and *distribute* wealth in various forms' (Meister 1991, p.105).

point of consumption. As such supply chain management takes logistical management and integrated logistics into the inter-organisational context.

'To be fully effective in today's competitive environment, firms must expand their integrated behaviour to incorporate customers and suppliers. This extension, through external integration, is referred to as *supply chain management*' (Bowersox 1997, p.34)[32].

The term supply chain management has been used at least since 1982, when Oliver and Webber published their article "Supply chain management: logistics catches up with strategy" (Christopher 1992). The terms used are both supply chain management and integrated supply chain management, but they are both inter-organisational concepts that comprise the same elements. Some authors use supply chain management, while others use integrated in addition to emphasise the focus on integration.

With supply chain management, i.e. an inter-organisational context, a new competitive entity is born. The supply chain has been raised as the competitive business entity to address, where it is the combined resources and competence of the supply chain that brings competitiveness, not the single firm or business unit.

'Integrated supply chain management implements a co-ordinated total supply or value chain from determination of external customer needs through product/service development, manufacturing/operations and internal/external distribution, including first, second and third tiers customers/suppliers. The objective is to provide the highest customer service and satisfaction levels and make the most effective use of the competencies of all organisations in the supply chain. *The supply chain, versus the single business unit, is positioned as the competitive unit*.' (Frayer *et al.* CLM 1997, pp.346-7).

Copper *et al*. (1997) and Lambert *et al*. (1998) published in two articles the idea of supply chain management extending beyond logistics, and draws the integration aspect further into that supply chain management is about integration of business processes;

'*Based on the review of literature and management practice, it is clear that there is a need for some level of co-ordination of activities and processes within and between organisations in the supply chain that extends beyond logistics. ... The integration of business processes is what we call supply chain management*' (Copper *et al*. 1997, pp.1-2).

Though, there may be a danger in presenting supply chain management as the integration of business processes view in that what originated from logistics management may be led to comprise all aspects of inter-organisational management. That may contribute to undermine the specific contribution of logistical concepts and logistics and supply chain management as a domain of knowledge.

The definitions of logistics has though been influenced by the ongoing development in supply chain management definitions and practice. The Council of Logistics Management, CLM, changed their definition of logistics management to apply to the developments of SCM;

[32] 'From the perspective of the total supply chain, efficiency is improved by eliminating duplication and waste. However, cross-organisational co-ordination requires joint planning and relationship management' (Bowersox 1997, p.26).

Table 4.3. The development in CLM's definition of logistics management.

Year	**Definition** (see www.clm1.org)
1986	'*Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information flow from point-of-origin to point-of- consumption for the purpose of conforming to customer requirements*'
1998	'*Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customer requirements*'

The change in CLM's definition of logistics management shows the transformation of logistics management from being its own entity, to becoming part of a greater set of business processes in the inter-organisational context.

The commonalties of the supply chain management literature are by Cooper *et al*. described to be:

- 'It evolves through several stages of increasing intra- and inter-organisational integration and co-ordination; and, in its broadest sense and implementation, it spans the entire chain from initial source (supplier's supplier, etc) to ultimate consumer (customer's customer, etc.).
- It potentially involves many independent organisations. Thus, managing intra- and inter-organisational relationships is of essential importance.
- It includes the bi-directional flow of products (materials and services) and information, the associated managerial and operational activities.
- It seeks to fulfil the goals of providing high customer value with an appropriate use of resources, and to build competitive chain advantages' (Cooper *et al*. 1997, p.4).

As a last comment with respect to the correlation among logistics and supply chain management, the following quote from Ross (1998) may draw it all together;

'It has already been discussed that integrated logistics management constitutes the tactical side of the SCM concept. In addition, there can be no denying that in the emergence of modern logistics can be found the seedbed of SCM. As the role of logistics has expanded from a preoccupation with warehousing and transportation to today's concern with integrating the logistics operations of the entire supply channel, SCM has been instrumental in merging the marketing and manufacturing with the distribution functions to provide the enterprise with new sources of competitive strength. In addition, the application of SCM can be seen in the integration of logistics activities among supply chain partners in the pursuit of shorter cycle times and reduced channel costs' (Ross 1998, p.24).

4.2.5 Demand chain management

Within logistics there is a demand side and a supply side. Logistics and supply chain management comprise both sides in their approaches. As the requests for customer specific products and solutions increases, and with increased complexity in many products among others in the consumer markets, as well as logistics and supply chain management concepts being applied to new areas, the management of the demand side has been elevated. Demand chain management, DCM, is a concept that has been taken into use to address this, but for practical purposes it may be said to be another name for supply chain management;

‘Is SCM the best term for this integrated management form? SCM was first proposed in 1982. More recently, the term *demand chain* has been suggested to provide additional focus on the customer. Since the end consumer is the focus of the entire supply chain, all members of the chain are suppliers to the end user. Hence supply chain may still be the appropriate terminology’ (Cooper *et al*. 1997, p.10).

If demand chain management is just another name for supply chain management it could have been presented together with supply chain management and integrated supply chain management. In this overview of the developments in logistics and supply chain management it is presented on its own. Demand chain management as a concept have aspects that are important specifically for supply chain management within the project context.

The concept of *demand* chain management was first used by a group of researchers and academics at the International Institute for Management Development, IMD (see Vollmann *et al*. 1995). However, the focus on the demand side, e.g. in production planning and control, is not new which may be seen through the development of the quantitative planning and control approach to materials requirements e.g. as presented in Orlicky (1975). As with supply chain management the objective of demand chain management is to;

‘develop synergy along the whole supply and delivery chain, from your suppliers’ suppliers, to your customers’ customers in order to satisfy the demand of the end customer’ (Vollmann et al. 1995 p.2).

The contributions of demand chain management is as supply chain management related to the logistical mission. Although the service element is left out, the element of value enhancement is kept, as was seen in the commonalities of SCM literature as presented by Cooper above;

’The DCM synergies are twofold: a reduction of cost and an increased value of the bundle of goods and services provided’ (op cit.).

Although demand chain management on first sight may be seen to be very closely related to supply chain management it addresses an aspect that is worth while to consider. By addressing the *demand* it gives emphasis to what is the driver of the supply chains and the process that lies behind developing and fulfilling that demand, and the impact that the supply chain, i.e., the supply chain actors, has in that process. Especially for more complex products, where the design and engineering processes of developing or customising a product to its need (the demand) is important with respect to the value that the product will have as part of the customer’s business.

‘The application of demand-driven techniques is most appropriate in situations where requirements are independent. … to provide maximum response to what occurs in the marketplace …’ (Bowersox *et al*. 1997, pp. 491-492).

Although this quote is related to the consumer market it may still be appropriate to use it for the project context. It is in this context that the requirements are most independent, i.e. the ‘one-of-a-kind’, ‘unique’ characteristics of the project object and the project-oriented context.

The design and engineering processes are the demand generating processes in the project context of the oil and gas industry. The design and engineering processes have impact on the supply chains both for fabrication and construction, as well as operations. The focus within demand chain management on the customers demand side help to integrate supply chain management more with total quality management, in realising the product that meets the demand, i.e. the customer’s specifications and requirements, this is e.g. described in Kanji *et al*. (1998).

The importance of addressing demand as part of the alignment of demand and supply is found in another recent supply chain management source (Gattorna 1998). They say that;

‘Most of the material presented in this book is new and previously unpublished. It reflects next-generation thinking about management of the supply chain for success. And while there will be many differing perspectives on the issues, some key themes emerge. Most powerful of them all is the message of *alignment* [of demand and supply in the supply chain] – a message about the sophisticated integration of all the attributes so that the supply chain operates as a single, integrated, cost-effective system’.

Demand chain management is also seen to emerge in another, more agile or fast and flexile oriented perspective[33]. This approach assumes among others that it should be possible, through smart use of information technology, to anticipate the customer demand prior to him ordering. I.e., when the demand arises, the goods or service needed is in place to cover the demand, without the customer ordering it;

‘A first step in releasing the value locked away in inefficient supply chain practices is to pose the problem in terms of the "*demand chain*", say Thomas Vollmann and Carlos Cordon. Demand chain thinking starts from the customer's needs and works backwards, replacing narrow focus on transport costs with consideration of how to achieve "mass customisation". This entails ever more precise, swift and efficient delivery of product/service bundles, which in turn places considerable demands on the information systems along the chain. But given good management of the right systems, suppliers should be able to anticipate customer companies' needs and deliver what is needed without the need for ordering. Internet technology -- via which suppliers can hook up to customers' intranets at very little cost -- can play a big part in this. *Such approaches require companies continuously to transform the way they work together. Information systems are important but are best seen as a fast follower of this strategic process rather than as a driver*’ (Vollmann *et al*., 1999).

As the quote above mentions, there are new concepts and strategies that lead, with technology as an enabler and adding value when being used to realise a strategy. This is followed up by a quote about ‘hyper-competitive’ markets, where the emphasis is put on the demand chain to be able to become customer-oriented in a fast and flexible context.

‘Many manufacturing companies are implementing new information systems to improve their supply chain management. These projects typically cost tens or hundreds of millions of dollars and take four or five years to complete. This is fine in moderately competitive markets, says Donald Marchand, but in hypercompetitive markets, where competitive advantage is sustained by continuous short-term changes,

[33] See Financial Times series on ‘Mastering information management’, ‘Information in the demand/supply chain’, Monday February 22nd 1999.

the time and expense are likely to be excessive. *Such markets require a "demand chain" approach, which focuses on fast, responsive interactions with the customer*; unlike moderate markets, standardisation of data upstream -- in financial and inventory management systems, say -- is not the main source of advantage (and may even be a hindrance as the competitive environment evolves)' (Marchand, 1999).

As discussed above demand chain management may comprise many of the elements of supply chain management. It should not be a competing approach to supply chain management, rather a complementary approach. I.e., the context in which each should be applied should be governing which approach to use. In the discussion of supply chain management in the project context, the discussion of the context influence on the choice of a supply chain or a demand chain approach will be further elaborated. The project context of the oil and gas industry could utilise both approaches in a constructive way.

4.2.6 Extended or virtual enterprises

The supply or demand chain management concepts, and their 'integrated' focus, base much of their perspectives on what may be termed extended or virtual enterprises. However, there are, or maybe more correctly should be, differences between the use of the two terms *extended* enterprise and *virtual* enterprise. Both are inter-organisational constructions, comprising the several organisations taking part in, or being the analysis focus of, the larger supply chain or supplier and producer network. The differences between the two should be in their duration and focus. As such a virtual enterprise may be said to be a sub-set of extended enterprises. Let us use one definition of a virtual enterprise that we feel addresses this point (Goranson 1999, p.65 and p.66);

'Our virtual enterprises are opportunistic aggregations of smaller units that come together and act as though they were a larger, long-lived enterprise. The *virtual* here is meant to convey that many of the advantages of a larger enterprise are synthesised by its members. In the most interesting case, this synthesis is *temporary*, built around a *specific opportunity*. ... A virtual enterprise is a temporary aggregation of core competencies and associated resources collaborating to address a specific situation, presumed to be a business opportunity' (Goranson 1999, pp.65-6).

Another quote reflecting the difference between extended and virtual enterprises is given by Jagdev et al. (1998);

'To some extent, it is a question of semantics, and perhaps the degree of integration between the enterprises and the objectives of the co-operating partners. One could state that, relatively speaking, in a virtual enterprise the degree of integration is closer and especially its scope of co-operation is wider. The extended enterprise can be considered as a special case (and a subset) of the virtual enterprise. Virtual enterprises usually operate in niche markets, are project based and tend to have, relative to extended enterprises a shorter life span. They form and reform based on market needs' (Jagdev et al., p.227).

We see that Jagdev et al. take the opposite position from us. They say that the extended enterprise is a sub-set of the virtual enterprise, as we said the opposite. We still believe that the virtual enterprise is a sub-set of the extended enterprise. However, as Jagdev et al. say, this is (to a large extent) semantics.

Further, Goranson defines four types of virtual enterprises that meet his view and definition of a virtual enterprise. These four types are given in Table 4.4 below.

Table 4.4. Four types of virtual enterprises, as defined by Goranson (1999).

Type 1;	An aggregation formed in response to an opportunity.
Type 2;	A relative permanent aggregation of core competencies that largely pre-exists, and which is seeking an opportunity.
Type 3;	A supplier chain which, while using relatively conventional business relationships, exhibits agility[34] in responding to market needs.
Type 4;	A bidding consortium.

As such an extended enterprise could be said to comprise much of what we think of when talking about the repetitive, long-term supply chains of e.g. a car manufacturer. On the other side, a virtual enterprise could also e.g. be seen as the extended project organisation or the project supply chains of a large-scale development project.

4.2.7 Future developments of logistics concepts

As the historical outline of the developments of logistics management and its derivatives shows, the trend goes from specific functions that has or had to be performed and was regarded as part of the overriding term logistics. The conceptual developments have ended with bringing the mission of logistics into the larger inter-organisational and integrated context of the supply chain, to be able to analyse the totality and its inter-relationships and cost position.

'Originally, logistics had a transportation and warehousing focus, which has gradually evolved into a "customer driven" integrated management system focus' (Novack *et al*. 1995, p.27).

The search has gone from the functional view to the view of competitiveness, where one seek to develop concepts that contributes to make visible the impact that elements and concepts from logistics may have on business competitiveness. In addition the organisational scope and context that is necessary to address and enhance the value that logistics may bring. In summary one may say that the focus is turned towards the environment and context, that logistics and supply chain management concepts and methodologies are to be applied to, as well as the core contributing elements of logistics and supply chain management in the given environment and context.

[34] We will return to the term agility below.

Table 4.5. Future themes for logistics and supply chain management.

Author	Emerging important aspects and elements
Novack *et al*. (1995)	Six emerging themes; Leadership and differentiation, marketing, scientific management, capability to integrate, ownership of responsibility, and value enhancement focus internally and externally.
CLM (1998)	Positioning, integration, agility, and measurement.
Gattorna (1998)	Alignment of demand and supply.
Goranson (1999)	The Agile Virtual Enterprise. Risk and reward sharing, light contractual formats.

As stated above the Council of Logistics Management has contributed to bringing forward much knowledge and theoretical aspect concerning logistics management, and primarily business logistics. They have also given their contribution to outlining emerging perspectives and concepts within the logistics management domain (CLM 1995). CLM outlines four perspectives/concepts as important to be able to keep up with the challenge of continuous change. The four concepts are; (i) *positioning*, (ii) *integration*, (iii) *agility*, and (iv) *measurement*.

One may say that what CLM proposes with their four concepts is to make better use of some core elements to understand and elevate the role and development that logistics and supply chain management has to focus on in a context where uncertainty and change are aspects that have to be dealt with specifically and proactively.

Focusing more specifically on alignment of demand and supply is another emerging aspect (Gattorna 1998), especially driven by the emerging 'e-'type solutions, which will become 'natural' business processes. As well as CLM's four concepts to survive and thrive in a changing world, the alignment aspect brings with it a need to better understand the core drivers or fundamentals that lie behind logistics and supply chain management. I.e., to know what the strategic basis is, as well as knowing which concepts and approaches to apply when and where, so that all relevant 'attributes' are integrated to make an 'optimal' supply chain.

'And while there will be many differing perspectives on the issues, some key themes emerge. Most powerful of them all is the message of *alignment* [of demand and supply in the supply chain] – a message about the sophisticated integration of all the attributes so that the supply chain operates as a single, integrated, cost-effective system' (Gattorna 1998).

More specifically one may say that the future development of logistics concepts will clarify and make more and better distinct use of the core concepts of logistics and the supply chain derivatives. That means that the further developments will address *core concepts* used in a *context specific* way. By contextually dependent is to be understood that the characteristics of the context will guide the development of specific logistics management derived solutions and 'concepts', based on a set of clearer and better understood core concepts.

'A final, and perhaps the most significant, reason for integration is that the complexity of future logistics will require innovative arrangements. The challenge for the new millennium is to develop *new ways* of satisfying logistical requirements, not simply using technology to perform *old ways more efficiently*' (Bowersox 1997, p.695).

As many developments in the future is seen to be more temporary and flexible in utilising upcoming, and often short term business opportunities this should also be seen as an upcoming element of logistics management developments. This is presented through Goranson's focus on the agile virtual enterprise (Goranson 1999).

The temporary aspects should open up for bringing aspects and elements from the project context into developing logistics concepts further. Aspects and elements from the project context and project management could contribute especially with focus on the ability to integrate organisation and business in the temporary, short-term perspective. Integrating organisations and people in the short term view may draw on both the channel oriented thinking of logistics with the objective orientation of the project context. Integrating business in the short term may draw on developments from the project context and project management within e.g. contract strategy and contractual relationships.

4.2.8 Summary of logistics and supply chain management

Above the development of logistics and supply chain management from its functional origins to its current status as a management concept has been presented. These developments have brought logistics and supply chain management back to the strategic importance as Alexander the Great gave it as a 'winning strategy' in his warfare.

Supply chain management has originated from developments within logistics management. From its origin logistics was concerned with the movement and storage of goods to bring the goods from the place where they originated to the place where they were 'consumed', this is named the logistical *material* flow. Later the focus of logistics came to include the flow of information that underlies the flow of materials, i.e. the logistical *information* flow.

The *mission* of logistics management is related to two elements. First is the *service* element that addresses the alignment of demand and supply, i.e., to have supply available to fulfil a given demand within a pre-defined time. The other is the *cost* element, i.e., the total cost position of obtaining the alignment of demand and supply throughout the whole supply chain. Thus, supply chain management is concerned with matching demand and supply in the most cost-effective way, taking a holistic view of the supply chain from 'point-of-origin' to 'point-of-consumption'.

Logistics management is concerned with obtaining the logistical mission based on *integration* of logistical material and information flows and organisational functions. Integration of flows means to see the logistical flows of material and information as interdependent processes. Organisational integration means to integrate the organisational functions into processes supporting the logistical flows, of material and information. The flow of material was the object of managerial attention, and the cost-bearing element, but the flow of information comprised the mechanisms used to initiate and control the flow of material. In logistics management this is all seen within the boundaries of a given organisation (firm).

With the move towards businesses focusing on core competence and as the value of externally procured goods and services increased compared to the value created internally, the need arose to extend the logistics management into the suppliers on the inbound logistics side. The importance of conforming to the operations and requirements of the customer established the need to bring the actors on the outbound logistics supply chain into developing and improving logistics management. Thereby supply chain management was developed as a concept.

Supply chain management brings logistics management into the inter-organisational context by addressing the logistical flows and organisational integration in the perspective of the supply chain, comprising several independent actors (firms). An important aspect here is that the supply chain is regarded as the *competitive unit*, i.e., each firm is competing as part of a supply chain and the objective is to establish supply chain relationships and processes that give the actors an asset compared to other supply chains. In the theory of supply chain management the flow of *services* and *funds* between the supply chain actors are added as the third and fourth logistical flow. As the flow of funds comprises much of the *incentive mechanisms* in making the supply chain operate it should be given special emphasis. Especially in the project context where the flow of funds is comprised in contract strategies, payment formats and payment schedules. Risk and reward sharing schemes are also part of the flow of funds, and are important elements to obtain supply chain management schemes in the project context.

Demand chain management is the latest term that have emerged in the academic world of logistics and supply chain management. For most practical purposes it may be regarded as the same as supply chain management, but as described, dependent on the context in which supply chain management shall be approached it may be useful to give special emphasis to *demand chain* management.

Logistics engineering focuses still more on the supply chains role in the life cycle perspective of an object. With a basis from defence applications that addressed the necessary logistical resources needed to maintain the combat responsiveness and availability of military equipment, it gained attention in industrial context where an object has to be developed taking the resources necessary to support its operation into account.

Further developments within the domain of logistics and supply chain management has been suggested should extend along the lines of focusing more directly on the core, contributing elements of logistics and supply chain management, and how these may be differentiated in use to apply to the specifics of given environments and contexts. I.e. contextually dependent logistics and supply chain management.

4.3 Uncertainty in logistics and supply chain management

Uncertainty in logistics and supply chain management is primarily related to the processes taking place between the two logistical 'end-points', i.e. the 'point-of-origin' and the 'point-of-consumption', where most of these processes are related to the *alignment of supply and demand*. The demand and supply processes will take different forms and rely on different formats and technologies when being 'transported' through the supply chains, dependent on the range of manufacturing types from *one-off* to *continuous* process. There is a large span in both volume and part variety among the different 'manufacturing' types, as seen from Figure 4.1.

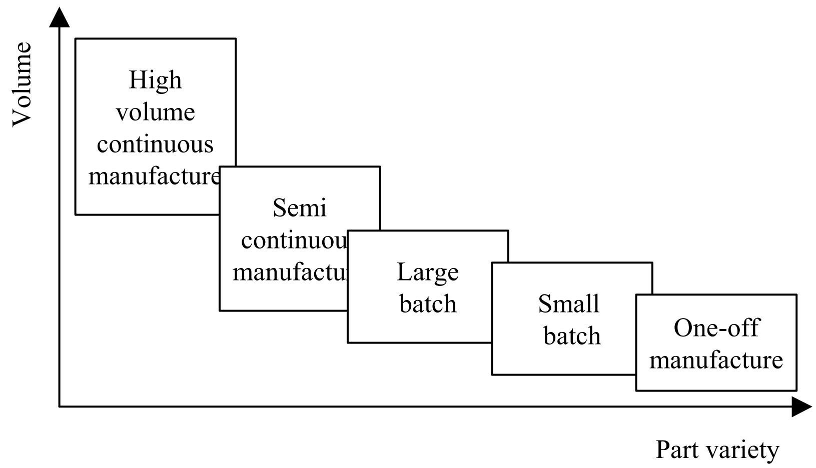

Figure 4.1. Span in parts volume and variety, dependent on type of 'manufacturing'.

It will be differences in the demand and supply processes dependent on the manufacturing type. These differences will also differentiate the type of uncertainties that may affect the logistics and supply chain processes. Uncertainty in the logistics and supply chain focus of demand/supply alignment, may also be related to the project context and the 'what's' and 'how's' of the project space. In such a perspective the uncertainty with respect to demand and supply may be seen as;

- *Demand* uncertainty - uncertainty with respect to '*what*'.
- *Supply* uncertainty – uncertainty with respect to '*how*'.

In addition to these, there are the issue of the meeting point between demand and supply, i.e. the aspect of time – uncertainty with respect to *when*. Then uncertainty may relate to what is needed, how to get hold of it, and when it is needed.

4.3.1 Demand

Demand processes vary from re-ordering mechanisms to replenish standard consumer goods or industrial parts, to interactive processes aimed at specifying what is needed to build complex one-of-a-kind products, e.g. project objects in oil and gas development projects.

Many of the demand triggering mechanisms in e.g. the fast-moving consumer goods, FMCG, market today are using point-of-sale type of technologies to catch and use demand information as close to the end-user, or point of consumption, as possible. As products in the FMCG market are examples of high volume and semi-continuous manufacturing type of products, they have a short time-scale from indication of need to delivery or replenishment. The demand processes in consumer goods markets are more characterised by *which amount, where*, rather than *what, to which specifications* that is more characteristics for determining the demand in the project context.

‘The future it has been suggested, is a combination of the known and the unknowable. The proportion of the latter tends to rise as the time-scale extends’ (Rosenhead 1989, p.194).

Uncertainty with respect to the demand in the future increases the longer into the future we see, or the longer time there is from the initial time a demand is set and until delivery is done. In the continuous and repetitive type of industries pull-oriented systems, often enabled through electronic re-ordering or replenishment systems have short response times, and the question is not so much what to replenish, rather how much and where to. Another situation is that of the one-off type of manufacturing. Such products are often large, e.g. like offshore oil and gas development projects, and there is long development and specification processes that underlay the demand definition of such manufacturing types. There is a long time-span from the initial demand specification up to the point when the goods or service has been delivered and the demand is fulfilled. Throughout the time cycle from the initial demand to delivery, there is possible to alter the initial demand specifications and thereby initiate change processes, as is familiar in engineering in the development phase of the project life cycle.

4.3.2 Supply

Supply processes in the high-volume setting of continuous and repetitive types of manufacturing often make use of already established supply and distribution processes and services. The question is often how much to replenish, of which products to which location. For the one-off situation in the project context *the ability to supply*, within the time frame available after the demand is specified, is the important issue. In the development phase of the project context many suppliers have one delivery, and then it is often of critical importance for the progress of the project object development that delivery take place as scheduled, otherwise the whole project schedule may be postponed. This is often part of the project planning and control activities, to monitor each supplier to see that their progress is so that they will be able to deliver on or before schedule.

If there are critical items, but of a nature so that there are several suppliers to choose among and reasonable cost compared to the value of having it on time, e.g. some welded steel items, then e.g. more orders have been made than actually needed. An example is that when twenty items were needed, five items were ordered from each of five suppliers. That was an excess of five items, but in the end one of the suppliers were not able to deliver in accordance with the schedule and the added insurance of having one supplier in excess proved to be a well suited supply insurance.

Below we will address uncertainty in the logistics and supply chain domain through a three-staged pyramid approach.

4.3.3 Growing opportunities and controlling risks

When describing uncertainty in the project context the difference and importance of the two sides of uncertainty, opportunity and risk was stressed. Uncertainty comprised both a wanted side, given by business oriented opportunities, as well as an unwanted side given by the presence, occurrence and materialisation of risk elements. Also within supply chains and supply chain management the two-sided uncertainty perspective could be useful. The two-sided aspects of uncertainty may be related to the logistics and supply chain context by Copacino's (1997) 'customer service pyramid'. In the '(customer) service pyramid' service elements are divided into three categories and related to the financial and market share impact of each. The first category is *reliability*, which constitute the basis, but that by itself will make you lose in the marketplace. The second category is *resilience* that enables you to adapt to the situation and be able to resume the supply chains mission if brought out of 'balance'. Resilient aspects will enable a company or supply chain to maintain its financial and market position. The third and final category is *creativity*, where you use new and improved ways of working, and thereby gain on both your financial and market position.

Table 4.6. The relation between uncertainty and the 'service pyramid'.

The two aspects of uncertainty	The elements of the 'service pyramid'.
Dealing with *opportunities*	Creativity
Dealing with *risks*	Resilience
	Reliability

If we relate the elements of the 'service pyramid' to the two aspects of uncertainty, we may say that the reliability and resilience part is related to risk aspects, or dealing with such, and that creativity is related to the opportunity side, or the ability to dealing with opportunities. The 'service pyramid' thereby becomes an approach to supply chain management in the uncertainty of the project context. This may be developed further by rewriting the 'service pyramid's' classification of reliable, resilient and creative supply chains and transferring them to the project context. Following the outline of the 'service pyramid', the supply chains related to a project may be divided into three groups: *active*, *reactive*, and *pro-active* supply chains. The difference between these three groups may be said to be that the active supply chains are those that are planned and executed as planned, while the latter two are not executed as planned, but are proactively planned for uncertainty situations, i.e. to handle risk or opportunity elements. The reactive supply chains are activated due to an ‘emergency’ situation, as contingency for unforeseen events. The pro-active supply chains are also activated based on an emerging need or request, though they are not initiated due to an ‘emergency’-like situation, but because they may improve time, cost or qualitative aspects of the project’s product, e.g. as part of design changes. Table 4.6 above then have to be revised as presented in table 4.7.

Table 4.7. Uncertainty elements and the ‘revised’ service pyramid’.

Uncertainty related aspects	**Elements of the ‘revised service pyramid’**
Focusing on opportunity elements	Pro-active
Focusing on risk elements	Re-active
A certain world, i.e. no uncertainty.	Active

Figure 4.2 juxtaposes Copacino’s ‘service pyramid’ and the ‘revised service pyramid’, aimed at the project context. The active supply chains may then be seen as the reliability element, i.e., those supply chains that must be a basis to realise the project’s product. The reactive supply chains may be seen as the resilient element, i.e., the supply chains that shall get the project back on track if something happens to the active supply chains, e.g. a supplier that is not able to deliver. The proactive supply chains are then those supply chains that will be necessary if the project is to be able to pursue better opportunities during the project’s life. The proactive supply chains are as such the creativity that shall enable the project, or its product to gain value above what is planned.

As shown in Figure 4.2 the two lower groups of supply chains may together be termed as giving ‘*operational robustness*’, while all three groups of supply chains together may be termed as giving ‘*business robustness*’ or ‘*project value robustness*’. We have then ended with this three-class separation of supply chains taking the aspects of uncertainty into account, and how these may be seen to contribute to robustness on two levels.

A question may then be raised whether this is important for logistics and supply chain management in the project context? Projects are temporary undertakings, with given time and cost targets, but with an emerging trend to regard value enhancement throughout the development phase. To become ‘operationally robust’ there is important that the processes that are about to realise the project’s product are robust, so that ‘nothing’ may prevent the creation from taking place, and the project’s product will be realised within time and cost targets. Seen from the perspective of ‘business robustness’ the project shall be value generating, so the upside of uncertainty – the value generating opportunities – must also be secured within the supply chain approach. The “business robustness" perspective may also be seen in the life-cycle perspective of the project object. The opportunity side of uncertainty is often related to elements that bring about improved operational performance of the project object, but although the creativity of the supply chains are aimed at the operations phase they often have to be implemented in the development phase.

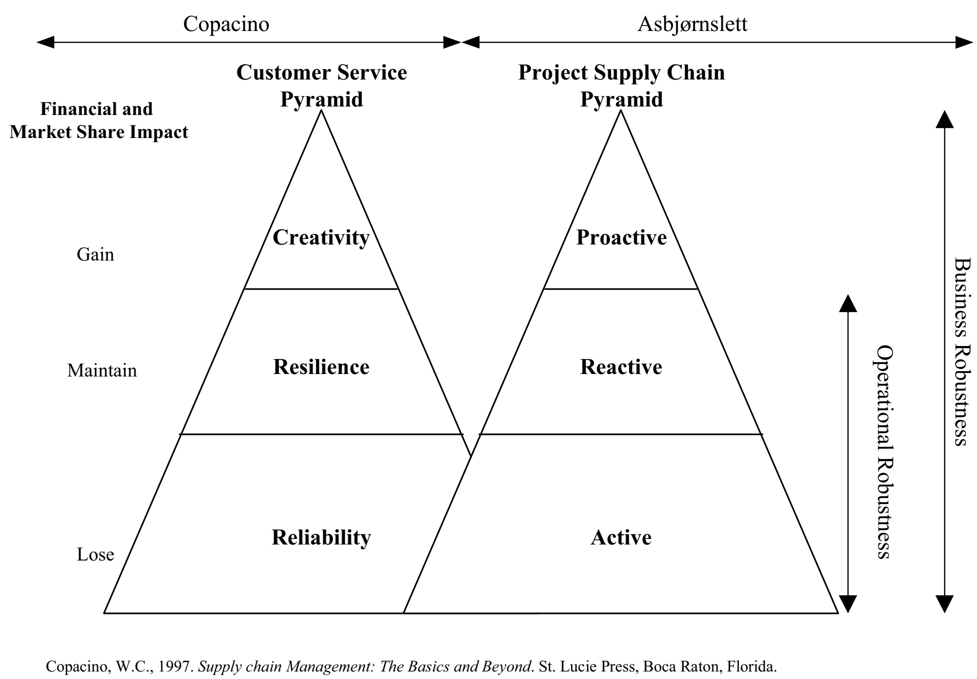

Figure 4.2. The customer service pyramid[35].

4.4 Some lessons from manufacturing

Several management concepts have emerged from the manufacturing domain. Among others the car manufacturing industry has been central in many of these developments. That many of these have been regarded as important may be seen in Fortune Magazine's rating of the businessman of the century (Fortune 1999), where Henry Ford of Ford and Albert P. Sloan of General Motors were among the four top contenders[36].

[35] Source: Revised from Copacino, C.W. 1997. *Supply Chain Management. The Basics and Beyond*. St. Lucie Press, Boca Raton, Florida.

[36] Among Henry Ford's new ideas and concepts was the concept of mass-production and the assembly-line to the manufacturing of 'complex' products, in Ford's case the automobile, for consumer use. Albert P. Sloan is said to have 'invented the art of organising and managing a large corporation' through a group model with a corporate office supporting autonomously operating divisions, co-ordinated through a set of 'standard procedures'.

Among concepts developed within among others the car manufacturing industry are the two concepts *lean* and *agile*. We may now raise a question regarding why we address these, and what development projects can learn from manufacturing. A project, through its life cycle has phases with different characteristics, from the one-of-a-kind situation, and rather short and temporary timeframe of development, to the repetitive processes and longer time frame of operations. The two manufacturing concepts lean and agile represents, in our view, two opposite approaches to manufacturing. Therefore, within these two concepts we want to address elements and aspects that could have a contribution to developing logistics and supply chain management in the project context.

Central to lean management is the elimination of waste. Thereby the focus is set on cost effectiveness and cost efficiency. This has particular importance in an operations setting, were a repetitive setting makes up the ground for continuous improvements. Central to agile management is mastering change and uncertainty. Change and uncertainty come by because there are business opportunities that we want to follow, but following these opportunities mean that we have to take the inherent risks into account. The supply chains and each actors role in them have particular influence on how agile we are or may be, and how well we are prepared for mastering this situation. The project-oriented context of the upstream oil & gas industry has been known for, especially technological, discontinuous improvements, and agile characteristics are important in such situations, as well as approaching the extended project organisation as an agile virtual enterprise.

4.4.1 Lean Production

Lean manufacturing or 'lean thinking' was brought to the public by the book '*The Machine that Changed the World*' (Womack *et al*. 1990). The book was one of the deliverables from the International Motor Vehicle Program. The sub-title of this book has a quite far-reaching hypothesis as it says that;

'The story of lean production – How Japan's secret weapon in the global auto wars will revolutionise western industry'.

Lean production methods as we have been used to know them were pioneered by Toyota in Japan, often referred to as the Toyota Production System. However, many of the underlying thoughts that led to lean concepts originated outside of Japan, and were imported to and refined in Japan under the build-up of the Japanese industry after World War II. One of these sources of knowledge was the North American movie industry, that in the 1930's was configured much as the industries we learn as lean today;

'The market was dominated by a few large, stable companies. … They were deeply vertically integrated, … . Competition among them drove them to what we today call lean manufacturing practices; flat organisations, pre-qualified suppliers, a version of just in time practices' (Goranson 1999, p.38).

Some claim that the success of developing lean concepts and organisational principles in Japan were due to their special way of organising into keiretsu's[37], based on their old feudal system, but in a 'democratic' form and focused on the market pull of business (Goranson 1999, p.38-9). The extended keiretsu 'organisation' could make it easier to obtain the necessary integration between inter-organisational entities that is necessary to 'drive out' as much waste as possible, in the search for cost efficiency;

'Japanese manufacturers were able to excel because their monolithic, vertically-integrated keiretsu were able to gather and lock in the majority of suppliers and dictate integration standards to the remainder. It is a crude way to integrate an enterprise; it trades agility for integration' (Goranson 1999, p.56).

The thoughts and concepts proposed by lean manufacturing have found foothold in western industry and are becoming more important as industries mature, margins are set under pressure, with an increasing pressure for cost effectiveness and efficiency, as sources of value enhancement. This is reflected in the five lean principles (Hines *et al*. 2000, p.4);

1. '**Specify** what does and does not create **value** from the customer's perspective and not from the perspective of individual firms.
2. **Identify** all the steps necessary to design, order and produce the product across **the whole value stream** to highlight **non value adding waste**.
3. Make those actions that create value **flow** without interruption, detours, backflows, waiting or scrap.
4. Only make what is **pulled** by the customer.
5. Strive for **perfection** by **continually removing** successive layers of waste, as they are uncovered'.

As can be seen from the lean principles, the aim is *value enhancement* based on *cost* effectiveness and efficiency, i.e. using costs effectively and efficiently to enhance value as perceived by the customer. This should be obtained through *waste reductions* refined through *continuous improvements*. As with the developments within logistics management lean thinking starts within the confines of the single company, but then extends into the inter-organisational arena of customers and suppliers, just as logistics management extends to supply chain management. The term used in lean thinking is not the supply chain, but the 'value stream'[38] that is found within the supply chain;

'In order to go lean, you need to understand customers and what they value. To get your company focused on these needs you must define the value streams inside your company and, later, the value streams in your wider supply chain as well' (Hines et al. 2000, p.4).

What is not perceived to bring value is perceived to be waste. Lean thinking make use of the seven wastes as defined within the Toyota Production System; (i) overproduction, (ii) defects, (iii) unnecessary inventory, (iv) inappropriate processing, (v) excessive transportation, (vi) waiting, and (vii) unnecessary motion. Both value creation and

[37] Keiretsu: A network of businesses that own stakes in one another as a means of mutual security, especially in Japan, and usually including large manufacturers and their suppliers of raw materials and components. (www.dictionary.com).

[38] The term 'value stream' is linked to the supply chain and supply chain management in Hines *et al*. (2000:2).

waste is generated through activities performed within a company. Lean thinking focuses on three types of activities within a company or between companies in a supply chain; (i) value adding, (ii) non value adding, and (iii) necessary non value adding activities. Value adding activities are those activities that are perceived by the customer to give value enhancement to a product or service. Non-value adding activities are activities that do not enhance the value in a product or service, and are regarded by the customer as not necessary. Necessary non value adding activities are activities that are necessary as support for the value adding activities, as the current supply process is constructed. Hines et al. (2000, p.10) gives some experience based proportions of these three types of activities to be found within a company.

Table 4.8. Three types of activity with experience based proportions.

Environment / **Activity types**	**Physical product environment** (e.g. manufacturing)	**Information environment** (e.g. office, distribution, or retail)
Value adding activity	5%	1%
Non value adding activity	60%	49%
Necessary non value adding activity	35%	50%

An interesting thought had been to estimate how such proportions would be throughout the different phases of a project's lifecycle.

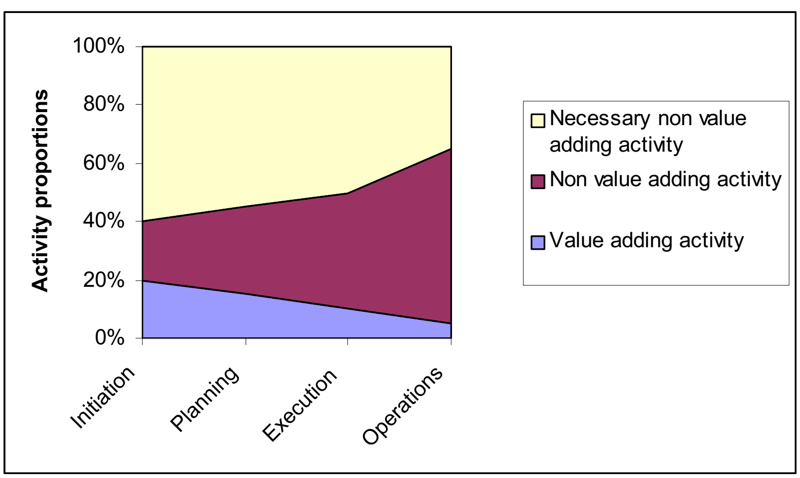

Figure 4.3. Indicative proportions among lean thinking activity types throughout project phases.

Figure 4.3 above show some indicative proportions among the lean thinking activity types. The proportions are based on the results presented by Hines *et al*., comparing the operations phase with the proportions from the manufacturing domain. The figure reflects that the value adding activities decreases from the initiation phase throughout to the operations phase. Though, the value adding activities have a rather large proportion in the early project phases as compared to the situation in the 'static' manufacturing domain. The project is in its early phases very much influenced by the 'customer', and as such value as perceived by the customer is engineered into the project object. It should also be noted that the 'necessary non value adding activities' have a rather large proportion, though decreasing, in the project phases leading up to operations. This may be said to be so because in the project front end there are a large number of 'creative' and value searching processes going on, needed to support the value adding activities. The activities related to bringing the value-contributing actors in to organise the larger project organisation, or project supply chain, may also be regarded as part of the 'necessary non value adding activities'. Finally one may say that the non-value adding activities get a larger share of the total number of activities performed as the project matures into the operations phase. This should not be so as the operations phase is a context characterised by repetitiveness and has the ability for continuous improvements;

'Removing wasted time and effort represents the biggest opportunity for performance improvement. Creating flow and pull starts with radically reorganising individual process steps, but the gains become truly significant as all the steps link together. As this happens more and more layers become visible and the process continues towards the theoretical end point of perfection, where every asset and every action adds value for the end customer. In this way, lean thinking represents a path of sustained performance improvement – and not a one off programme' (www.cf.ac.uk/carbs/lerc/about/ leanthink.html).

The outline of lean thinking presented above shows that *repetitiveness as the basis for underlying continuous improvements* is central. Authors and researchers working within the lean thinking concept says that it may be applied to different industries and contexts. E.g. Womack et al. (1996) uses lean thinking towards the construction industry, but ends up with trying to make the construction industry into a repetitive context, with the manufacturing context as its ideal. Though, they address one point that is worth mentioning;

'While a few buyers enjoy the complexities of today's construction industry, including the ability to change their minds about the details of their building during the six months to a year of typical contract-to-close cycles, most buyers would like to get exactly the building they need as quickly as possible at the lowest price' (Womack *et al*. 1996, p.291-2).

They here see value creation as minimising cost (or price) and short delivery time from the demand is defined. For the project context in general, the definition of value is hard and is often harder when it has to be converted to a specific demand that shall create and deliver the value. A central aspect of the demand process, and its search for 'value' is shown above with the point about the lead time of the 'contract-to-close' cycle and the customer's ability to influence the demand process throughout this cycle. For the project context though, the central aspects of 'business opportunity', 'temporarily', 'uniqueness' and 'one-of-a-kind' could stress or stretch the lean concept. Another concept form the manufacturing domain is based on *agility* and is termed agile manufacturing. The relationships and differences between lean and agile have been debated among researchers and practitioners, and we will revert to that after our outline and discussion of agility below.

4.4.2 Agility and Agile Manufacturing

Agility or the quality of being agile is often regarded as a quality or characteristic of a person or an animal;

Agile: Having the faculty of quick motion in the limbs; apt or ready to move.

Agility: The quality of being agile (Webster's Revised Unabridged Dictionary (1913), web1913).

As agile and agility often is referred to as aspects characterising a person or an animal, it may both be with respect to physical, as well as mental capabilities. Within the project context it is approached with respect to organisational and inter-organisational aspects. Agility is in itself not a step on the development 'ladder' of the domain of logistical and supply chain management, though it has great influence on and similarities with developments within the domain, and is therefore presented here.

Agility and agile manufacturing came to be known after the publication in 1991 of the U.S. report *21st Century Manufacturing Enterprise Strategy: An Industry-Led View*. The report was one of the deliverables from an industry-led U.S. Presidential Commission established to address how to make U.S. industry regain its global competitiveness. As a result of the report the Agility Forum was established with an aim to;

'Facilitate the return of the U.S. industry to global competitiveness through the adoption of the "agile" organisational paradigm' (Preiss, 1995).

As an organisational paradigm agility is related to the inter-organisational context, and is related to the product's lifecycle from design through to final disposal;

'Agility is an umbrella term. It extends over a broad spectrum of correlated developments that together define a comprehensive change in the prevailing system of competition. …At the level of *design*, agile competition is characterised by a *holistic* methodology that integrates supplier relations, production processes, business processes, customer relations, and the products use and eventual disposal' (Goldman *et al*. 1995, p.xvi).

This approach to agility within the design element makes it applicable to the development phase of, and a life cycle approach to the project context, as it takes a holistic approach both to the supply chain and the life cycle. In an alliance contract, both related to the development and operations phase, both the alliance and agile organisational paradigm have as a core the holistic perspective on competition that involves all actors in a common competitive unit. This is similar to the supply chain as the competitive entity. As in an alliance contract, based on risk- and gain-sharing mechanisms, the first principal element of agility is related to 'enriching customers'. Participants gain a 'reward' for delivering value to customers, where in the project context the 'customer' may be seen as the owner of the oil and gas resources – the basic business opportunity. Agility has further relations to the project context in that it is based on organisations coming together and creating an inter-organisational construction, or a virtual enterprise, adapted to exploit a *temporary* business opportunity (an entrepreneurial approach), i.e. new, emerging business opportunities implies the establishment of a new, temporary inter-organisational entity that will pursue and exploit the opportunity;

‘Agile involves the ability to optimise resources within, and to get external resources integrated into, your enterprise to be able to respond to an unanticipated spectrum of product needs [the opportunity]’ (Goranson 1999, p.90).

As agile manufacturing is based on temporary inter-organisational constructions, in a setting characterised by change and uncertainty, where the organisational construction will change over time, dependent on business opportunities, an important ability is the **ability to get new actors into the temporary ‘virtual enterprise’, make use of their value contribution, and then end the specific relationship for the specific situation**;

‘The important differentiator is the *ability* to develop *new* relationships with suppliers and customers’ (Preiss 1995-A, p.9).

Just like a project organisation the agile virtual enterprise has the up-front understanding of ‘working relationships coming to an end’. Maybe not directly with a planned end date as a project, but the awareness and preparedness that closing a relationship is a natural end;

‘A virtual enterprise is an *agile* virtual enterprise if it is formed with the intent of dissolving or quickly and cheaply reconfiguring in direct response to a change in the opportunity’ (Goranson 1999, p.68).

We see here that the emphasis is on the ability to develop new relationships, i.e. the ability to initiate and operate in a project context. The project context is also characterised by *uncertainty*, which leads to *changes*, due both to materialisation of risks and opportunities. Mastering of change and uncertainty is the second principal element of agility, and by some regarded as the original idea of agility.

‘[T]he original idea of agility: The ability to engineer your enterprise to respond well to unexpected change, to even leverage that ability as a competitive strategy. Engineering is a key term here, since it implies formal management principles rather than vague concepts’ (Goranson 1999, p.xiii).

Change and uncertainty has to be both acknowledged and dealt with. In the oil and gas industry exploitation of given oil and gas resources is the business opportunity, and several organisations have to come together and blend their competence to develop and operate a project object that can exploit the oil and gas resources profitably. In agility terms it relates to the third principal element of agility – ‘*co-operating to enhance competitiveness*’. The inter-organisational project organisation is ‘constructed’ to leverage the competence of each individual organisation, and as such becomes a ‘*knowledge driven enterprise*’, which is the fourth principal dimension of agility. The third and fourth dimension of agility brings us back to the virtual enterprise;

‘A virtual enterprise is a temporary aggregation of core competencies and associated resources collaborating to address a specific situation, presumed to be a business opportunity’ (Goranson 1999, p.66).

Table 4.9. The four principal elements of agility (Preiss, 1995).

Enriching customers – Products vs. Solutions	In an agile world, customers pay either a fee for skills, materials and a modest profit for products, or they pay a percentage of the perceived value for solutions. Companies adopt a value-based strategy to configure products and services into solutions which enrich their customers.
Mastering change and uncertainty – Entrepreneurial organisation	Agile competition is based on the ability to thrive on change and uncertainty. Companies use an entrepreneurial organisational strategy, which can respond more quickly than a hierarchical structure to changing conditions.
Co-operating to enhance competitiveness – Virtual organisation	In an agile organisation, co-operation enhances competitive capability. Companies use the virtual company model inside and outside to share responsibility and enhance co-operation opportunistically across organisational lines.
Knowledge-Driven Enterprise: Leveraging the impact of people and information	In an agile environment, organisations sell skills, knowledge and information over time. Companies make investments to increase the strategic impact of their people and information on their bottom line.

As many of the developments within logistics and supply chain management, agility is based on information technology as an enabler. The management of information therefore becomes an important asset, and may be regarded as objects to be developed, stored and put into use. In relation to the manufacturing context where work-in-process, WIP, is used to secure and improve the material flow, the information counterpart is information-in-process, IIP;

'For an agile system WIP (work-in-process) is not required, but IIP (information-in-process) is required everywhere. … An agile system is coupled by information (IIP), not by material WIP' (Preiss 1995-A, pp.11-12).

When information-in-process is used in the flow of information as work-in-process in the material flow, it may improve the organisation's ability to respond. A relation to the material flow may be the bottleneck principle[39], where WIP should be stored before bottlenecks to keep them working, and thereby not influenced by distortions elsewhere in the system that would have a negative impact on the systems time response or throughput. In the agile domain, IIP may be used to make the system time responsive.

'In agile, or dynamic, coupled systems, the capability for time response is a critical competitive factor' (Preiss 1995-A, p.13).

As a relation to the material flow, information could be stored at locations in the supply chain, where it made best use to facilitate timely response, when response where wanted, i.e. to best align supply and demand. Preiss (1995-A) addresses this in relation to the scheduling problem in the inter-organisational supply chain;

[39] See e.g. Goldratt and Cox (1984), Goldratt (1990-A) and Goldratt (1990-B)

'The scheduling problem in a total value-adding chain includes two interesting decisions. The first is; up to which point in the chain to bring catalogue products and at which point to invoke customised work. The second is; if a time-dependent response is required, where to locate inventory and surge machine capacity and how the payment for these should be equitably shared among all the companies in the value adding chain'.

With respect to the inter-organisational project supply chains there will be points in the chains that could be referred to as *project de-coupling* points, i.e. points above which the 'product' is specific and 'unique', and below which standard components are brought forward. Preiss (op cit.) does also refer to another important aspect in such agile virtual enterprises related to distribution of costs and financial gains between the actors involved. This is what we know from the project context as 'risk/reward' sharing schemes.

Agility is also found in the domain of logistics and supply chain management. The Council of Logistics Management, CLM, defined agility as one of four core logistics competencies to substantiate 'world class logistics'. The other three competencies were positioning, integration and measurement, though agility was regarded as the 'essential end state' of logistics performance;

'Thus, it is safe to conclude that agility is the essential end state of world class logistics performance. … Agility is the competency that sustains world class performance over time [author: i.e. the ability to change to pursue new, temporary business opportunities]. It is extremely important to stress the inter-connectiveness between agility, positioning and integration' (CLM 1995, p.185).

CLM uses three terms to describe agile capabilities; *relevancy*, *accommodation* and *flexibility*. These are other terms than is used in the manufacturing context to describe agility. The terms as defined and used by CLM, and their respective logistical drivers are presented in Table 4.10.

Table 4.10. Three agile capabilities, (CLM) and their relation to the project context.

Capability	**Relevancy:** The ability to maintain focus on the changing need of customers.	**Accommodation:** The ability to respond to unique customer requests.	**Flexibility:** The ability to adapt to unexpected circumstances.
Drivers	Customer cocooning Dominant logistics franchise	End-casting Order-to-delivery alignment Synchronisation Cross-shipment	Routinization Postponement Time Form
Relation to the project context	The demand processes and proactive demand chain management.	The ability to align the demand and supply chains	The ability to deal with changes due to emerging opportunities and risk.
Service pyramid	Resilience and reliability.	Creativity.	Resilience and creativity.

The agile capability flexibility is related to mastering the change and uncertainty element of agility.

'Flexibility concerns a firm's [author: maybe more importantly a supply chain's] capability to encounter, resolve and, when appropriate, exploit the unexpected emergency or opportunity that confronts logistical operations' (CLM 1995, p.187).

Above we have presented some aspects of agility that we mean have relevance for the project context, and logistics and supply chain management within that context. Especially for the development phase we mean that agility is important as a concept, and we will revert to that when developing the project supply chain management concept in chapter six. Now we would like to address some of the differences between the two concepts discussed above, lean and agile.

4.4.3 Lean versus agile

As part of developments within the manufacturing domain, agility follows the trend from mass production and lean manufacturing. Mass production was suitable in a competitive and market situation where there was a demand for common, standardised products. Special requests where few and could be covered by small craft shops. Each actor could in this setting act as one independent actor. Lean systems came into order in the mass production setting when outsourcing, and thereby a larger dependency on external organisations to produce standardised products came into place. Lean systems have to be cost-effective and not least cost-efficient. Still, in lean systems the demand (business opportunity) is more or less given in a longer-term setting, and the system may opt for continuous improvements. In the lean system the actors are linked and act as one competitive unit, as e.g. in the supply chain management context. In the agile setting the business opportunity is shorter-term, temporary with not the same possibility and rationale for continuous development, it should be 'right the first time'. Cost effectiveness and efficiency is still important, but has to be obtained through discontinuous improvements. The senior vice president of procurement in a larger EPC contractor said it like this;

'Developments and improvements must be made between projects. We have to go through discontinuous improvements both with respect to technologies applied, products developed, and work processes. … This includes establishing new relationships and developing old ones, and it all must be right the first time out [i.e. when a new project (business opportunity) shall be executed]'.

The actors are also in the agile setting linked together, but in a dynamic context they have to be able to re-configure themselves to meet new demands, which may involve taking new actors into the competitive unit, as described above from the project context. Table 4.11 outline some differences between mass, lean and agile systems, and may be used to outline the contributions for supply chain management in the project-oriented context.

The characteristics of the agile context given above are to a large extent applicable to the project context and specifically for supply chain management within the project-oriented context. Work processes as outlined above have to be formed and managed as relationships among several organisations. Developing inter-organisational relationships needs time and needs managerial attention. A main difference between lean and agile is found with respect to how such relationships are regarded;

Table 4.11. Mass, lean, and agile work processes (based on Preiss 1995-A, p.15).

Type of system	**Mass**	**Lean**	**Agile**
Characteristic	Uncoupled, static	Coupled, static	Coupled, dynamic
Internal differentiating attribute	Every station a statistically random constraint	One permanent constraint	Never any constraining resource
Operational management goal	Utilisation factor of each individual resource	Utilisation of the whole plant = utilisation of the constraining resource	Able to exploit change as opportunities.
Material inventory location	Everywhere	To serve the constraint	None – all make to customer-individualised order
Information inventory distribution	Local	Across processes	Wide variety of unpredictable subjects in the Information in Process (IIP)
Knowledge required	Local	Only of given processes	Entrepreneurial turning of information into profitable knowledge
Executive management goal	Utilisation of each individual resource	Utilisation factor for plant seen as a whole	Be a permanent part of the customers' customer satisfaction process
Interactions with customers' and suppliers' processes	None – connection is via product only	Processes linked in static business relationships	Processes linked in easily changeable relationships

'Agility has been expressed as having four underlying principles; (i) delivering value to customers, (ii) being ready for change, (iii) valuing human knowledge and skills, and (iv) forming virtual partnerships. Of these, the first three can be found within the operating philosophies of companies generally thought to be "lean" … The fourth principle is different. In fact, *agile and lean take quite different attitudes towards partnerships*, and here is where an important research and practical challenge may lie. Companies like Toyota stress how long it takes to develop effective partnerships for procurement of complex automobile assemblies. Relationships of 20+ years are typical. In the world of agility, *where such partnerships are predicted to be of dramatically shorter duration, extra attention will have to be paid to launching and maintaining supplier relationships*' (Whitney *et al*. 1995, pp.2-3).

Table 4.12 below gives a summary of remarks given by Goranson (1999) on how they see the differences between lean and agile (the remarks is drawn from several, different pages in their book).

Table 4.12. Differences between lean and agile as seen by Goranson (1999).

Lean	Agile
Lean is a state	Agility is strategic, system-wide set of capabilities
Lean means integration	Agility means loose couplings
Lean optimises processes	Agility optimises the ability to adapt processes to new conditions
Lean focuses on profitability today	Agility focuses on profitability tomorrow
Lean is static	Agility is dynamic
Lean means just-in-time-manufacturing	Agility means just-in-time-organisation
Lean means flat organisations	Agility means virtual organisations
Lean means a decreased supplier base	Agility means a larger set of potential suppliers in a loosely coupled network

Finally we would like to summarise the differences between lean and agile as we see them in Table 4.13.

Table 4.13. Some differences between lean and agile.

Lean	Agile
Going concern, long term view	Temporary, shorter term view
Improving business	Realising business – business opportunities
Continuous improvements	Discontinuous improvements
Developing supplier relationships	Launching and maintaining supplier relationships
'Reactive' – develops, then improve	Proactive – develop/improve concurrently
Extended enterprise	Virtual enterprise
Improving over time	First time capability
Cost efficient	Cost effective

Then, after we now have outlined elements related to the development of logistics and supply chain management, and related issues, we will now look into how this has been addressed in theory related to the project context.

4.5 Logistics and Supply chain management in the project context

There are supply chains in many environments and supply chain management is conducted within several contexts. Supply chains may be found in the financial marketplace, where financial information is moving the goods, i.e. financial objects or derivatives. Supply chain management may also be applicable public services, e.g. in healthcare. The patients may be perceived as the 'material', information regarding the criticality of a patient's illness may state the 'delivery' time and the demand for support. Services may be perceived as the personnel attending the patients (i.e. physicians, nurses, etc.), and funds, e.g. through public funding, membership or insurance, may decide where, when or whether you are treated.

Logistics and supply chain management are though most known from the industrial context where it varies from highly repetitive, high-volume supply chains found in the consumer goods markets, to the one-of-a-kind project context of engineering, constructing and operating large-scale, complex objects (i.e. industrial plants, offshore installations, etc.). In the supply chains of the development phase in the project context, engineers try to establish the demand in developing an object that is suitable to fit a purpose in a 'best possible way'.

In the project context large amounts of information, people, equipment and materials, as well as several fabrication and construction sites are part of the supply chains that realises the project's product. They are themselves actors in the supply chain and part of the logistics processes. Logistics and supply chain management is not an explicit project process in itself or part of project management as it is published today, e.g. in the Project Management Institute's knowledge area. This is so although several experienced professionals and authors within the project management domain have pointed to its importance, and that it should be given due attention in accordance with its importance for project realisation, both with respect to schedule and cost impacts.[40]

Project management has as a domain of knowledge developed, often based on using concepts and methodologies from other domain of managerial knowledge. Hetland (1999) says it like this;

'On good and bad we may say that project management is a subject that draws extensively on other subjects. The development of project management over time will therefore be extensively influenced by development in other subjects. The choice of other subjects is although not given once and for all. What is perceived as currently relevant is evaluated by active project management environments'.

An example that is relevant in this context is the focus that CRINE Network give supply chain management as a competitiveness factor for the British oil and gas industry.

Below an outline is given of earlier approaches to logistics and supply chain management in the project-oriented context, before a basis for supply chain management in the project context is outlined.

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[40] Both Kerridge (1987) and Harrison (1992) points to the impact that materials management may have on schedule and cost in realisation of the projects product. Harrison (1992) points further to the mismatch between its importance and the attention it is given within project management.

4.5.1 Earlier approaches

Logistics and supply chain management related to the project-oriented context has been addressed by several authors approaching the topic from different angles, and with different objectives. Logistics and supply chain management in the oil & gas industry (Silver 1986, 1988, CRINE 1998 & 1999, Burton *et al*. 1999), materials management in construction projects (Kerridge 1987, O'Brien 1995, Stukhart 1995, CII 1988), materials management as part of project management (Harrison 1992, Lock 1994, Rolstadås 1997), within the landbased construction industry (Byggforskningsrådet 1991, SBI 1995, Pahkala *et al*. 1997), partnering and alliances in the oil and gas industry (Schultzel *et al*. 1996, Vollmann *et al*. 1995), benchmarking of oil & gas procurement functions (CAPS 1997), partnering and total quality management (Oberlender 1993, Kanji *et al*. 1998), and project-oriented supply chain management (Asbjørnslett 1998).

Issues related to logistics and supply chain management has been addressed within the oil and gas industry for some year. Silver (1986 & 1988) address materials management (as he calls it), or logistics or supply chain management as it would have been called using current terminology, to the different phases of large-scale construction projects. Through several case studies and question based interviews he finds out how materials management is perceived and its different aspects dealt with, within the organisations, owners and contractors, involved in such large-scale construction projects. Based on his findings Silver outlines some concerns, suggestions for improvement, and potential research topics. All in all Silver touches into several aspects that make logistics management within the project context different from the continuous supply, manufacturing and distribution context. Among the aspects that Silver raises we find *uncertainty and the design change process, responsibility along the supply chain, degree of reactive versus proactive attitude towards logistics and supply chain management, early involvement of logistics functions and suppliers, and the long-term perspective of supply chain relationships versus the one-of-a-kind context of projects*. Though Silver touches into many interesting aspects and elements, he raises more questions than attempts to address approaches to manage the consequences involved in the questions raised. Silvers research report and article is the first one that publishes a search into the relationship between logistics management and the project context.

A new initiative within the area of supply chain management in the oil and gas industry was presented in a newsletter from CRINE Network (CRINE 1998), they state that supply chain management developments within the British oil and gas industry is their primary focus element for a year to come. The aims they outline are related to *awareness*, *assessment*, and *implementation* (CRINE 1998, p.3).

> 'The focus of CRINE's effort is specifically to bring about: '(i) Broad awareness of the potential contribution of SCM to increased effectiveness and efficiency; (ii) Focused awareness for selected companies; (iii) An assessment of where the industry stands yielding identified and prioritised opportunities; (iv) The identification of projects to address these main opportunities; (v) The delivery of means and training for the industry to apply SCM techniques.'

In sum the aim is 'to have a programme that gets companies beyond awareness and into improvement for their own activities, both internally and with their contractors and suppliers.' (CRINE 1998, p.3). A first deliverable from this initiative was a booklet titled; '*How Supply Chain Management Works*' (DTI 1998) that outlines how supply chain management is approached in different types of industries, and what is characteristic of and the main focus to achieve through supply chain management approaches in these industries. CRINE Network further published the results of a study about the contemporary practice of supply chain management in the British oil and gas industry (CRINE 1999-A) and a supply chain improvement methodology (CRINE 1999-B). All of CRINE Network's publications are good in bringing understanding of what supply chain management is about, as well as building awareness around current aspects and challenges as perceived by the industry. Their methodology brings a good balance between the context (the demand and supply market and its actors and stakeholders) and approaches to gain knowledge about your own supply chain and your part in the bigger project-oriented supply chains. All in all CRINE Network manages to raise important issues of supply chain management to give raised awareness as well as means to approach it, to build competitive advantage for the British oil and gas industry.

A later article (Burton *et al*. 1999) approaches supply chain management or strategic supply initiatives in the oil and gas industry and the relation these have on business success and shareholder returns. Burton addresses several aspects and elements that are regarded as strategically important by the industry actors. He then compares the applicability of these elements as strategic drivers with the level of implementation that these elements have reached in the companies studied. They show that there is a *discrepancy between what is perceived to be of strategic applicability and what is being implemented*, together with what is perceived to be the greatest barriers to achieving the intended strategic supply initiatives. The article gives a good impression of what is perceived by the industry to be of value to pursue, but also the current status and what is keeping the industry from reaching the potential benefits inherent in a strategic approach to procurement and supply chain management.

If we move to the functional area of materials management in construction projects we find that this is an area that has been addressed thoroughly from several sources. Kerridge (1987-I & -II) outlines in two journal articles a guideline perspective to materials management within the context of large-scale construction projects. The articles are planning and control oriented and relate to the project control domain, and are limited to functional relationships internally in the executing company (the contractor) of engineering, procurement, and construction contracts. As such the emphasis is on internal dependency and integration,[41] and not on external integration and supply chain management aspects.

During the four years 1985 through 1988 the Construction Industry Institute, CII, an interest organisation of the North-American construction industry, conducting their work based on industrial and academic participants, undertook a research programme into materials management in the construction industry. The research was published in several publications, where the two most comprehensive are CII (1988) and Stukhart

[41] The term 'internal integration' is not used in the articles.

(1995). Stukhart was the lead researcher, and involved in all CII-internal publications from the research. The publications give a deep and thorough presentation of the functional elements within the subject. On the other hand the publications do not take the supply chain management perspective nor do they address the specific characteristics related to the project context.

Within project management literature the area of logistics management have achieved some attention, though from different aspects and with differing thoroughness. Harrison (1992) points to the importance of the subject and that it receives far less attention than it should be given due to its importance. Besides pointing to the 'fact' that logistics management is important and outlining the interfaces between a materials management system and other project management systems, Harrison does not give any approaches to enhance the subject as part of project management. Lock (1994) look into some functional elements of materials management – none of which addresses the project's dependence on its supply chains. The focus is introvert, which may be correct if one at the same time relate the internal aspects and functions to the whole of the inter-organisational supply chains bringing forward the project's physical resources. Rolstadås (1997) addresses procurement, contract administration, and materials management, but as the rest of the project management literature Rolstadås present an introvert and classic project control focus. The focus is on the internal functional process and on the formal process between owner (buyer) and contractor (seller) and the different contractual forms that may be built between the two. Supply chain related aspects is nor a subject in Rolstadås' book.

Within the construction industry in the Nordic countries some research has been undertaken related to logistics management in construction projects. In Sweden Byggforskningsrådet (1991) published the results of a research effort aimed at testing how manufacturing based approaches to and methods of logistics management (material flow) could be transformed to suit the needs of the construction industry. The rationale for the research was the improvements obtained within the manufacturing industry and the possibility of obtaining the same standards within the construction industry. The publication of the research points to the elements of integrated logistics and the need to manage down through the different actors of the supply chain.[42] The research report does both in approach as well as in its outline reflect that an effort is made to adjust concepts and methods from industrial logistics management to the material flows of the construction industry. This may also be expected as the research and report was outlined by a logistics specialist from the car manufacturing industry.

A later Danish report SBI (1995) takes a broader view of logistics management within the construction industry. It does not take a certain approach to it as Byggforskningsrådet (1991) did, but in stead tries to define what logistics management is about and which experiences has been drawn from logistics management efforts within the construction industry. The objective is to inspire to a continuing effort to seek improvements through logistics management in the construction industry. The report focuses on establishing a common understanding of what logistics management is all

[42] The term 'supply chain' is not used directly in the report, but the organisational construction they describe is an inter-organisational supply chain.

about, and how (on an overall level) it may be used to enhance the construction industry. Logistics and logistics management is presented as a holistic perspective on the material flows of the project. It is also interesting to see that they focus on the impact and importance that the supply chains have on the realisation process of the project's product, and that they see the project's product as the 'consumer' in the supply chain process.[43] The report does also point to the importance of the relationships between the actors in the supply chain to obtain good logistics management, or supply chain management that may be a more correct term in this respect. They also address that the total cost aspects of logistics management is related to finding and eliminating non-value adding cost elements down through the supply chain, in stead of chasing best prices in an adversarial buyer-seller relationship. All in all a report that both comprises good logistics management as well as relating it to the specific characteristics of the project context and the construction process.

Through a case-study based research O'Brien (1995) addresses the relationships in the trade-off between transportation, inventory and production costs in the supply chains for a small construction project. Among other aspects he raises the importance of uncertainty in timing on supply-chain costs and performance, and the impact this has on a project specific analysis versus a manufacturing analysis in a continuous manufacturing context. Thereby O'Brien raises the difference and difficulties that lies in using lean manufacturing oriented concepts like just in time, in a non-repetitive context like the one found in project context.

The term '*construction logistics chain*' is introduced by Pahkala *et al.* (1997) as partnering in a supplier network, consisting of contractors, sub-contractors and suppliers. The focus is partnering within the supplier and contractor network as an aspect brought forward with the total-quality movement of the eighties. Although the article does not directly state logistics management or supply chain management specifically the context of their research are construction logistics, and they bring forward the basis for externally integrated logistics management within the construction industry, i.e. construction supply chain management.

Vollmann *et al.* (1995) introduces the concept '*demand chain management*' to focus specifically on buyer-supplier relationships. They relate the concept demand chain management to an offshore oil and gas development project that was executed as an alliance between the operator, contractor and a few suppliers. As they use the concept demand chain management they relate it to the design, planning and development processes that were undertaken by the alliance partners in developing the project object and the supply chain to realise it that in a best possible way met the operators demand. As such they compare the alliance with a demand chain approach to the project, which resulted in improved cost and schedule parameters, compared to a comparative project undertaken with 'arm-length' relationships with the suppliers. Partnering as it is used in this article is often termed *horizontal partnering* to reflect the horizontal partnership

[43] They do not say specifically the project's product is the *consumer*, but they say that the materials brought forward through the supply chains are 'consumed' when installed into the project's product at the construction site.

among the top-level tiers of the supply chain, a partnership aimed at the demand processes, more than the supply processes.

Another aspect to partnering is presented by Schultzel *et al*. (1996). Here it is supplier partnering seen from an EPC[44] contractor's point of view, i.e. partnering down into the contractor's supply chain. It is an approach that focus on total installed costs, and how these may be reduced through multi-project acquisition agreements that brings repetitiveness into the supply chain relationships of the contractor. Again a lean manufacturing oriented approach. It also shows the contractor's reliance on its lower-tier supply chain actors in becoming a competitive supply chain to realise solutions for the contractor's customers;

'In summary, the program to reduce TIC [total installed cost] and schedule by quantity buying of common commodities through establishing strategic multi project aquisition agreements (MPAA's) has demonstrated that it can be extremely successful. The partnering agreements have all of the necessary elements – vision, mission, trust, open communication, mutual benefit, and continuous improvement – that one would find between two parties, and in this case it was the vendors who became part of an alliance that would help Bechtel with its clients' (Schultzel 1996, p. 137).

This type of partnering is often termed vertical partnering as it goes down into the supply chain, focusing more on the supply side than on the demand side.

As with all managerial aspects there is a question to quantify and show results of improvements made. Benchmarking is a technique used extensively in different industries to compare one's results with the best or average in the industry. CAPS (1997 I & II) show results of a benchmarking effort undertaken in the oil and gas as well as the construction industry. The benchmarking parameters are related to purchasing activities and costs.

Total quality management equalling supply chain management in the project context may sound like odd man out. Kanji *et al*. (1998) presents an approach where supply chain management is presented as a 'facilitator' of achieving the goals of partnering, and at the same time be focused on the aims of total quality management. This approach is quite interesting as it brings with it the merging of ideas and the focus that has to be obtained in a partnering construction. Especially in the development phase of a project object to develop an object that fulfils the functional specifications and requirements of the owner, and at the same time does it based on the principles of total quality management to make an object without 'extra fat'. The last is an important requirement in the partnering and alliance concept, as the incentive mechanisms are often based on some sort of risk-/reward-sharing mechanism between the owner and the other actors in the alliance (partners).

An early version of the concept presented in this thesis, project supply chain management, was presented at a doctorate workshop arranged by the European Logistics Association, ELA, June 10-12, 1998 (Asbjørnslett 1998-A). A presentation (Asbjørnslett 1998-B) based on this article and further developments in the author's work was given after invitation at the 15th German Logistics Congress, October 22nd

[44] EPC = Engineering, Procurement and Construction, i.e. a contractor able to and committed to perform both engineering, procurement and construction of a project object for a client.

1998. This was done before CRINE Network presented their supply chain management initiative in the September 1998 issue of the CRINE Network newsletter.

4.5.2 Has project management and supply chain management been integrated?

The forefront of logistics management is contextually related to the inter-organisational aspects of supply chain management. There is still some ambiguity with respect to the extent of the number of integrating processes between the actors of the supply chain, i.e. which has their core within logistics management and which has not. Though, the supply chain has become the new unit of competitive analysis, i.e. companies are not competing against each other, but supply chains are.

The basic elements of logistics management are found within the integrated logistics concept, with its focus on both flows of information and physical goods, supporting the logistical mission elements service and total cost positioning. Although several concepts may be used to support or illuminate the key perspectives and concepts of logistics management, one should distinguish between the core logistical contribution and the contribution or support that may be found in other perspectives. Finally agility is found as a new and emerging concept within logistics management. With agility logistics is approaching the project-oriented context, with its unique and temporary characteristics. As agility is focusing on the ability to be fast and flexible, i.e. the ability to adapt to new possibilities and supply chain structures, it is bringing logistics closer to the project context with the project's need to establish and operate temporary supply chains.

Logistics and supply chain management within the project-oriented context has emerged both from the logistics domain and from the project management domain. There has though not been much integrative effort undertaken to combine the two. Much is based on functional elements of logistics and materials management, much related to the project planning and control perspective. Authors and lecturers address its importance, but does not outline the concept with its full implications, and give a rather introvert view of the topic. Finally, examples of good efforts to bring logistics and supply chain management into industries within the project context are found with examples from the construction industry in the Nordic countries, and the British oil and gas industry.

What is still missing is an outline of what are the main characteristics and drivers of logistics and supply chain management in the project-oriented context. Especially, how does the project-oriented context set different conditions for supply chain management, as opposed to the repetitive context of the consumer and capital goods industries, e.g. the context of the car manufacturing industry.

4.5.3 Project Supply Chain Management

In Part III of this thesis the concept project supply chain management, PSCM is outlined. PSCM may be regarded as part of the systemic constructivistic project management approach. Hetland (2000) regards the systemic constructivistic project management approach like (translated from Norwegian);

‘The main point is partly that we (1) see the world through individual “glasses” and partly that we (2) are free to choose which “glasses” we want to use to perceive the world. The latter open for that we may create “project constructs” in such a way that they fit our way of working, i.e. we *choose* to delimit actor structures and work processes in such a way that the project’s value added becomes as large as possible’.

The systemic constructivistic project management approach means that the supply chain management approach is intentionally chosen to approach the project context and project management, because of a belief that this approach may enhance the value of project management. The project becomes an intentional construction regarded as the business opportunity, and the supply chain approach becomes an intentional construction regarding the supply chain as the competitive entity, to increase the project’s competitiveness.

The definition of project supply chain management as it is defined in this thesis is;

Project supply chain management seeks value enhancement in projects through logistics’ focus on demand and supply alignment. This is met through the characteristics of logistics throughout the project life cycle with an agile approach to demand chain management in the development phase and a lean approach to supply chain management in the operations phase. Thereby meeting the need for value enhancement through engineering and the supply chains contribution in developing demand for the project object, and creating value through cost efficiency in the operations supply chains.

5. The Project Supply Chain Challenge

5.1 Introduction

The aim of this chapter is to outline the challenge of the oil and gas supply chain. First we shortly discuss the business context, a driver for change in project strategy, execution and organisation, both from the macro perspective, the inter-organisational industry perspective, and the micro perspective of the firm. Secondly we outline and seek references to the challenge of the oil and gas supply chain, as we see it. Then we shortly outline and discuss the oil and gas supply chain stakeholders and actors. Finally we relate the challenge of the oil and gas supply chain to aspects presented in chapter three and four.

5.2 The Business Context

Projects of the type focused in this thesis are realised because they constitute a business opportunity. The project or the business opportunity is influenced by and realised within a business context. Related to the project supply chain context, one may say that the competitiveness of the business context is made up of three levels;

1. Competitiveness in the *macro* perspective
2. Competitiveness in the *inter-organisational* perspective
3. Competitiveness in the *micro* perspective

These contextual levels increase the complexity of project management, and in addition there is an increasing rate of change that has to be taken into account;

'Nothing ever remains stationary. The context in which projects are being formed and managed is constantly changing, and indeed in the 1990s it is changing at a rate not experienced in over 40 years. The political situation of the 1990s is dramatically new and fluid. Business and finance have to operate in conditions of unprecedented uncertainty. Social pressures are mounting sharply. A number of environmental issues have become very serious. Technology continues to develop rapidly. And the practice of management is changing' (Morris 1994, p.273).

5.2.1 Competitiveness in the macro perspective

The oil and gas industry is an industry in which the competitiveness to a large extent is dependent upon the CAPEX and OPEX needed to become able to exploit the hydrocarbon resources. The up-front capital disbursements, both needed in exploration and in CAPEX, are high, and as such the industry is very capital intensive and funds often need to be obtained from several sources. The CAPEX level are again to a large extent dependent on the geographical location of the hydrocarbon resources, e.g. whether they are located below the seabed in the Gulf of Mexico, the North Sea, under the Siberian permafrost in Russia, or below the desert in the Middle East. I.e., whether the hydrocarbon resources are located offshore, in shallow or deep waters, or onshore, in difficult or simple terrain and climate. The consequence of this is that industry competitiveness is dependent upon the area in which the industry is to operate. That will often impact the industry's approach to projects dependent on geographic region and terrain. A quote by a General Manager for the British branch of an international engineering contractor may be used to support this;

'To be able to compete for projects in the North Sea area, we have to present and work under novel approaches to project strategy and management. When competing for projects in areas that are more competitive, e.g. in the Middle East, we can use 'old' approaches' (R.L., Epci Advisory Council meeting, London, 23 April, 1999).

This was as well the background for the CRINE and NORSOK initiatives to develop the competitiveness of the British and Norwegian Continental Shelves.

'Early in the 1990's it became evident that the cost position that was established in the oil and gas industry was too high to ensure that the fields on the Norwegian Continental Shelf would be competitive against oil and gas developments in other regions' (Kaasen 1999, p.19).

Among the initiatives raised through CRINE and NORSOK were changes in the inter-organisational working relationships among the actors of the oil and gas project supply chain.

5.2.2 Competitiveness in the inter-organisational perspective

Large-scale projects of the type found in the oil and gas industry are inter-organisational endeavours. What is needed is competitiveness in the inter-organisational domain, as e.g. CRINE Network and the NORSOK Collaboration Panel has addressed through CRINE Network's supply chain management initiative (CRINE 1998 & 1999) and the NORSOK Collaboration Panel's acknowledgement of the '[inter-organisational] procurement processes as the most important processes among operator, contractors and suppliers' (NORSOK 1998).

The underlying aspect of supply chain management is that *the supply chain is the competitive entity*. This is due to the fact that the share of value contribution from contractors and suppliers to an end product is increasing, and that there are many sources of synergies to exploit for both development and operations through the interfaces of the supply chain. In the development phase of the project context the supply chain is focused towards a temporary setting where there is a large degree of uncertainty and high complexity both with respect to the scope and technical issues of the project object, as well as in the organisational domain. However, there is and will be a continuous search for enhanced 'value added', both through cost reductions and improved income, e.g. through technology development;

'[R]equiring competitors to intensify their efforts at cost leadership, while also seeking to boost revenues through the *deployment of innovative technologies and processes*. Many look to market innovations, while others seek to unlock "supply chain" value through innovative relationships with suppliers' (Burton *et al*. 1999, p.54).

The key is to bring new concepts and approaches to the project context, and to enable the industries and actors operating in project contexts to make use of approaches applied successfully for increased competitiveness in other industries. As said above, the British CRINE Network addressed supply chain management in the oil and gas industry through their initiative, and thereby opened up to further explore the possibilities and new approaches needed for this. The Norwegian NORSOK Collaboration panel on the other hand, just stated that this was important, maybe even the most important inter-organisational issue for competitiveness, though they did not address it further. *The question then is how the characteristics of logistics and supply chain management processes change to be suitable for the purposes of the competitiveness of the oil and gas industry?*

5.2.3 Competitiveness in the micro perspective

Though the supply chain is regarded as the competitive entity, the supply chain is an inter-organisational construction of individual firms. As such each firm must be competitive by itself, as well as have 'equal' competitive opportunity to become part of the supply chain, and be competitive as part of a supply chain. Competitiveness in the micro perspective then become competitiveness of each actor in being attractive as a supply chain actor, both able to quickly adapt to a supply chain context and uphold its attractiveness and contribution as a supply chain actor.

Though, there are differences between the different types of actors in a project supply chain. Most of the differences are related to differences in what is the core business of each related to a project, i.e. the difference to whether the development or operations phase is their core business. These differences are acknowledged, and have to be dealt with. Especially this is related to the relationship between the Operator and the contractor, which have the following (simplified) differences in profit schemes of a project;

Operator's profit = Life-cycle Income – CAPEX – OPEX

Contractor's profit = Contract Price – Contractor's Cost

Some requirements that address how actors should position themselves and behave to optimise a project supply chain, and to be an attractive supply chain member is given in Appendix B.

5.3 The Oil and Gas Supply Chain

5.3.1 General

Figure 5.1. below illustrate the supply chains of the oil and gas project, or more correctly the relationship between the *project value chain*, the *services* and *goods*

supply chains of the development phase, and the *operations, maintenance* and *modifications* supply chains of the operations phase.

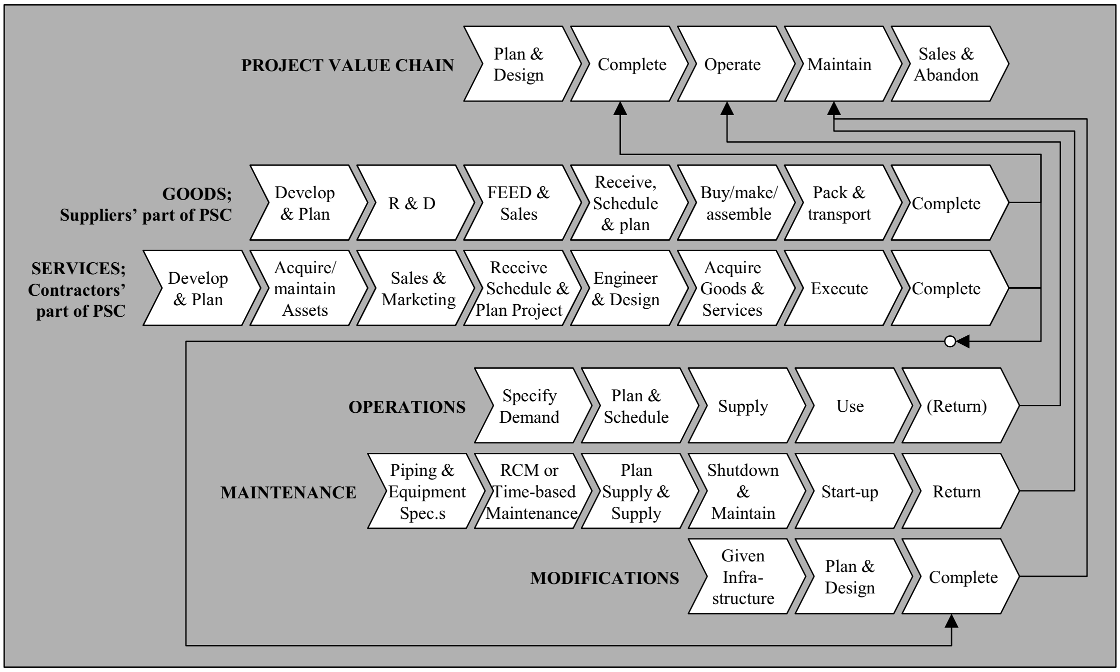


Figure 5.1. The oil and gas supply chain.

The project value chain is in the development phase ('Plan & Design' and 'Complete') supported by the contractors' part of the project supply chain, PSC, through engineering (demand development) and construction 'services' (supply consumption). Then both indirectly through the contractors' service chain, and directly through e.g. the operator's frame contracts and agreements, the suppliers supply 'goods', equipment and bulk, to meet the engineered demand at the construction site. In the operations phase we may say that three different supply chains are involved. The first is the operations supply chain, bringing in all supply needed for drilling, process plant operations, and catering, both rental equipment, bulk chemicals, and other consumables. The other is the maintenance supply chain, involved both in unplanned and planned maintenance. The planned is shown in figure 5.x. The last supply chain is the modifications demand/supply chain. This is to a large extent a development demand/supply chain, though with the extra factor of having to take the opportunities and limitations of the existing infrastructure into account. One may say that the modification demand/supply chain covers the remaining openness of the project (refer to the project atlas in chapter three).

Then what is the focus of the oil and gas supply chain throughout the project lifecycle? Figure 5.2 below is revised from IPA (1995), with some comments to its message.

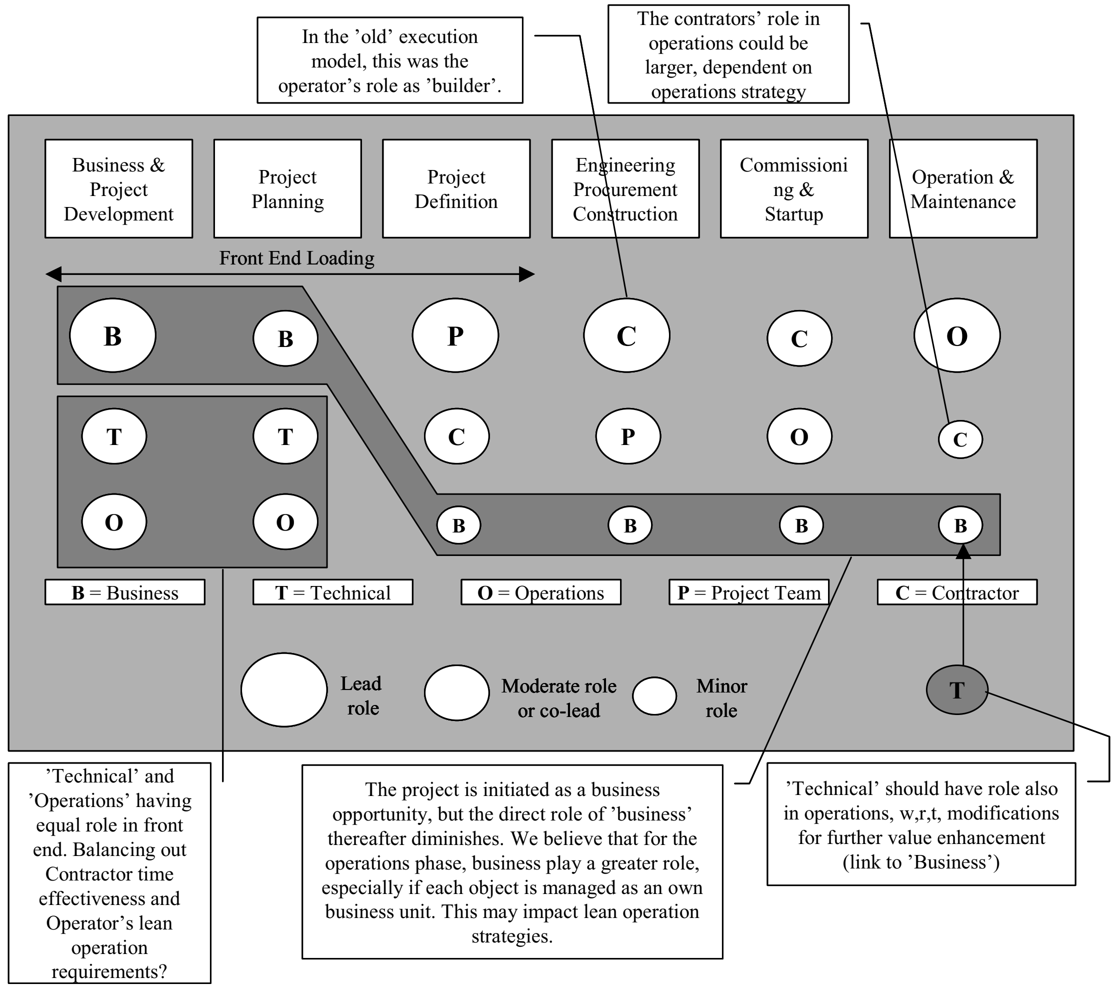


Figure 5.2. Focus of the oil and gas supply chain throughout the lifecycle (based on figure by IPA, 1995).

The message of figure 5.2 is the changing focus on different roles throughout the project's lifecycle. 'Business' is the main focus in the front end of the project, to be realised through value enhancing solutions for 'technical' and 'operations'. However, 'business' has a role all through the project lifecycle, though diminishing relative to other roles. A question is though whether 'business' should have been given a larger role in the operations phase, as each installation often is managed as unique business units, thereby they may have an impact on synergy potentials for lean operations among several installations. The major role of the contractor(s) is found in the EPC part, though this role was the Operator's role, as the 'builder', in previous execution models (not integrated EPC type models). Also in operations, the role of contractors could have been elevated, as many operations models use an outsourcing approach with a set of contractors with specific responsibility for different parts of the operation. Finally, 'technical' could or should have a stronger role in operations, as 'technical' linked with 'business' are the basis for further value enhancements, e.g. extending the plateau production of an installation, realised through modifications projects.

5.3.2 The roles of inter-organisational PSC actors

In table 5.1 below we have described the actors of the inter-organisational project supply chain, as we see their role and objective as part of the project demand/supply chain.

Table 5.1. Roles of the inter-organisational PSC actors.

Phase	Actors	Roles	Objective
Development	License owners	Owner and sponsor.	Ensure that the project meets the profit required.
	Operator	Project manager and value enhancement responsible. Strategic and tactical demand/supply chain manager.	As license owner. Develop own operator competence. Project success.
	Contractors (1st tier suppliers)	Solution providers. Tactical and operative demand/supply chain manager.	Project object(s) delivered and accepted, giving a profit. Project success.
	Sub-contractors (2nd tier suppliers)	System and technology suppliers. Demand and supply chain contributors.	Development, acknowledgement of solution and competence. Commercial, increased business in industry.
	Suppliers (3rd tier suppliers)	Component suppliers. Minor role in demand chain, major impact on supply chain.	Commercial. Increased business with operator.
Operations	License owners	Owner and stakeholder.	Ensure that the project meets the profit required.
	Operator	"Operator", i.e. operations value enhancement responsible. Actor may change from development.	Meeting production targets and targets for installation up-time. Cost effectiveness. HES focus.
	Contractors	Responsible for functional progress, e.g. length of drilled hole per day.	Commercial. Meet incentives and measures in own contracts.

	Suppliers	Rental equipment and consumables.	Commercial.
	Logistics service providers	Transport from suppliers to supply base. Supply base services and warehousing. Offshore transport.	Commercial. Increased business, scope of work and number of installations covered. Solutions developer.

Development

The license partners are the owners of the petroleum field to be developed and exploited. As owners the license partners have several roles;

'Generally, owners have three roles. The first is to ensure that the project is conceived and realised meets its objectives. This is the *sponsor's* role: that of ensuring that the plant makes the profit required or the weapons system performs properly, or that the aid or welfare programme delivers real benefit. The second is the task of ensuring that once handed over to operations, the product will perform optimally. This is the *operator's* role: it covers a variety of factors, by far the most critical of which are technical efficiency, safety and environmental performance. The third is that of the *builder*, or project manager: ensuring that the project is realised effectively and efficiently. It seems to me that in principle these duties should be performed entirely by the owner, subject only to the extent to which he does not – or should not – have the resources or skills, outlook or experience to perform them adequately' (Morris 1994, p.252).

Another issue that is related to the role clarification and influence between owners and the Operator, is the issue of split operatorship between the development and operations phase. If one owner company act as Operator during the development phase, and another owner company take over as Operator after operations has commenced, this may have a rather big impact on an approach to the project supply chain construct. E.g. if the operator for development takes a lean approach to the development, making the project object fit with the other installations in his portfolio, then that may become or bring a 'richer' set of supply chains to the company taking over as operator in the operations phase.

To be competitive the supply chain actors must posses different strengths. In the upper-level project supply chain relationship between the Operator and contractor organisations, the following differences in strengths has been outlined;

Table 5.2. Strengths of owner organisation versus contractor organisation (IPA 1995).

Owner organisation	**Contractor (1st tier supplier) organisation**
▪ Identification of customer needs ▪ Feasibility/economic analysis R&D capability for project basic data and piloting issues ▪ Knowledge of plant conditions and needs ▪ Process expertise, maintenance know-how and operability information	▪ Equipment specifications and vendor inspections ▪ Detailed knowledge of vendor standards and capabilities ▪ Advanced project scheduling and tracking systems ▪ Contracting and procurement planning ▪ Extensive experience with construction management

As Table 5.2 shows, the main strengths of the owner organisation, i.e. the Operator, is seen to be that of ‘sponsor’ and ‘operator’. The ‘sponsor’ role of the owner organisation is primarily a part of the front-end phase of the project, while the ‘operator’ role is part of operating the project object. The main strengths of the contractor organisation are regarded to be related to an owner’s ‘builder’ role. The contractor is seen as project manager, or maybe more precisely project planner and controller. As Morris (1994) stated above the role of the ‘builder’ is a role that the owner should hold himself.

The contractor(s) are brought into the project supply chain to support the Operator with the ‘builder’ role. The contractor could also take part in and support the Operator in fulfilling his role as project sponsor, i.e. in ensuring that most value enhancement is taken out of the project. The difference between the contractor’s support to the Operator in these two roles give room for some reflection. What is the role of the contractor? Is it to be a supplier of capacity, i.e. people with a competence to ‘help’ the Operator’s ‘builder’ role, or as a supplier of capability, i.e. helping the Operator making the most out of the business opportunity?

In an EPC or EPCI project the contractor may be regarded as the demand and supply chain co-ordinator, establishing and co-ordinating the development supply chains on behalf of the operator. Or as a contractor’s procurement executive stated;

‘The contractor is the hub in a network, which mission is to specify the elements and parts of the whole [the demand and demand chain process], as well as obtain and compound the elements and parts into a whole [the supply and supply chain processes]’.

The contractor use sub-contractors that are providers and fabricators of e.g. systems. These sub-contractors have in many cases taken over parts of the contractor’s scope of work, often through that the contractor have transferred engineering capabilities and software to sub-contractors with which the contractor has long term agreements.

Thereby the sub-contractors take active part not only in the contractor's supply chain, as well as the contractor's demand chain.

Several of the sub-contractors focus on standardisation of their products and systems, and simplification of their deliverables so that they can improve their time competitiveness, i.e. become 'quick response' suppliers. Quick response strategies may enhance the sub-contractor's position in the supply chain, both schedule and cost position. The sub-contractors' position then become much like suppliers of systems or modules e.g. in the car manufacturing industry. They have to provide their share of new technology and value enhancement as part of the demand chain, and then they have to be good at their supply side so that they are able to meet new delivery schemes in trying to reduce the length of the development schedule. The sub-contractor role fit as such into a development towards more segmentation of the project objects.

At the end of the demand/supply chains we find the part suppliers. They take part in both the demand chain and the supply chain. They do also often have a role both in development as well as in operations. There are two main categories of goods that the suppliers provide, equipment and bulk. Below in table 5.3 an engineering and construction contractor's supplier strategy with respect to supply category is listed. We see that there are three categories of supplies, critical, standardised and other, which are separated based on criticality both for the;

√ demand chain – 'critical' impacting the execution model and value through technology, and 'standardised' impacting technology.

√ supply chain – 'critical' with respect to securing availability, 'standardised' based on lead time, and 'other' based on the supply chain cost position.

Table 5.3. A Contractor's supplier strategy with respect to type of supplies (LL 990614).

Type of supplies	# of suppliers per product	Focus	Drivers
Critical	1	Product development, standardisation, communication, cost efficiency programmes	Major impact on design, interface documentation from suppliers crucial for finalisation of design, high cost, complex manufacture and/or technology, availability in market
Standardised	2 – 3	Standardisation and use of suppliers product range.	Challenging from a technical point of view, long delivery or high cost.
Other	Many	Selection based on commercials	

Operations

In the operations phase, the license owners continue their role as owner and sponsor of the project, with the objective of ensuring that the project delivers its required profit. This is from a cost efficiency (lean) perspective an interesting constellation, as the license owners may be operators for other fields in a region, so that a driving mechanism for utilising synergies through collaboration among several installations and operators, is directly linked to the sponsor role of the license owners.

The Operator will either continue to be the same as the owner-company having the operator role through the development phase, or it could be changed so that another owner-company take over the role in the operation phase, e.g. when the installation has come in stable production. This may be a challenge for the project supply chain, as it is one operator that will have to operate supply chains partly established by another operator. The development operator could e.g. choose project supply chains based on long-term synergies across installations were he himself is operator. Then for the owner-company taking over in the operations phase, the supply chains established to give the development operator synergies could result in the opposite for the operations operator.

Contractors in the operations phase are responsible both for completing the development of the project (not the project object), e.g. drilling, and as part of long-term operations, e.g. maintenance contractors.

Suppliers could be linked to the contractors, e.g. for supply of rental equipment to be used by the contractor on the installation offshore. Or they may be part of the Operator's supply chain, e.g. through long-term contracts and agreements, and often supplying to several installations that the Operator operates.

The logistics service providers make up the link between the suppliers and the offshore installations. They are more becoming integrated logistics service companies that provide full scale of logistics or supply chain services, including transport from suppliers to the offshore supply base, base services, and offshore transport. The logistics service providers may either operate the services fully on behalf of an operator, or offer part services to the operators. The logistics service providers are following the general trend in the logistics service industry in developing and offering complete services. They are also in a good position to develop solutions that extract synergies across several operators.

5.3.3 The roles of intra-organisational PSC actors

The role and objectives of some key actors and stakeholders in the internal project organisation are listed in figure 5.x.

Table 5.4. Roles of the intra-organisational PSC actors.

Phase	Actors	Roles	Objective
Development	Management	Demand and supply *context regulators*.	Deliver a project object according to expectations. Meeting the financial basis on which the project was sanctioned.
	Engineering	*Demand generators* – 'point of origin'. Demand chain managers of the project supply chain.	Designing an object based on available options to best meet the business requirements of the owners.
	Procurement	Demand *fulfillers* – tactical and operational supply and demand alignment.	Making best possible use of long term supply chain relationships, and the market to cover engineering's requirements
	Construction	Supply *consumers* – 'point of consumption'.	Realising the project object according to schedule.
	Project control	*Demand/supply co-ordination* – Value enhancement through time- and cost-wise control of the project demand and supply chains.	Giving a best possible status and future estimate, cost and schedule-wise, to help guide decisions and actions in E, P, and C.
Operations	Offshore operations	Planning and optimisation of production. Plan and initiate supply requirements.	Meet or exceed production rate and up-time of facilities.
	Onshore support	Order and administer the commercial side of supplies.	Improve effectiveness, contracts and terms, and efficiency, internal process, of administrative supply process.
	Supply organisation	The demand/supply chain coordinator and single point of contact. Establish and commit demand and supply side, periodically.	Optimise supply operations long and short term to meet offshore requirements.

Development

For the development phase there is five actors or functions that have a central role in the project demand/supply chain, i.e. management, engineering, procurement, construction and project control.

Management is set to manage the project under the context given by the company strategy, project strategy, and the broader project context. The strategies that are part of the managerial context are further specified into aims, means and measures relevant to the project construct, and as a managerial tool to manage the project forward. The term ‘budget’ is a good example of how management is given focus and set to ‘operate’. Is the budget a cost or value measure, to be kept within, met exactly, or tried to challenge? If the budget is a maximum cost level, not to be exceeded in any circumstances, then that will influence how the project supply chain actors have to approach the project. Risk reduction and cost minimising is the name of the game, i.e. the project has to be ‘closed’. On the other side, if the budget is a type of ‘value’ measure, then it may be something that should at least be met, but preferably exceeded. This will challenge the demand side of the project supply side, setting the frame to work within towards new opportunities and seeking value, taking both life cycle income and cost profiles into account, i.e. the project should work at least initially in the ‘open’ part of the project atlas. However, management will often (always?) move towards securing some ‘expected’ results or measures related to the project objectives.

The second function is engineering. Engineering has an important, and maybe the most important role, seen from the *demand* side of logistics in large-scale development and construction projects. Earlier, the engineer got an assignment, with a given specification, and designed out of own experience and competence, with rather large degrees of freedom. Today, the engineer must to a larger extent take given terms, e.g. frame agreements, into account, leading to a more predefined and ’lean’ approach. The engineer’s role in this new situation becomes important to develop and improve the processes of realising a qualitative product based on the engineers understanding of the demand and the options available in the ‘lean’ supply chain.

Within such a framework the engineer may be viewed as both an *artist* as well as a *craftsman*. As an artist the engineer want to have a large action or freedom space with respect to the design that he creates. He will also retain the option to change or alter his design as he develops his understanding, or as new information (or new technology) become available. The artist is mostly represented in the early conceptual development phase of the project object. The solution created by the artist, although rough, will establish a basis for the demand that will ultimately trigger the supply chains. With a lean approach to a project’s supply chain the engineer’s freedom space in developing his solution is limited.

As a craftsman the engineer use his functional knowledge and competence in developing, or bringing together the details of the conceptual solution developed by the artist. In doing this he has to apply to the rules and specifications given for his function. In designing the details of the object/product he is guided by a set of choices with respect to equipment and materials to be used, as outlined e.g. through frame contracts and agreements. The aim of frame contracts or agreements may be regarded as moving the ‘openness’ of the artist’s role through to meet the cost-effective and cost-efficient needs of operations of the project object, often based on utilising synergies across a portfolio of project object’s to be operated, thereby ‘closing’ the degrees of freedom available for the engineer to use.

As such the engineering role is twofold. First it is developing the demand, i.e. the functionally oriented engineer, often seen as the optimal technological solution to the problem. Then there is to define the specifications needed from the product that shall fulfil that demand, i.e. the product-oriented engineer. One approach to balancing the technological development role versus the commercial, or business oriented demand fulfilment role of the engineer is presented in Figure 5.3.

After the demand has been defined and specified by engineering, procurement comes into the picture to close the commercial commitments and delivery schedules with suppliers, and thereby activating and committing the supply chain downwards, as well as upwards (towards the engineers) committing the demand chain. The roles and functions between procurement and engineering may be regarded as in Table 5.5 below.

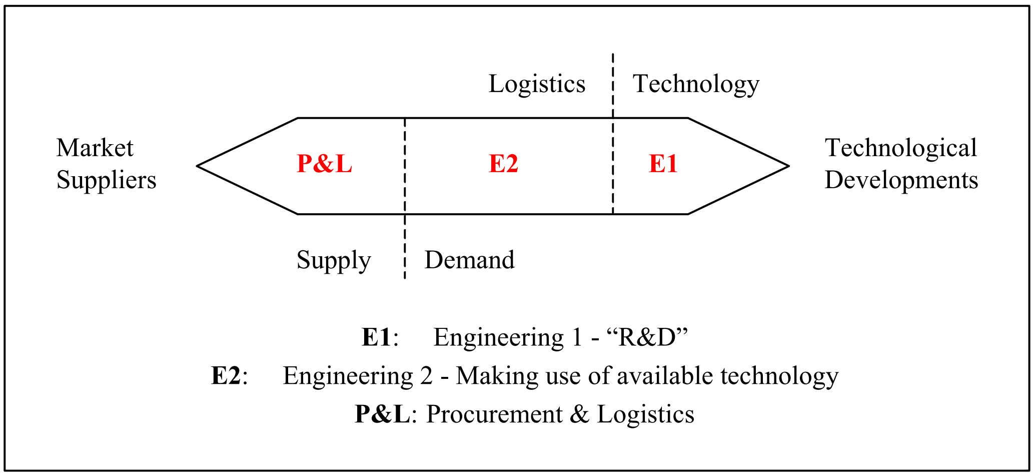


Figure 5.3. The engineer's role in a project's demand and supply processes.

Table 5.5. Roles and competence distribution among engineering and procurement.

Engineering	**Procurement**
Demand oriented.	Supply oriented.
Technical competence.	Relational and commercial competence.
Product-market competence.	Market-availability competence.

Procurement is in relatively continuous contact with the suppliers in the market. Then when a demand is specified from engineering, a matching supply process is activated and directed through procurement to the suppliers in the market. Finally delivery is brought back to the engineering domain, now in the fabrication or construction context.

However, procurement is related to logistics, but there is a difference between the procurement role and the role of logistics in the supply process. A commissioning executive for a major field development project on the Norwegian Continental Shelf gave his comments with respect to procurement's contemporary 'standing' related to a project's needs;

'Procurement is not flexible enough to cover the dynamic needs of the project;

- Procurement: *Static*, manages based on rules and principles.
- Projects: *Dynamic*, strategic guidelines, with dynamic execution.

Projects runs fast, and they don't stop when started, the project just look for solutions.'

The difference between the perceived static position of procurement versus the dynamic needs of the project bring with it a need to develop *dynamic supply chain relationships*. Dynamic will in this context mean the ability to balance and search for good demand/supply alignment together with the engineers and the supply market. As such the ongoing dialogue within the triangle between engineering, procurement and suppliers is in the longer-term view aimed at influencing suppliers in the market to develop new technology, concepts and solutions. Or, how engineering may be integrated with the suppliers so that new developments 'continuously' become available for the product-oriented engineer to be applied in the demand/supply process – when needed in a dynamic or agile manner. This outlines the role for the 'logistics' professional on the project team. There is then a need to broaden the procurement competence to further incorporate logistics and supply chain management competence, or as a logistics responsible in a project team said;

'Procurement is all routines, rules, systems, and commercial and contractual aspects – i.e. focus on "local" price, not "global flow". Logistics is experience based, to secure "global flow and commissioning", comprising everything not covered in "local" focuses. Logistics is co-ordinating procurements between demand, availability and "transport"'.

The fourth project internal function is construction. Construction may be regarded as the consumer or customer of the demand generated by engineering. In construction all material, pre-fabricated items and equipment are brought together into the whole and final project object. As such construction involves a vast number of resources, and 'consumes' vast resources such as man-hours, fabrication and construction drawings, materials and equipment. Thornton *et al*. (1996) address assembly, which may be regarded as construction in this project context, as the organisational point that is the '*proof of the pudding*' with respect to seeing whether the demand and supply chains perform as expected;

'In virtually every site in our project, the people pushing most strongly for new design, procurement and production methods are *those responsible for performing assembly'* (Thornton *et al*. 1996).

At the assembly point, or for the project context the fabrication and ultimately the construction point(s), all pieces come together and weaknesses in the demand and supply processes and chains will be revealed, as items may be wrong, e.g. changes has happened that has not been communicated to all relevant actors in the supply chain, does not fit, or are not available when needed. The assembly/fabrication/construction point may as such be regarded as the '*point of consumption*' in the demand/supply chain perspective.

As such the consequences are that construction may both be impacted by, as well as may impact the supply chains. The supply chains delivery service to construction in accordance with schedule and construction programs are important for schedule adherence and progress for the project in meeting milestones. Good delivery service is also important with respect to construction costs, as the construction-staff will not be able to perform their work if materials and equipment is not available when promised and needed. This means *increased costs without increase in progress*, giving rise to contractual issues regarding responsibility and payment for lost construction man-hours. As such construction is dependent on timely and secure deliveries to make construction cost- and time-efficient, meaning that the logistics *service* aspect is important for construction.

Then again construction may be the ‘source’ of or detect necessary changes, and thereby impact the demand/supply chain(s). E.g. if construction detects a design ‘error’ making something ‘impossible’ to construct, or place into the bigger construction, then changes have to be made that may affect several tiers down into the supply chain. These changes have to be effected rapidly, not to delay the construction or even the total project schedule un-necessary. As such a change will have effect as the *domino principle* down through the supply chain.

The last function described here is project planning and control. The project planning and control functions are mainly related to structuring, sequencing and estimating the scope of work, time schedule and cost budgets, as well as the important function of measuring and controlling the progress in scope of work versus the progress in accumulated cost and schedule. As such one may say that project planning and control is related to structuring, quantifying and updating the coordinating structures and quantities of the project as it moves from the ‘open’ to the ‘closed’ mode, and as it moves from planning to and through execution.

Project planning and control comprises two central functions with the role to co-ordinate the different elements and interrelationships of the holistic perspective of the project, i.e. the planner and the cost engineer. As the ‘single point of contact’ for the project’s planning and control information the planner and cost engineer have a central and co-ordinating role in and for the project demand/supply chains. As the planner and cost engineer have a comprehensive overview of the parts and relationships of and among the project’s parts and actors, and are strictly dependent on complete and regular data and information about status and progress, they need extensive communication with the project supply chain actors, both internally and externally in the extended project organisation. Through their role as a point for collecting data, the planner and cost engineer analyse and present information that are valuable and necessary for all actors in the project supply chains. The planning and control information is important for the project as a whole and for each of the project supply chain actors, as it is the medium that relates local aspects and status to the overall aspects and status, thereby communicating consequences that could have commercial effect for both the project and project supply chain actors, hopefully in due time so that corrective action could be taken if necessary.

Operations

The intra-organisational operations of the project object comprises the operations organisation that take over the project object after it is developed and commissioned. To make the picture simple let us focus on three different parts that are relevant for logistics and supply chain management in the operations of the project object. These three parts are; (i) the offshore operations organisation, (ii) the onshore support organisation, and (iii) the operations logistics support organisation.

The offshore operations is the direct operations organisation located on and operating the offshore installation, i.e. the project object. The onshore support organisation and the offshore operations organisation is often termed the project's 'operations organisation'[45], but here we have chosen to separate the offshore and onshore part, as they have different roles as part of the operations supply chain and logistics management. The third and last, the logistics support organisation, may be regarded as the hub in the operations supply chain and logistics management, namely the 'base' operations. The 'oil bases' as they are often termed are partly operated by the operators themselves, or by third party logistics providers which the operator have outsourced base and logistics services partly or fully to.

The demand generator in the operations phase is the offshore operations organisation. The demand information goes through the onshore support organisation, the operations logistics support organisation, or directly to the supplier. The flow of goods then goes from the supplier, transported via the supply bases and the logistics support organisation, out to the offshore installation by supply vessel or helicopter. For some goods a return process is also included, e.g. for rental equipment, as the goods are returned to the supplier after being used offshore.

Though, the operations organisation, or the operations experience of the operator do also take directly part in the project object development. Then their role is to bring operational experience with respect to choices of equipment and solutions, so that use and operations of equipment and systems functions well in the offshore operations environment, as well for later maintenance and modifications. Thereby one may say that the offshore operations organisation directly influences the demand management in the project development phase.

'Operations influence the choice of components directly in the contractors purchasing organisation, and may thereby influence the use of the frame agreements' (JMP, 990124).

However, the main importance of the different parts of the operations organisations is in the operations phase. The onshore support organisation is the administrative and commercial management centre for the operations phase of the project. In the supply chain their role is in managing the contractual terms and conditions, as well as other both tactical and operational procurement issues. E.g. much of the offshore procurement demand is led through procurement in the onshore support organisation, then further down the supply chain to the supplier.

[45] In Norwegian; Prosjektets 'driftsorganisasjon'.

The logistics support organisation is an important part in the operations supply chain as it is the link in the logistics chain between the offshore installation and the onshore suppliers. The supply chain management role is often divided between the onshore support organisation and the logistics support organisation at the bases. The onshore support organisation is often tied to the *information based demand* side of the offshore supply operation, while the logistics support organisation is tied to both the flow of information and goods in the offshore supply chain, from the offshore demand to the supplier and out to offshore delivery of the goods.

5.4 External Bodies – Law and legislation

External to the project and the internal and external actors of the project supply chain there are national, multi- and inter-national 'bodies' that may have influence on the project supply chain. These bodies may influence the ability to construct and develop project supply construction, e.g. laws and regulations to secure that competitiveness is upheld, i.e. to prevent cartels, monopolies etc., in industries and markets. Here we will just show a couple of examples on the influence such may have on project supply chain constructions.

'It is obviously easier to build an alliance on the back of an existing relationship, or to roll over from one contract to the next, and a longer-term relationship can save time in setting up new projects. However, there are some issues which cannot be ignored here. The *European Union Procurement Directives* impose strict requirements on procurement by Government or public authorities and on procurement by "utilities" companies (including oil companies operating under Government franchises). On the face of it, these directives may make it difficult – if not impossible – to restrict bid lists to a select few, or to select suppliers on a basis other than the lowest price, or the most "economically advantageous" bid. Similar regulations may apply in other countries. World Bank procurement procedures are widely applied by state enterprises in the Third World, even where no World Bank money is involved. Partnering arrangements have been criticised for becoming too cosy and being insulated from the pressure of competitive pricing. In the longer term, if owners and suppliers pair off this will reduce market capacity and competitiveness' (Pritchard 1994).

If we e.g. go to the Norwegian petroleum industry, some Norwegian petroleum companies come under the definition of "utility" company, i.e. it is a company controlled by the Norwegian Government, and EU's Procurement Directive has to be adhered to;

'The European Union's Purchasing Directive are based on paragraph eighty in their Treaty of Rome, which states that along a supply or procurement chain there shall be competitive selection in at least one link' (Instefjord, 30.06.99).

An example of a supply or procurement chain where the initial link was established in accordance with the competitiveness rules of the Treaty of Rome for thereafter to make use of that and thereby have more degrees of freedom in selecting actors for and constructing the project supply chain;

'All procurement in this development project is contractually executed through the Contractor. The Contractor was chosen after competitive bidding in accordance with the European Union's purchasing directives, and therefore we are free to select sub-contractors and suppliers without taking EU's purchasing directives into account'.

From the industries side the European Union's purchasing directives may be met through conscious distribution and use of roles between the Operator and the Contractor. From the other side, the European Union may give their opinion about the petroleum industry's use of the market for procurements;

'EU's purchasing directives point out that the petroleum industry must be better at:

- specifying and use what is available in the marketplace today,
- not specifying what is 'just not' in the market place – that should be developed continuously and brought to the market place to be used in future projects' (OA, 990614).

This is important seen from the view of up-keeping competitiveness in the market-place, as one in specifying product details, especially that needs to be developed may favour specific suppliers or lock out others that have 'similar' products.

Another dimension to the level of competitiveness in the marketplace, is the ability to develop project supply chain constructions that are competitive, as well as keeping the construction within legally defined constraints. As well as EU's Procurement Directive that shall secure to up-keep competitiveness in market-places, there are directives and rules that define how a company are defined, or more precisely in which category a company is to be placed e.g. for taxation purposes. A question may be asked whether a change in organisational structure and formal business relationship does change how a company are 'defined' by legal interpretation of terms. An example may be taken from the offshore petroleum field Yme[46]. In Yme two oilfield services companies have incentive contracts related to the production capacity of the Yme project object. The question then is whether the two service companies are service companies as defined by legal terms, or whether they are to be regarded as a production company. The core of this question is the difference in taxation between service companies and production companies. A production company is due to pay a production tax of 78%, which is considerably higher than the normal business tax level of a service company. To keep this type of incentive contractual arrangement under surveillance, bureaucrats monitor the incentive arrangement to see whether the contractual arrangement make the service companies legally regarded as production companies. This is an example of the influence that 'governing bodies' have on the ability to create competitive project supply chain arrangements based on the core competencies and capabilities of each actor in the supply chain.

5.5 The challenge of the oil and gas project supply chain

One may say that value enhancement in oil and gas projects are 'engineered' into the project, either through project processes or through novel technology. The demand definition and specification process in project development is directly related to the value positioning of the project. This demand process is both established through and will commit the supply chain when the defined demand shall be supplied. This is

[46] Based on a discussion with Mr. Odd Instefjord, June 2000.

established through the contract execution model[47]. During the last decade there has been changes in the contract execution models from the operator being the hub and using function specific contractors for specific functions and parts of the project scope of work. The operator did also have closer contact with a broader set of technology providing suppliers, and an extensive technology development dialogue was present among the operator's engineering functions and the same of contractors' and suppliers'. Then in the late nineteen eighties this was believed to be a costly set-up. This was to a large extent the same as the situation found in the defence industry.

During the cold war the defence budgets were more or less 'limitless'. Cost should not be an issue that could give the opponents an edge in the weapon technological advances, and thereby lead to disturb the power-balance in an unwanted direction. As in the oil and gas industry this gave rise to an entire culture where engineering and demand definition meant technological development, which again meant new, specific supply chains to cover the demand both in manufacturing and support. After the cold war the defence budgets has been exposed to dramatic cuts and costs both in development and support has become an issue;

'The United States still desires to maintain a technological edge over potential enemies, but cost is now as important as performance. Therefore, the pressures to use unproven, high-risk, and potentially expensive advances in weapons are reduced. Whereas the unknowns associated with designing cutting edge technologies are lowered, other factors increase the difficulties of decision-making by the IPPD [Integrated Product and Process Development] team. The long duration of the Cold War gave rise to an entire culture; one that saw generations of military leaders and weapons designers matured in an atmosphere where the issue of *cost was secondary to performance. No longer!*' (Usher *et al*. 1998, p.286).

This may also be used to reflect the current situation in the offshore petroleum industry. With the focus on being competitive and profitable, and thereby able to meet very low oil prices, the focus on development and operations has become a cost-conscious one. This is a situation that leads to new challenges for the engineering community of the offshore petroleum engineers. The mental adjustments necessary for engineering may in many respects be found to be that of the defence industry community. Although the cost issue has gained a strong foothold, the question in the end is **project value**. And value in a project is dependent in **income, costs, and time**. Technological choices, as well as models for project development and execution may influence all these three.

5.5.1 Cost and income – Value of technology

Then, how does the above relate to the challenges of the oil and gas supply chain? Let us refer to two, possibly counter argumentative, quotes by the British Department of Trade and Industry;

[47] The TIKO-II (Kinn et al., 1998) report written jointly by a group of representatives from the operator Statoil and the contractor Kværner, gives a thorough analysis of the challenges and problems of contract execution models for Norwegain offshore development projects, and the related elements in the relationship between the operator and the main contractor.

’Over the last four years, with a fairly stable, relatively low oil price, there has been a drive to reduce costs in the partly-depleted North Sea oil province. The multinational oil companies operating on the UK Continental Shelf (Operators) are changing the pattern of business relationships within the industry network. Instead of dealing directly with a large number of subcontractors as they previously did when the main concern was to get the oil flowing, regardless of cost, most are progressively moving to a **“lean supply”** approach. In its most extreme form, this means drawing up a single contract with a prime contractor or “alliance” group of contractors, which takes responsibility for constructing and managing a major production facility. Prime contractors in their turn have publicly announced that they are seeking to reduce the number of subcontractors and to develop long term relationships with a smaller number of favoured partners and most have taken steps to implement this policy’ (DTI, 1997).

‘In the face of reducing margins and increasingly difficult and expensive exploration and production challenges**, reduction of activity is a real possibility unless there is a constant stream of innovative ideas and technologies feeding through** from indigenous supply firms, particularly those in the small to medium-sized (SME) bracket, to enable continuous cost reductions’ (DTI, 1998).

So the challenge of the oil and gas industry was to increase the competitiveness of the North Sea oil province, especially to meet lower oil prices. The answer was a ‘lean supply’ approach towards the oil and gas supply chain, both for development and operations. But, at the same time it is estimated that innovation and technology development will stand for approximately 50% of the future value enhancement[48] in the oil and gas industry. In this situation, the oil and gas industry has tried to copy lean practices, e.g. as found in the automotive industry[49]. As the oil and gas industry of the North Sea area are becoming mature, they are focusing more on cost efficiency, than on cost effectiveness and value enhancements through e.g. a rich set of suppliers with technology development capabilities.

‘A substantial group of indigenous technology-based oil-related companies has been formed since the discovery of oil on the UK continental shelf. … These SMEs have been contributing to the flow of new technology, and this was originally promoted by their close relationships with the Operators, and end-users. The close relationship which previously existed between the Operators and the technology-based oil-related companies permitted close integration of their operations and R&D. However, this has been substantially lost now that most Operators tend to confine their direct interactions to the large integrated service contractors and have, indeed, closed many of the functional departments which used to interact with suppliers. Now most responsibility for managing innovations lies with the contractors, with whom many SME’s have not had dealings in the past. **The continued growth of the smaller, innovative companies in a highly competitive global market is dependent on maintaining their technological competitiveness, but the perception is that changing contracting practice is threatening this**’ (DTI 1997).

So, due to the need for improved competitiveness, the answer was ‘lean supply’, which is a good strategy in a repetitive context were it is about refinement of already established processes. In the project atlas presented in chapter three we called this a **closed state**. The cost of such a strategy could be that the many SME’s[50] that provided

[48] Presentation given by INTSOK.

[49] The automotive industry does also have a challenge in getting more innovations and technological development through the supply chain from 2nd tier suppliers, i.e. suppliers below the system suppliers developing and delivering systems to the automotive assembler. See e.g. DTI 1998 for a discussion of this.

[50] SME, small and medium-sized enterprise.

the necessary innovations and technology developments are lost from the marketplace, with the effect that new innovations could be reduced, with the ultimate consequence that fewer new projects would come on stream due to not having access to technology that could make the projects cost effective.

Below we have taken a set of quotes from a 'discussion' by the British Department of Trade and Industry (DTI, 1998), outlining the development of the lean supply concept in the oil and gas industry versus the degree of innovations and technology development, and shortened them into the following list;

√ The initiative Win 90s established lean supply practices; operators moving to closer relationships with one or two main contractor(s) to exploit interface synergies.

√ The main contractor began to form the whole interface between the operator and the rest of the supply chain.

√ Operators' downsizes their technical departments, reducing their ability to undertake research and development and their ability to evaluate new technologies.

√ A view is that operators have lost their ability to evaluate new technologies. Taken over by main contractors.

√ Whereas SMEs could approach engineering departments in operators and find 'product champions' they now have to identify project teams, which may consist of operator and contractor engineers, and who are essentially mobile.

√ Win 90s continued by CRINE.

√ Industrial stakeholders agree that these various changes in supply methods are having, or may have an adverse effect on innovation.

√ There is a shared perception that the largest percentage of new technologies have come from SMEs.

√ Cost cutting initiatives often embodied in alliancing agreements, usually transfer increased risks onto the contractor, making the contractors highly reluctant to take on any new ideas since innovation means greater risks, and they therefore tend to stick with tried and tested technology.

√ Contractors may not be accessing best technologies when these are available in the market place, due to preferring to source tried and tested technology rather than risk using an innovation despite it having the potential to reduce costs for the operator; and demanding excessively large cost reductions before considering an idea.

√ In order to cut costs operators and contractors have to seek innovation from SMEs.

√ It seems clear that also contractors will pass down the responsibility for technology identification and development to SMEs.

Pre-CRINE and pre-NORSOK, technology development happened to a large extent through a broad base of SME's working tightly to the technological problem core. This could be regarded as a **'rich', not 'lean'** approach. Some say that even in the post-NORSOK period, the improvements in cost and execution time were due to technological developments.

'Although the actual performance ['NORSOK-performance'] represents a considerable achievement compared with traditional budgets and development schedules, it is more likely that these achievements are **caused by more cost effective technical concepts** than by the use of the NORSOK … contract execution principles' (Kinn et al. 1998, p.1).

The 'lean supply' approach may be very well suited for the repetitive context of the operations phase, when the supply chains are established and the demand is prescribed for a longer term, but it may be a wrong concept to pursue for the one of a kind, new technology dependent context of the project development phase. When the context is such that new technology is needed to make smaller reservoirs financially exploitable, the question may more be about the **ability to in an engineered way being able to manage** the search or development of new technology and/or processes that may make a new project feasible or enhances the value of the project.

5.5.2 Time – Value of the execution process

What was said above about the main contractor filling the 'whole' interface between the operator and the rest of the supply chain is a modifiable truth. The operators' does also have their long-term frame agreements and frame contracts with their own suppliers, which the operator often demand that the main contractor use in a specific project. This may again be the basis for discussions between the operator and the contractor, regarding whose supply chain to use, the operator's or the contractor's to get the most time-effective execution.

When the development phase with its demand and supply chain processes is completed, the operator will therefore in the operations phase be making use of operations supply chains established partly by the operator and partly by the contractor. Use of frame agreements for long-term demand and supply chain relationships as sources of effectiveness and efficiency both for the development phase as well as the operations phase of the project life-cycle, become central in the relationship and distribution of roles between the Operator and contractor as project supply chain actors. A central question is whether it is the Operator's or the contractors frame agreements and contracts that are to be used, and why. A contractor procurement executive said it like this;

'Our [the contractor's] claim is that we as contractor develop concepts, products and solutions together with our sub-contractors and suppliers, and that it therefore is necessary that it is us [the contractor] that possess the long-term, development oriented agreements and contacts with these. The petroleum companies counter-argument is that they need the long term agreements and contract due to the need for simplification and efficiency in operations'.

Table 5.6. Who's supply chain to use in development.

Operator's supply chain	**Contractor's supply chain**
Could effect in leaner operations (not necessarily if change in operatorship) Potential for supply synergies across operator's installations. Higher execution time risk. Improving network relations in the industry (indirectly improving contractor's agile capabilities).	Shorter execution time, due to using 'pre-defined' and established demand/supply chains, with a potential for continuous development. Less execution risk. Strengthening contractor's lean execution model.

As such the main question for whose frame agreements to use is whether one is aiming for effectiveness and value enhancement through the operator's frame agreements, which should result in shorter development execution time, or aiming for value enhancement through efficiency in the operations phase. Another dimension used by the Operator is that they want to exploit and enhance the effect of operational synergies between several licences. The background for the use of frame agreements is the aspect of development of competitive products and solutions, as well as the efficiency element of reuse.

Seen from the contractor's point of view this is much about whether the contractor has to establish new relationships when executing a project based on the operator's supply chain, or whether the contractor may use its own supply chain relationships;

'There has also been a change in when developments should take place in the industry. The old approach was that developments should take place *within* the projects. This takes more time in the projects, as well as it brings more uncertainty into the project. The new approach is that developments should take place *outside of and between* projects. This approach differentiates more clearly between product development and product execution' (meeting with a contractor representative, 990614).

Then we are into the effect that time has on the value enhancement through project execution. As was stated in chapter one describing the main changes resulting from the NORSOK process, the overlap between the project phases is increased, contracts are placed early, and work is commenced based on preliminary technical information, in order to reduce the project execution time. The importance of reducing the project execution time is due to the value position of the project for the project owners. The net present value of the project is improved by reduced execution time, due to earlier income from operations, and shorter time between the large cost spending of the execution phase and start of operations and income. This positive effect is to some degree counteracted by increased costs, when the execution time becomes too short and the quality costs start to raise due to more concurrent activity than what the project organisation is able to manage. The question therefore is what is the most optimal execution time?

Figure 5.4 shows the declining life cycle income, LCI, as a function of the execution time. The CAPEX cost curve, here given without risk measures, is also shown, with the minimum point of the curve showing the optimal execution time from a CAPEX cost point of view. By bringing the CAPEX costs curve and the LCI income curve together, this gives us the net present value curve of the project, with its highest point marking the optimal execution time from a net present value point of view. A natural question to ask is whether it is the same life cycle income curve or CAPEX curve that applies for both ‘execution times’, or whether it is possible to ‘lift’ the LCI curve with a longer execution time due to improved time for design optimisation or use of new technology, or lower the CAPEX curve?

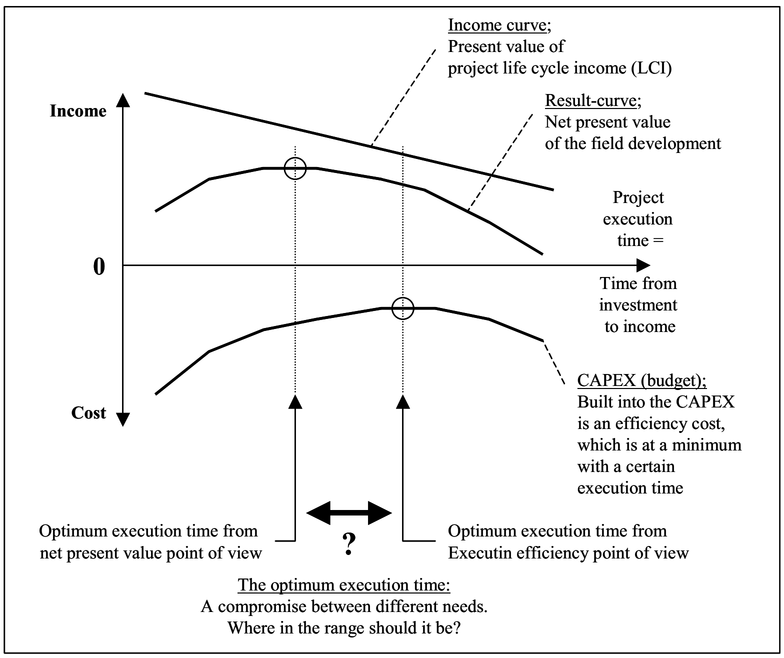


Figure 5.4. The optimum execution time (Based on figure in TIKO-II, 1998).

This opens up for alternatives, and alternative supply chains. Being able to establish new supply chains if new opportunities or risks are uncovered through uncertainty management of the project, then being able to undertake evaluations that could answer whether the value position of the project would be enhanced, i.e. pre-evaluating the changed cost position and changes in execution time if going for alternative technologies and/or processes.

5.6 Summarizing the challenge

The challenge of the oil and gas supply chain in the North Sea region, as presented above, is two-fold. First it is the ability to be able to support and take advantage of innovations and technological development that may keep up the competitiveness of the oil and gas region. The other is related to finding the most 'optimal' execution time, taking the option of alternative routes into account. Both are aimed at macro competitiveness, through inter-organisational capabilities and capacities, where the project specific supply chain has to be competitive, both in enabling use of innovative technologies, and without compromising on the execution time. And this should be made manageable in a planned and controlled way.

Table 5.7. Summarizing the challenges of the oil and gas [project] supply chain in the North Sea region.

Challenge	Description
Innovations and technology development **[Cost and income impact on value]**	Being able to develop relationships in the industry demand/supply chains that enables and sustains the initiation and use of innovations and technology development.
Project development execution time **[Time impact on value]**	Being able to establish extended project organisations that are able to execute the project development in a 'correct' scheduled time, and in a controlled manner.

In chapter one we presented the developments of project execution and management through four stages in the North Sea oil and gas industry. There we saw that improved project planning and control, through CTR-catalogues, 'Front End Loading', and incentives for the contractor to control his own costs were means applied in 'stage two' to meet the recommendations from 'stage one'; detailed definitions and tight change control. Then in 'stage three' new project and contract execution models were introduced, with a lean supply approach to the supply chain. Together with bringing the supply chain earlier into the project, to take part in project definition and project object specification, together with committing the supply chain earlier, in a still open project context, through placing contracts with larger contractor risks on a less defined basis (more degrees of freedom, both on the contractor and operator side), resulted in an 'open' situation to be developed based on a lean supply chain.

In other words, we may say that in stage two the focus was on closing the project through strict project planning and control means, especially before committing the supply chain, but having a multitude of potential supply chains (and thereby technology) to develop from. Then in stage three we may say that the project is opened up, especially to the contribution of the supply chain and even when committing the supply chain, but the portfolio of supply chains to develop from is reduced due to lean supply developments. This benefited the execution time, but at the sacrifice of the (potential) opportunity value of alternative technology. In summary we may say that;

Stage 2; Approach a **closed project**, with a **rich (open) supply chain**.

Stage 3; Approach an **open project**, with a **lean (closed) supply chain**.

The consequence may be that when opening up the demand processes, concurrently with applying lean supply, as in stage three, one may see that technology development in is danger of being lost, with its potential value enhancement contribution. At the same time the concurrent execution process, with a lean supply chain seeks to manage the time element of the value enhancement process in a controlled manner. However, if project value enhancement from both technology (cost and income), as well as time shall become an opportunity, then one may seek to combine the approaches of stage two and three in one way or another. Combining the steps from stage two and three could e.g. for stage four mean to;

Stage 4: Approach[51] an **open project**, with a **rich (open) supply chain**.

Approach a **closed project** with a **lean (closed) supply chain**.

This means that new project planning and control concepts and means should be established that enables to up-keep and manage the option of a rich and open supply chain for an open project setting, though still keeping manageable control of the time processes of the project development and execution.

So then what we have defined for the three stages could be shown as in figure 5.5.

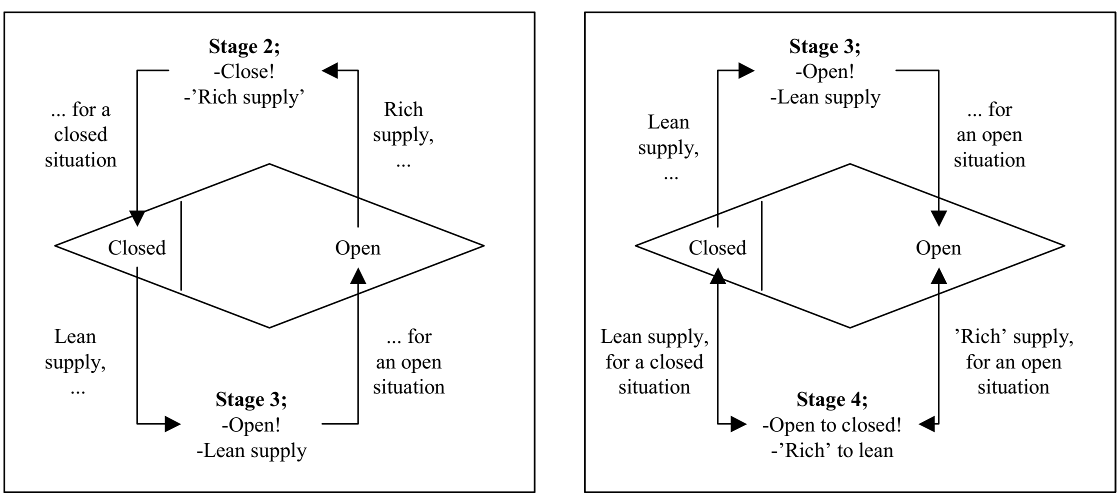


Figure 5.5. The three stages and their use of rich or lean supply chain concepts, to approach closed or open projects.

To use some terms that we defined in chapter four, we may say that the 'rich' or open supply chain approach may be supported by the concept of agility and lessons from

[51] Here we have used the term 'approach', but what should be more appropriate is to say 'optimise' in the sense that one will seek the solutions that give the most project value to the project owner, but were the supply chain also make a reasonable profit taking their risk exposure into account.

agile manufacturing. This has direct relations to the project development phase as described above. However, the project operations phase is both a closed project state, as well as have a 'closed', repetitive supply chain, i.e. a context suitable for lean supply chain approaches.

If we now summarise what we have said regarding the three stages of developments of project execution and management in the North Sea, then it may be presented as in table 5.8. below.

Table 5.8. The three stages and their use of rich or lean supply chain concepts, to approach closed or open projects.

Stage	Project	Supply chain	Operations	Supply chain
Stage 2[52]	Closed	"Agile"	Closed	"Agile"
Stage 3	Open	Lean	Closed	Lean
Stage 4 – Alt 1	Open	Agile	Closed	Lean
Stage 4 – Alt 2	Closed	Lean	Closed	Lean

Taking the conclusion from table 5.8 with us, we will now move to the third part of this thesis. The development of the **project supply chain management concept, PSCM**. The development of the PSCM concept and the related methodological guidelines seek to meet the challenges of the project context or state, in both the development and operation phase, with appropriate logistics approaches to the corresponding supply chains.

[52] We have for the operations phase of stage two said that it is following an agile approach. This is not the fully correct use of terms. What we mean by using that term is that at that point in time there were still not that much focus on utilising synergies for supply across several offshore installations. This means that each offshore installation was still being supplied from its own supply 'warehouses', with its own material. This is a 'rich' (cost un-efficient) rather than an agile approach.

6. Project Supply Chain Management – The Concept

6.1 Introduction

This chapter outlines and discusses the concept of project supply chain management, PSCM. PSCM may be regarded as an artificial construction as defined by Simon (1990);

‘The thesis is that certain phenomena are “artificial” in a very specific sense: they are as they are only because of *a system being moulded, by goals or purposes, to the environment in which it lives*. If natural phenomena have an air of “necessity” about them in their subservience to natural law, artificial phenomena have an air of “contingency” in their malleability by environment. … artificiality is interesting principally when it concerns complex systems that live in complex environments. The topics of artificiality and complexity are inextricably interwoven. … Fulfilment of purpose or adaptation to a goal involves a relation among three terms: the *purpose* or goal, the *character* of the artefact, and the *environment* in which the artefact performs’ (Simon 1990, pp. ix-xi, 8).

As stated by a Norwegian Public Study [NOU 1988] there is a need for system knowledge when new facts or trends are emerging;

‘New facts need system knowledge … Shortly said: the basic theoretical foundations of learning is vital both for the interpretation of new information and as a guide to direct the search for new facts. The better the theories are, the longer they last. And it is those concepts, models and theories that one is familiar with that decides what one may conceive of the unknown. The production of new knowledge makes it more necessary than ever to know *such fundaments of understanding*. The large flow of explorations and findings necessitates fundamental knowledge – *systems for interpretation and action* – now more than ever. Without systems knowledge the explosion of knowledge will lead to greater confusion and perplexity. The flood of impressions becomes fuzziness if the frames of reference that can give them meaning, are missing’ (NOU 1988, p.9).

With respect to supply chain management in the project context of the oil and gas industry, it is being perceived as a new, emerging competitive aspect of the oil and gas industry, e.g. as addressed through CRINE Network’s supply chain management initiative. To be able to ‘navigate’ in this new world of words, concepts, models and theories, there should be outlined how logistics and supply chain management is different from and focus as compared to other industries. The concept of project supply chain management, PSCM, is set to outline that.

Before we start looking into PSCM as a concept, a short introduction to some terms is needed. First the term concept, which may be defined as;

*‘**Concept**: a word or phrase used in propositions to describe real world relationships; concepts are neither true nor false, only more or less useful’*[53].

[53]‘Concept: a word or phrase used in propositions to describe real world relationships; concepts are neither true nor false, only more or less useful; the cognitive meaning of a term and the smallest unit of (conscious) thought processes; concepts are neither true nor false but more or less applicable (a) to recognise an object as an instance of the concept, (b) to produce or to understand sentences in which the concept is expressed and (c) to develop constructs or cognitive systems using the concept in question’ (Web Dictionary of Cybernetics and Systems, http://pespmc1.vub.ac.be/ASC/Concept.html).

The main idea behind developing the PSCM concept has been to outline a concept that is 'neither true nor false, only more or less useful' to understand 'the character of the artefact' as Simon says above, and that thereby could act as a 'fundament for understanding' and a 'system for interpretation' as the needs stated by NOU. Then PSCM may be the frames that could guide logistics and supply chain management in this project context. The concept should again be based on some principles;

'Principle: a basic generalisation that is accepted as true and that can be used as a basis for reasoning or conduct'[54]

To develop knowledge takes time and a concept built on a set of principles could be useful in that process;

'As with almost all innovations, implementation precedes understanding. The aircraft industry, to cite one example, was decades old before a theoretical basis for designing aircraft began to develop, and decades more passed before theoretical models were mature enough to allow new designs to be deducted from them. Agility is happening. This book is an attempt to understand what is happening and to capture that understanding in a first-generation model' (Goldman et al. 1995, p.xvii).

As with the aircraft industry and the concept of agility, supply chain management in the project context of the oil and gas industry is 'happening', i.e. the awareness of its impact is becoming more clear. The project supply chain management concept, PSCM, is an attempt to try to capture the characteristics of that through a conceptual development.

6.2 Principles and Characteristics of Project Supply Chain Management

Now we will start with stating the principles that PSCM is built on, and then describe the characteristics of PSCM. First the characteristics will be outlined and described per se, before the characteristics is 'summarised' in two 'statements' one for the development phase and the operations phase of the project respectively.

6.2.1 The Principles of PSCM

The principles of project supply chain management is outlined to be the basis for developing the key describing characteristics of logistics and supply chain management within the project context. The underlying assumptions for the principles is the notion of the project as a business opportunity, with the project supply chains as a competitive entity that may enhance the value of the project, i.e. the business opportunity. Value enhancement through the project supply chain may then be explained through a logistics and supply chain management approach. As such the principles of project supply chain management are the same as the three underlying assumptions of this thesis;

- The *project* as the *business opportunity*.

[54] From Webster Unabridged Dictionary/WordNet, http://work.ucsd.edu:5141/cgi-bin/http_webster/ .

- The *supply chain* as the *competitive entity*.
- *Competitiveness through logistics and supply chain management*, focused on alignment of supply and demand in the project context.

We then have a set of principles that build up the foundation from both the project as well as the logistics and supply chain side. Within the project context addressed here, the project is a business opportunity that has to attract investors able and willing to invest the necessary financial means to realise the project. The supply chain is as described in the previous chapter the extended entity that make the owners of the project able to realise the scope of work and technological content of the project. The last principle is the principle that takes the contribution from logistics into account. Logistics is ultimately about aligning the supply with the demand in a best possible way, and in the project context that has to be done throughout the life-cycle of the project and the project object. Aligning demand and supply in this project context is driven by engineering processes, within an open context in the development phase, meaning that uncertainty is an important aspect to take into account. In the operations phase the project is in a closed state, and the processes and uncertainty changes character. This necessitates that the characteristics of PSCM change from the development phase to the operations phase. Together with the characteristics of PSCM (described below) these principles will be the basis for the PSCM concept.

6.2.2 The Characteristics of PSCM

As a business opportunity and a value generating ‘entity’, the project could be separated into a development phase and an operations phase. These two phases have distinctly different characteristics, which should be reflected in the characteristics of a logistics and supply chain management approach to this context, i.e. the characteristics of PSCM.

As described earlier, a key describing characteristic of the inbound supply chains of car manufacturers is *robustness* (Schneider *et al.*, 1994). Their processes have a high degree of repetitiveness and delivery frequency, with tight interrelationships and connection within the inter-organisational supply and system manufacturing network. Further the automotive supply network is characterised by lean use of resources so that if one supply chain stopped, the whole supply network would stop within a short period of time. The supply chains therefore have to be robust.

The project context focused on here is primarily characterised by being a unique business opportunity, with two distinct phases that again are unique with respect to the characteristics that describe their supply chains and processes. In table 6.1 below we present the characteristics of project supply chain management, as we propose them, related to five different aspects describing the project supply chains.

The first characteristic is the project life cycle, stating the importance of being aware of the *differences in characteristics* between the two distinct phases, development and operations. The second characteristic is the supply chain focus, driven by the *targeted, one-of-a-kind* demand/supply in the development phase, versus the *repetitive* demand/supply in the operations phase. Then the third characteristic is the logistics drivers, or whether the main driver of the supply chains should be *demand or supply* in the development versus the operations phase respectively. Then come the organisational processes, characterised by *agile* characteristics in the development phase and *lean* characteristics in the operations phase. The final characteristic is then related to the service quality, an important logistics mission, focusing on *resilience* in the development phase and *robustness* in the operations phase. Each of the PSCM characteristics is described more thoroughly below.

Table 6.1. The characteristics of project supply chain management.

Aspect	Characteristics	
1. The project life cycle	Development	Operations
2. The supply chain focus	One-of-a-kind	Repetitive
3. Logistics drivers	Demand chain management	Supply chain management
4. Organisational processes	Agile	Lean
5. Service quality	Resilient	Robust

The project life cycle

The project life cycle is characterised by the two distinctly different phases development and operations. The development phase is focused on developing a business opportunity and the project object enabling the owner to exploit the business opportunity. The focus is on developing the business opportunity in a context that is influenced by a high degree of uncertainty, where value enhancement has to be developed through combined knowledge, competence and cost *effectiveness* in the extended, or 'virtual' organisation that comprise all the actors taking part in the development (demand) and supply operations. The operations phase on the other hand have to generate the income that the project object is set to do, and do that in the most cost *efficient* way. The uncertainty is reduced to an operation risk management aspect. While the development phase is temporary and working under limited time, the operation context is repetitive, with ample time for refinement.

The origin of the project is when knowledge about a business opportunity starts to emerge. In the context of development projects in the oil and gas industry that is when geological data is collected, refined, analysed and interpreted. The first time period of the project is known as the project's front-end, or 'project development' as we said in chapter three. This is the time period from the point in time when the first data is found 'describing' whether hydrocarbon reserves are present below the seabed, and a business opportunity starts to emerge, up to the point in time when the project has been defined and acknowledged as a project and 'big spending' starts. 'Big spending' may be regarded as the point in time of placing and committing to contracts with contractors, sub-contractors and suppliers, i.e. the start of the major capital expenditures of the project object development phase.

The development phase of the project is characterised by bringing it from an *open* state, towards *closing* several degrees of uncertainty, both risks and opportunities. The high degree of uncertainty that characterises this phase is related both to opportunities for value generation that the project owner want to take advantage of, and at the same time risks that should be hedged against. The development phase ends when the project object is commissioned, set into operation and reviewed for a period to see that it is able to deliver as specified.

In the commissioning phase, when the development phase ends and operations commence, a rather radical change occurs in the logistics and supply chain management setting for the project object. At this point in time the project object has been developed and all needs generated by the technical and support processes are defined, and the project object shall be operated for a longer period of years to exploit the reserves in the reservoir and produce the oil and gas resources and generate value for the project owners. The objective has changed from being *cost-effective* in using costs for life cycle value enhancement in the development phase, to becoming *cost-efficient* with respect to operations and value seeking in enhancing the options available to enhance the production.

The supply chain focus

A logistics and supply chain management concept aimed at this project context has to focus in on the specifics of each of the two phases, i.e. the 'unique, one-of-a-kind' project object to be developed in the development phase, and the repetitiveness in the operations of the project object.

In a logistics and supply chain perspective the project object development means first and foremost the development, i.e. engineering, fabrication, construction and commissioning of a 'one-of-a-kind' project object. The processes involved in the development phase are directly influenced by the development setting, i.e. developing and constructing a unique object. The setting is moving from an 'open' area with rather wide degrees of freedom available, through specifying, committing and thereby 'closing' the project, in creating a specific object with all its detail, to exploit the business opportunity in an 'optimal' way.

The project object development is characterised by a large scope of engineering. The project object to be developed is unique, and therefore the engineering is targeted at specifying specific materials and equipment to be used. At the same time one may say that engineering comprises the value enhancement processes that shall make use of the opportunities inherent in the uncertainty of the 'what's' and 'how's' of the object development processes. The engineering processes therefore have to balance the search for value enhancement through making use of new, state-of-the-art technology and solutions, against the time frame available to establish specific needs, that again can be committed to deliverables from actors further down in the supply chain. This is a demand specification process, which we prefer to use the term *demand chain management* for.

In the operations phase, the supply chain focus is characterised by *repetitiveness*. The logistical drivers are repetitive, driven by technical processes and predefined operations schedules. This accounts for 'more of the same', where reliable replenishment when needed is in focus. Replenishment from a supply base and through a supply system that is characterised by efficiency, both with respect to cost and time, and reliability. This is a process where supply is in focus, and we prefer to use the term *supply chain management* for. The repetitiveness of operations establishes the ground for fine tuning and through that making the organisational processes lean. And as for the supply chains of the car manufacturing suppliers, lean supply chains need to focus on the robustness of their service quality. These are the characteristics that characterise the operations phase and that will be further described below.

Logistics drivers

In chapter four, in the outline of the developments in logistics and supply chain management theory, we stated that there were maybe only a conceptual difference between *supply chain* management and *demand chain* management. Though, we stated also that there could be reasons to separate the usage of the two terms when addressing logistics and supply chain management in the project context. Here we emphasise the term *demand* chain management in the development phase, and the term *supply* chain management in the operations phase. The reason for this dual use of terms and their differences are outlined and discussed below.

<u>Demand chain management in the development phase</u>

The objective of the development phase is to develop a project object that in a best possible way creates value for the owners in a life cycle perspective. This means that the capital expenditure laid out during the development phase should be kept low, but at the same time should give value enhancement in the life-cycle, i.e. it should be cost-effective. As inn all supply chains there is an initial demand that triggers the supply processes, whether there is a pull (given demand) or push (estimated demand) orientation. The demand in the development phase is defined, and redefined through change processes, and set by engineers, through the engineering processes in conceptual and detail engineering. The demand may further be changed during the fabrication and construction activities, to suit exact fabrication or construction needs that have not been adequately covered in detail engineering.

Horizontal alliances between the operator and one or more contractors have been used to support the demand chain management objective and function as described here. These are often referred to as alliance contracts. In such horizontal alliances it is the two upper-most tiers of organisations in the project supply chain that are the anchorage point of the demand chain management processes. The operator and the contractor(s) may be regarded as a ‘horizontal alliance’ construction in establishing and defining the demand[55].

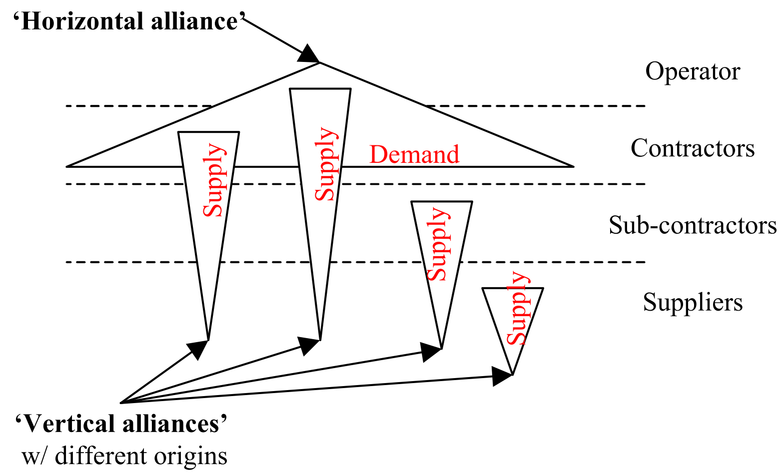


Figure 6.1. Organisational demand and supply alignment in the development phase.

Figure 6.1 illustrates how a horizontal alliance may be seen as the cornerstone of a demand chain management approach. The operator and the contractor(s) constitute the main node in the demand chain, in managing and being the ultimate generator and customer of the outcome of the demand processes. Each of the actors have again relationships with suppliers of both short and long term duration. In the process of engineering value into and specifying the project object and establishing the demand, each actor draws on his set of supplier relationships. As such these suppliers not only take part in supplying, when a demand is specified, but also in specifying the demand, as they support their higher tier customers with knowledge and competence in finding e.g. the most optimal and value enhancing technology, given the time available within the schedule. One may then say that the extended project organisation, as a demand chain, comprises the horizontal alliance of the operator and contractor(s), and their vertical supplier alliances or relationships, of which the ones are used that contribute most to the value enhancement of the project through the project object development.

Though there is a primary focus on demand chain management in the development phase, the supply chains does also play an important part. Although the demand processes establishes the potential for value enhancement and cost effectiveness, the supply chains and the supply processes are *necessary to realise* the development, i.e. supply the demanded (engineering specified) material and equipment, fabricate and construct. In figure 6.2 below we see that the demand chain originates in the horizontal alliance (whether formal or informal) between the operator and the contractor(s). From

[55] See e.g. the description of the Cleeton Compression Project in Harrison et al. 1996, and the reference to British Petroleum in Vollmann et al. 1995.

the top-level demand stipulation the demand processes moves downwards to sub-contractors and suppliers, and ultimately to sub-suppliers. The demand processes are commitment intensive in that the operator and contractor specifies the initial demand, that again may be adjusted (due to changes) through product-oriented processes with sub-contractors, suppliers or sub-suppliers, for at the end to be committed through contractual bindings.

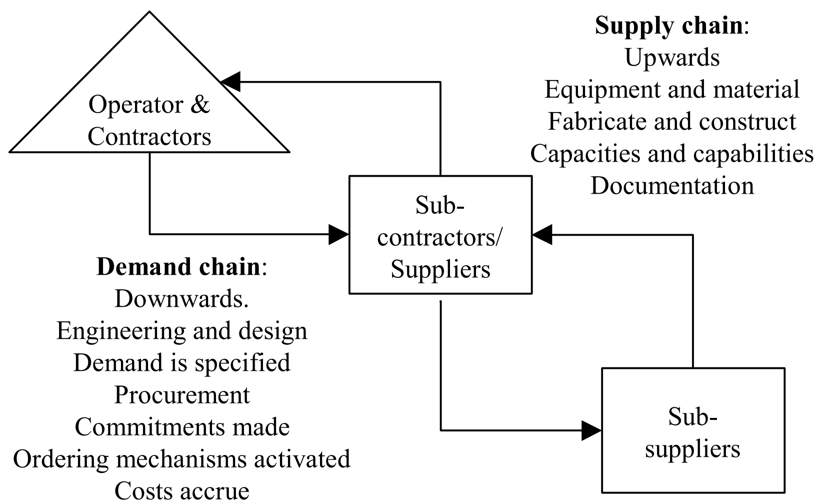


Figure 6.2. Alignment of demand and supply in the development phase.

Supply chain management in the operations phase

When the project object is developed and operations commence, the setting becomes repetitive with respect to the logistics operations and supply chain management. The demand processes goes from being defined by engineering in the development phase, to becoming defined by technical processes and work plans, i.e. the demand is more or less given, except for contingencies and incidents that 'disturb' what is planned. The focus is oriented towards the supply as compared to the development phase's demand focus. The focus is therefore towards the supply chains, and project value shall be enhanced through cost efficiency and reliable logistics support for the operations.

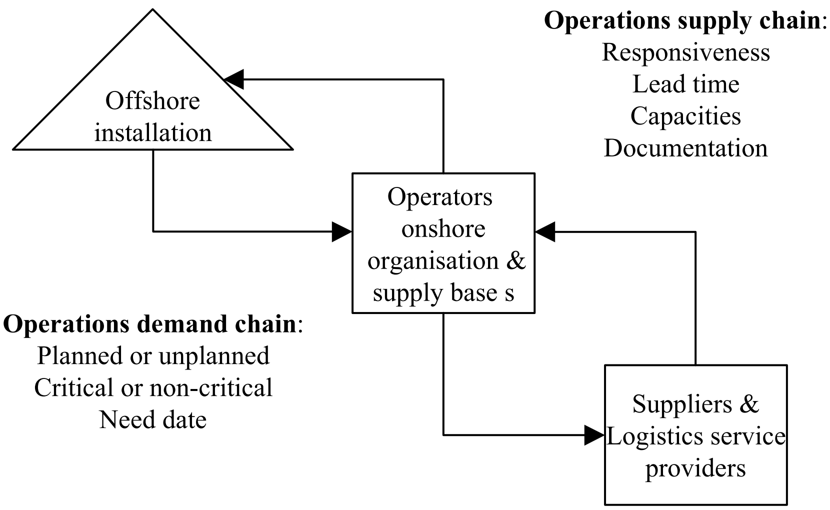


Figure 6.3. Alignment of demand and supply in the operations phase.

An example of a supply chain from supplier to an offshore oil & gas platform is shown below. The chain shows goods ordered from the platform, via procurement in the operator's onshore operations organisation, and supplied from the supplier, through using a logistics service provider to the offshore supply base, and then offshore transport to the platform via a supply ship.

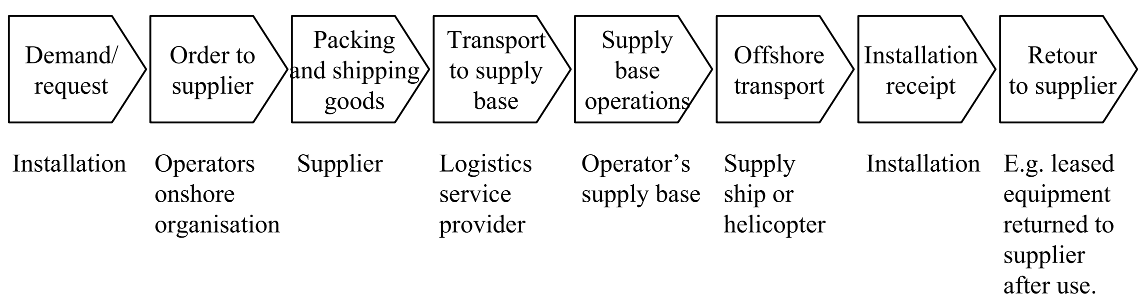


Figure 6.4. An example of an offshore supply process and supply chain.

Organisational processes

The objective of logistics management is to align supply with demand in a cost and time effective way. What becomes an additional point in the project context is that the demand/supply processes in the development phase play an essential part in the value enhancement of the project value through the engineering of the project object. In seeking the most value, i.e. engineering value into the project object, the processes have to be adaptable to *accommodate the opportunities* that arise throughout the development of the project object. Therefore the logistics alignment of demand and supply in the development phase should be characterised by *agility*.

When the project object is fully developed and set into operations, further value enhancement could be achieved through seeking *cost efficiency in the supply system*. Therefore the logistics alignment of demand and supply in the operations phase should be characterised by being *lean*, removing waste from the supply chains through the supply system, though keeping it reliable.

Agile (development phase)

Value enhancement in the oil and gas industry is to a large extent dependent on technological progress and innovations. It has been estimated that approximately *fifty percent* of future improvements in cost position and competitiveness will come from improvements in technology. As such there will be an important aspect of supply chain management to address the technological development capacity both within and outside an inter-organisational supply chain construction, e.g. the portfolio of long-term frame agreements;

> 'From the 1990s on, everyone working on the design and definition of projects should be aware of the need for and benefit of forecasting likely technological change over the following five to ten years. Very simply, if managed technology forecasting is not performed then future competitiveness will be diminished' (Morris 1994, p.297).

These technological changes has to be accounted for through the engineering processes in developing the project object, and thereby engineering value into the project, i.e. the engineering processes have to account and employ opportunities that emerges due to technological developments. This will often require changes, which requires that the extended or virtual project organisation is able to meet these. This is the core of agility and the agile virtual enterprise;

> 'The agile virtual enterprise is one that simply responds well (at low time and cost) to unexpected change' (Goranson 1999, p.67).

However, changes are a costly process, and as CAPEX costs should be kept as low as possible, one should approach building agility into the parts of the organisation where changes are likely to occur, in stead of trying to hedge all risks (i.e. risks of not being able to pursue a wanted opportunity), so that resources are not wasted;

> 'Agility is insurance, and investment decisions need to be made accordingly. … The ability to accommodate change that is unimportant or unlikely to occur represents the wasting of resources' (Goranson 1999, p.77).

In terms of being able to exploit technological opportunities, without wasting resources necessitates blending technology development and organisational agility as part of project management;

> 'Future products are managed as portfolios according to their degree of technological uncertainty and the organisational relationships needed to bring them 'to market'. The organisational and control attributes of project management have a major role in accomplishing this successfully' (Morris 1994, p.297).

If organisational agility is left out, this necessitates managing development within the project demand/supply chain between projects, so that new technology and processes are ready to be used for new, upcoming projects, but that is a lean approach;

‘There has also been a change in when developments should take place in the oil and gas industry. The old approach was that developments should take place *within* the projects. This takes more time in the projects, as well as it brings more uncertainty into the project. The new approach is that developments should take place *outside of and between* projects. This approach differentiates more clearly between product development versus the fabrication of a product’ (A Norsok representative, June 1999).

As the quote above states, a lean approach seeks to reduce risk. An agile approach does also try to reduce risk, but does it in another way. The agile risk reducing approach is aimed at trying to use resources to hedge the possibility to capture the opportunities where they are most likely to emerge, i.e. reducing the risk to miss opportunities, but in a cost-effective way.

As such agility needs to be *‘engineered’ into the project organisation*, to make it work as an agile virtual enterprise. The result of agility will be that the virtual enterprise are able to proactively manage *‘moving targets’*, as new opportunities arise where the organisation must decide whether to follow the opportunity or leave it due to either cost or time constraints. As it often is a time pressure for developing the project object, the old or ‘classic’ model acting much like a ‘relay race’ has been left for more concurrent processes, where much work is done in parallel. This puts even greater stress on the agile ability of the project organisation, as the available time to cost effectively follow opportunities become reduced. The difference between the classical model and a generic, concurrent model, with an increased need for interrelationships is shown in figure 6.5 below.

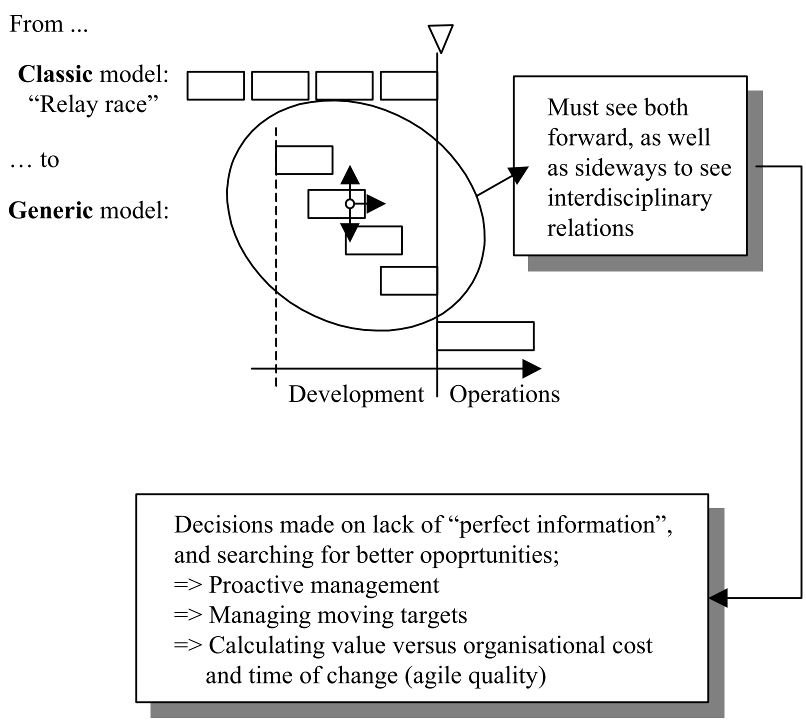


Figure 6.5. Enhance the agility in project development.

In addition to the generic, functional model above, highlighting internal agility, there is a need for the extended project organisation to be agile in itself;

'Overall, there are these four contexts of agility: (1) The sum of internal agility of each of the components. (2) The (probably quite different) agility of the Virtual Enterprise as a whole. (3) The ability of each component to quickly/cheaply aggregate. (4) The ability of each component to quickly/cheaply change the aggregation boundary. … *This is to say that the agility of the virtual enterprise comes from the ability of each component to be added, or subtracted, and to fluidly change its relationship with the partners, plus the skill of the virtual enterprise organizer'* (Goranson 1999, p.70).

As an agile virtual enterprise, the extended project organisation needs to be able to reconfigure itself, amongst other establishing new supply chains through bringing new partners and suppliers in as needed when new opportunities emerges. The question then is how this could be made practical?

Lean (operations phase)

Central in lean concepts stands waste reductions through continuous improvements. A necessary basis for this is that there is a repetitive context, so that there is at least a minimum of continuity for improvements to be carried out within. In chapter four we outlined three different types of activities that lean thinking focuses on; value adding activities, non-value adding activities, and necessary non-value adding activities. As we also pointed out in chapter four, these activities should be approached and focused in the whole supply chain, not only per actor in the chain. The chain focus is easier when the chain, or more appropriate the network of chains, is stable over time.

The operations phase of the project life cycle has the necessary continuity and repetitiveness for lean thinking to be applied. It does also have supply chains that are stable over time, i.e. both the production processes to be supported and supplied and the supply network can for this purpose be regarded as constant over time. There are also both value adding, as well as necessary non-value adding activities, and naturally non-value adding activities, or waste in the total supply chain network and the inherent processes. As such the operations context and its supply chains are so that 'lean thinking' may be a natural approach for value enhancement.

Lean thinking is focused around the five lean principles *value, the value stream, flow, pull,* and *perfection* (Womack *et al*. 1996). These principles may be regarded as a serial development from initially starting with defining value as perceived by the customer of the product and/or service that is delivered, then mapping the chain of actors and functions that take part in delivering the product or service. Then the chain should be 're-engineered' to establish a 'flow' bringing the product or service through to the final customer, 'pulled' by the customer so that it only 'flows' when the customer wants something. That means a tightly coordinated chain that works as one entity. This requires *transparency* into the elements and processes of the chain, so that the actors involved could improve the chain as one entity. This leads to the final principle of lean thinking, the continuous improvements.

If we see this in the operations phase of the project context, this means that the operator should define what type of value that the supply chains delivers to the operations of the project object, then map all the supply chains delivering specific products or services to get a 'transparent' mapping of the chain as a basis for co-operative improvement work among the actors in the supply chains. Then the demand and supply processes of the supply chains should be re-engineered to get efficient and effective pull-based flow from the initial supplier to the final customer, i.e. the project object in this case. However, the operations phase is more or less similar for several offshore installations, i.e. project object for different projects, as well as for several operators. This means that the potential for waste reductions is not only along the whole supply chain, and in treating it as one entity, but also *synergies across several installations and operators* should be aimed for. For the oil and gas industry and the offshore installations, the supplier base may be varying a bit, but still it is the same type of products being supplied from the same type of suppliers, through more or less identical supply schemes, so that the potential for cross-installation and –operator synergies should be apparent. This type of synergies seeking to develop lean solutions not only for a single installation (project object), but for several installations e.g. in a geographic area, may be regarded as what we referred to as competitiveness in the macro perspective in chapter five.

Examples of lean thinking along these lines may be found among others in Ernst *et al*. (1997) in their description of potential types of alliances in upstream oil and gas industry. Among the types of alliances they propose are 'consolidation joint ventures', 'enhanced supplier relationships and outsourcing alliances', and 'advantaged networks of producers and suppliers' that cover elements of lean thinking and the utilisation of synergies for improved value/cost ratio in the upstream oil and gas industry. Further the CRINE Network in the UK has proposed similar initiatives among others in their *'Pan Industry Initiatives'* as part of their supply chain management initiative (CRINE 1999-A).

Service quality

The service quality of supply chain management is one of the key aspects of logistics. The term 'service quality' itself, may not be the best to use in this respect, but it is a term that help to address what is sought to point out. Bowersox *et al*. (1997) say that basic logistics service is measured in terms of availability, operational performance, and service reliability, defined as in table 6.2.

Table 6.2. Logistics service measures.

Measure	Description
Availability	Having inventory to consistently meet customer material or product requirements (demand).
Operational performance	Deals with the elapsed time from order receipt to delivery, and is further defined through; *Speed and consistency* – first consistency of service, then improving delivery speed; *Flexibility* – able to accommodate unusual and unexpected customer requests; and finally *malfunction and recovery* – required time to recover when a malfunction occur in the supply chain, affecting the delivery.
Service reliability	Logistics quality and the ability to accurately measure inventory availability and operational performance.

We have used two terms here, *resilience* for the development phase and *robustness* for the operations phase. In relation to Bowersox's definitions they are first and foremost related to service reliability, but with some differences regarding the operational performance measures, and ultimately aimed at availability. As will be explained below, resilience is used to reflect the *ability to adapt*, while robustness is used to reflect the *ability to withstand*. Resilience and robustness has as such quite similar objectives in their core, though they have at least a theoretical difference in their approach and meaning that is useful for pointing out the differences in the characteristics of project supply chain management in the development phase versus the operations phase, and the related agile and lean organisational processes.

Resilience (development phase)

The reason for choosing resilience as the describing characteristic for service quality in the development phase, is the terms focus on the ability to be able to come 'back on track' after a 'disturbance'. Changes may e.g. be perceived as 'disturbance' for demand and supply chain management during the engineering development processes.

'[T]he true vulnerability of technological and social systems cannot always be predicted. Since this has been demonstrated repeatedly, it becomes obvious that resilience, that is the ability to accommodate change without catastrophic failure, must be given greater cognisance in decision-making. … Resilience, for better or for worse, leads to greater permanence in a world of flux' (Foster 1993, p.36).

As the quote above from Foster shows, there is a direct relation between resilience and agility, which may be seen as an other reason for choosing to focus on resilience as a service quality characteristic;

'An agile response might be required concerning a negative change as well as to address a positive opportunity. For example, a positive opportunity would be a newly identified customer niche, or a leveragable technology. A negative change may be a new restrictive law, a raw material that disappears, or a customer who has been enticed away' (Goranson 1999, p.68).

With an agile approach to engineering and value enhancement in the development phase, the exploitation of opportunities inherent in the open setting and the involved uncertainty, there is a large chance that the means sought does not lead to the desired end. That means that if one seeks to exploit novel technology and solutions, one cannot predict that they will give the desired outcome, or an outcome at all. But if one follows such a path one has to activate a supply chain to research and develop the needed or wanted technology. However, if one sees that it does not lead to the desired end, the established supply chain has to be 'terminated', and another solution chosen and the corresponding supply chain activated. This means that the approach to service quality has to be resilient, so that one is aware that a solution may not lead to the desired end, and therefore the corresponding supply chain has to be 'terminated', but due to a resilient approach this is accounted for and a 'procedure' for an alternative solution and activation of the corresponding supply chain is in place. This is shown in figure 6.6.

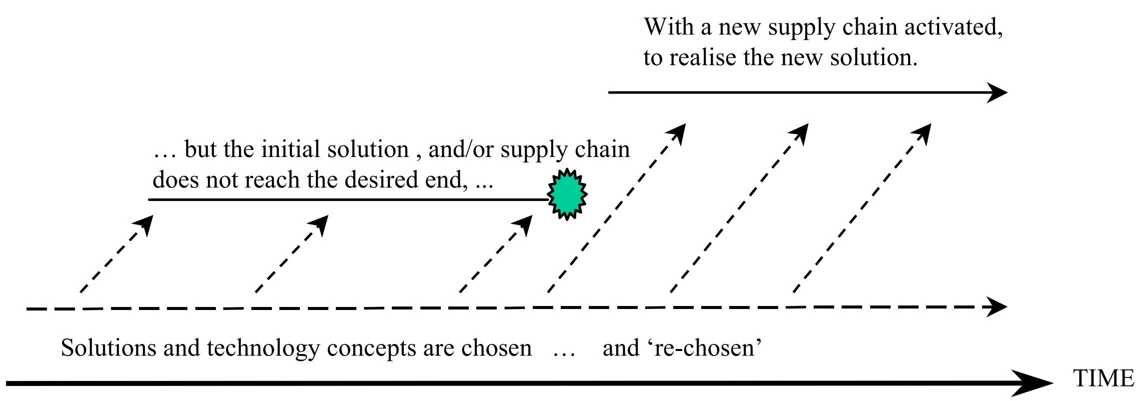


Figure 6.6. Resilience as the ability to convert to a new solution and corresponding supply chain (read text in figure from bottom upwards).

Reference to this type of reasoning may also be found in Goransson (1999);

'Our case study addressed lowering the cost of getting it right the second (or third) time, by relaxing the period of time that design decisions need to be frozen. Typically, in the defense environment, all major design decisions are made in the very early phases, because of the perceived need to lock in suppliers (and their processes). It's the way the system works. We change that.' (Goransson 1999, p.187).

Goransson (*op cit.*) seeks to play time against cost, through relaxing the time constraint. As Figure 6.7 below shows cost commitments, and thereby e.g. technology commitments, are delayed in time, which may be possible if one have business and work processes in the project extended enterprise that fit the requirements needed to be able to bring forward a necessary end within an ultimate time frame.

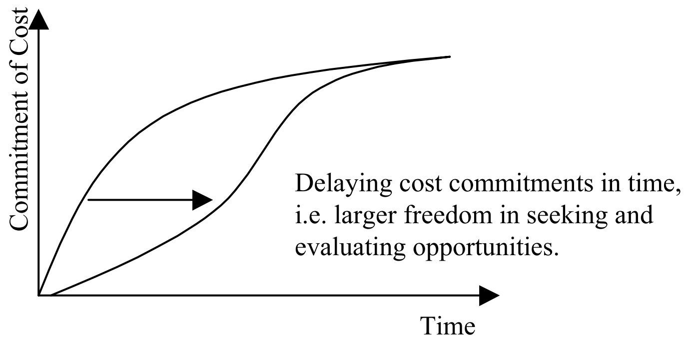


Figure 6.7. An agile supply chain allows design changes to be made later (based on Goranson 1999, p.187).

<u>Robust (operations phase)</u>

The reason for choosing robustness as the describing characteristic for service quality in the operations phase is that the supply chains shall not be the cause for interruption or stop in production by the project object. I.e. value of break in production is so high that one should seek to eliminate all possible causes for that. Therefore we use the rather strong term robustness, as they did for the supply chains of the car manufacturing industry.

The project object that 'produces' the hydrocarbon resources have given delivery service targets. This service target is 98% up-time[56] of the facilities, i.e. the facilities should be able keep up production for 98% of the planned production time, i.e. except for planned shutdowns. Such a service measure may be weakened if the supply chains that shall supply the facilities with needed supplies break down for any reason.

As there is limited storage space on the offshore infrastructure itself, there is a need to store needed goods at different locations onshore and that requires good and robust supply chains from suppliers all the way to the offshore infrastructure.

6.2.3 PSCM characteristics in summary

The characteristics of project supply chain management may be summarised into one 'statement' for each of the two main phases of the project, development and operations;

- *Agile and resilient demand chain management in the development phase.*
- *Lean and robust supply chain management in the operations phase.*

[56] Ref. O. Instefjord, Statoil.

Development phase; Agile and resilient demand chain management

To summarise the project supply chain management characteristics for the development phase the terms *demand, agile,* and *resilient* are the three that should be given attention. For both the development phase and the operations phase the chain perspective should be taken as the basis for value creation and value enhancement. However, the development phase is a phase were the project and the project object is to be developed, i.e. the aim is to define and specify the *demand* that in sum through the fabrication and construction activities will become the project object. Therefore we have chosen to emphasise demand chain management specifically for the development phase. We have used the term *agile* to point to the importance of seeking and evaluating opportunities that could bring value enhancement to the project. The engineering processes are concurrent and they have an underlying mission to engineer project value into the project object within the time and cost frames set. The context is defined by a high degree of uncertainty so that opportunities as well as risks will emerge, necessitating an agile approach either explicitly or implicitly. The term *resilient* is used to reflect the uncertainty in the development phase, and some of it will mature, so that the demand/supply chains has to be able to 'come back again', i.e. be resilient, to aim for the final objective.

Before we move to the operations phase let us use one quote to point to the difference between the development versus the operations context;

'[S]ince World War II, manufacturers of complex products like air-planes and cars operate in a defense-industry manner. These people who worry more about managing a supply chain rather than supporting a more profitable virtual enterprise with the same players' (Goranson 1999, p.29).

The context of the development phase is that of the virtual enterprise aimed at meeting and generating a project object that could realise a business opportunity, i.e. demand ultimately set by the context that the business opportunity is to be realised within is in focus. This as opposed to the operations phase where it is 'only' about 'managing a supply chain', though that is in itself very important, given the mission and objective of the operations phase and the supply chains part of it.

Operations phase; Lean and robust supply chain management

As for the development phase, the operations phase does also have three terms that we would like to summarise the attention around. The terms *supply, lean,* and *robust* is what we mean should characterise the operations phase of the project life cycle. The operations context is one of repetitiveness, keeping focus on the details so that the whole 'machinery' goes like 'clockwork'. This is the ultimate basis for lean thinking where not only the potential for waste reduction could be discovered through incremental rounds of continuous improvement, but also making the whole supply operations more robust through revealing elements that could be a risk factor. We have used the term supply specifically for the operations phase because it is a repetitive supply operation. The demand is already defined and the supply chains should be robust so that they do not contribute to disturbing the production. The term robust is used specifically to indicate that although the supply chains should be lean, that should never compromise their service quality, because a stop in the revenue generation of the production by the project object in most cases far outweighs the incremental supply cost. I.e. the service quality in operation should strive for a 100% service degree.

6.3 PSCM – Concept and Definition

The characteristics of project supply chain management outlined above show that we have a project supply chain that is built up of one branch for the project object development and another branch for the project object operations. Seen as one, these two project supply chain branches constitute the entity that shall make the project as a business opportunity competitive.

6.3.1 Project Supply Chain Management – The Concept

Project supply chain management is a concept, i.e. '*a word or phrase used in propositions to describe real world relationships*', being '*neither true nor false, only more or less useful*'. The basis for the project supply chain management concept has been laid in the previous parts and chapters of this thesis. Table 6.3 lists the "building blocks" for the PSCM concept as it has been developed this far.

Table 6.3. The building blocks of the PSCM concept.

"Building block"	**Contribution**
Ch.3 Projects and Project Management	A value enhancement focus for a business opportunity. The 'openness' of project development – uncertainty and degrees of freedom with respect to what's and how's; The basis of agility. The project lifecycle – starting with the front end, ending with the end of operations; Taking the whole life of the business opportunity into account. Strategies and routes are different; Being aware of the underlying characteristics and choices.
Ch. 4 Logistics and Supply Chain Management	Alignment of supply and demand in an inter-organisational chain perspective – demand and supply chain management. Lean – Adding value through removing waste (cost efficient). Agile – Adding value through pursuing opportunities (cost effective).
Ch.5 The Project Supply Chain Challenge	The business context – competitiveness as the underlying driver. The challenges of the oil and gas supply chain – value enhancement through technology and execution models, measured in cost, income and time.
Ch. 6.2.1 The Principles of PSCM	The project as the business opportunity. The supply chain as the competitive entity.

	Alignment of supply and demand for competitiveness.
Ch.6.2.2/3 The Characteristics of PSCM	Agile and resilient demand chain management in the development phase. Lean and robust supply chain management in the operations phase.

The building blocks of the PSCM concept start with discussions of projects and project management outlined in chapter three. Projects are '*open*', they have inherent uncertainty and complexity, as well as degrees of freedom, both in scope and the organisational construction developed to undertake it. The uncertainty is reflected with respect to *what* to do and *how* to do it, and that has to be defined and decided on in the project *front end*, to have the right basis and approach for managing it through the execution part of the development phase. The supply chain actors are important in this, and has to be brought into the extended project organisation, or the project supply chain at an appropriate point in time. Therefore, projects of the type addressed here are not 'rushed into', i.e. they comprise a front end in their lifecycle that shall both secure the business basis for realising the project, as well as preparing for both the execution part of developments, and the operations and continuous development of the project object and the project. We questioned whether a *value enhancement* approach to project management was in place, and which perspectives that are necessary for such a perspective to gain foothold. How a value enhancement perspective is approached is dependent on the level of *ambition*, or needed ambition e.g. due to competitive pressures, among the project's owners and stakeholders. This again have to be reflected in the project *strategy*, and will have an impact on the approach to and the construction, selection of actors to and development of the project supply chain, through the contracting, procurement and operations strategy. When these strategies is laid, this again will have impact on the *routes* that is to be followed through the project execution phase.

The development of logistics has brought the logistics concepts to the inter-organisational domain, with the demand/supply chains as the competitive entity. There is a distinction in the use of the terms supply chain versus demand chain that should be clear as they have their distinct roles in value enhancement processes. The logistics objective is *alignment* of supply and demand through the inter-organisational demand and supply chains. The project inherent uncertainty with respect to 'what's' and 'how's' will influence the logistics uncertainty in that the demand processes is influenced by the degree of uncertainty in what's and uncertainty in the supply processes is influenced by the degree of uncertainty in how's. We also found the concepts *agile* and *lean* from the manufacturing domain. These concepts created a background for two different 'manufacturing' contexts. The first, agile, aimed at the context of temporary business opportunities that need several companies connecting together to be able to exploit the temporary business opportunity. The other one, lean is aimed at continuous improvements in an inter-organisational setting of repetitive operations. The agile concept with strong similarities to a project's development phase, and the lean concept with strong similarities to a project's operations phase.

In the project business context we saw that competitiveness is driven by macro forces, demanding competitiveness to be developed through demand/supply chain constructions that compete against other demand/supply chains. Each company have to take their role and contribution as a chain actor into account in developing their own competitive strengths and capabilities related to organisational issues.

Drawing all this together we came up with the *principles* of project supply chain management. The project as the business opportunity, with a value enhancement focus and approach, playing with the uncertainties of the project in a proactive management approach that seeks to develop the opportunities and control the risks. The project supply chains constitute the competitive entity that shall undertake the project, throughout its lifecycle, and it is through the project supply chains that one are able to enhance the value of the project. The project supply chain play on utilising the logistics supply and demand alignment objective in searching for value in and through the project object.

The *characteristics* of project supply chain management have their root in agile demand chain management in the development phase and lean supply chain management in the operations phase. As such the concept of project supply chain management take the openness and uncertainty of the project development context, with respect to 'what's' and 'how's', through to dealing with uncertainty in the logistics perspective related to demand and supply aspects, i.e. we have a situation in need of agile qualities. Bringing the project's openness towards a closed state through the development phase, to the operations phase that are 'closed', but with defined degrees of freedom to exploit further opportunities (through modifications), developed through lean approaches to value enhancement. This again has to be seen in the project chain construct, as it is the project chain that is the developing, executing and operating entity of the project and the project object. We then have the project supply chain management concept as given in Table 6.4;

Table 6.4. The PSCM concept.

Principles	**Characteristics**	
The *project* as the *business opportunity*	Development	Operations
The *supply chain* as the *competitive entity*	One-of-a-kind	Repetitive
Competitiveness through logistics and supply chain management, focused on alignment of supply and demand in the project context	Demand chain management	Supply Chain Management
	Agile	Lean
	Resilient	Robust

We then have a logistics and supply chain management concept that 'obey' the logistics objectives of supply/demand alignment. That takes account of the specialities of the project context's development and operations phases, and is aimed at value enhancement for the project as a business opportunity realised through the project supply chain as a competitive entity throughout the lifecycle of the project. That is the concept of project supply chain management.

6.3.2 Project Supply Chain Management – A Definition

To make up a new concept a definition is often needed to communicate with stakeholders within the different domains, both theoretically and practically.

The definition of project supply chain management as it is defined in this thesis is;

> *Project supply chain management seeks value enhancement in projects through logistics' focus on demand and supply alignment. This is met through the characteristics of logistics throughout the project life cycle with an agile approach to demand chain management in the development phase and a lean approach to supply chain management in the operations phase. Thereby meeting the need for value enhancement through engineering and the supply chains contribution in developing demand for the project object, and creating value through cost efficiency in the operations supply chains.*

Why then may we say that PSCM is an important new approach? Logistics and supply chain management is already taking place in the oil and gas industry. As the quote from Goldman (1995) in the introduction to this chapter stated; '*As with almost all innovations, implementation precedes understanding*'. To answer the question we therefore have to go back to what was stated in the Norwegian Public Study (NOU 1988) also referred to in the introduction; '*New facts need system knowledge. ... Shortly said: the basic theoretical foundations of learning is vital both for the interpretation of new information and as a guide to direct the search for new facts*'. Project supply chain management is happening today. However, to further develop supply chain management in the project context of the oil and gas industry, there is a need to lay out what should be the core guidelines for this development, where to seek new knowledge for improving. This is what the development of the PSCM concept is one contribution to.

Above we have outlined project supply chain management as a concept that meets the characteristics that logistics and supply chain management sets in aligning supply with demand in the project context of developing and operating a project object, to enhance the value of the project as a business opportunity. Project supply chain management is as a concept not viable unless it is supported by structures that may help to put it into practical use. The next chapter aim to do that, in outlining methodological guidelines along the line of the PSCM concept.

7. Methodological Guideline for PSCM Analysis

7.1 Introduction

What is the intention with methodological guidelines for supply chains? It shall be a guide to address the questions that is important with respect to the context and the characteristics of the supply chains that are approached, as well as the mission of those supply chains. When approaching project-oriented supply chains one have to take both the specific context of the project as well as the supply chain approach into account. Methodological guidelines for analysis of supply chains are as such both of general character, to be applied in a variety of contexts, as well as of specific character, developed and aimed for use within a specific context.

This chapter outlines a methodological guideline for project supply chain management, PSCM. The emphasis is put on describing elements and aspects that should be part of PSCM for the development and the operations phase. The description does not aim to be exhaustive or complete, but aim to address a set of elements and aspects that we regard to be important following the concept presented in this thesis. Methodological developments within project management and logistics and supply chain management has also been commented upon by authors representing management professionals and academics.

’The methodology used is actually much more important than which technique is used. Methodology is defined as ‘the system of methods and principles used in a particular discipline’ and methodical is defined as ‘characterised by method and orderliness: systematic’. Both are required in the planning and control of projects, and they are independent of the techniques used. Methodology is concerned with how you go about planning and controlling a project in a systematic manner, that is, the process rather than the ingredients’ (Harrison 1992, p.105).

Commenting on the future research topics and areas within supply chain management, Lambert *et al*. states the following;

‘A top priority should be research to develop a normative model that can guide managers in the effort to develop and manage their supply chains’ (Lambert et al. 1998, p.14).

The methodological guideline developed here is an attempt to ‘guide managers in the effort to develop and manage their supply chains’ in the project context. Then, how shall methodology and guideline be understood in this chapter? Methodology and guideline shall be seen in relation to the two definitions below;

‘A methodology is a kind of "coaching" -- not a formula for producing a result, but a set of practices that can lead to appropriate questioning and to appropriate change’[57].

‘Guideline; a rule or principle that provides guidance to appropriate behaviour’.

[57] Web Dictionary of Cybernetics and Systems, http://pespmc1.vub.ac.be/ASC/Methodology.html

Methodological guidelines should as such meet the aim of the future research proposals set out by Lambert *et al*. to '*guide managers in the effort to develop and manage their supply chains*', in this case in the project context.

Given that a project's supply network is not fully developed the methodological guidelines should help to build an understanding of important aspects to address up-front. The methodological guidelines should as well be of help in the process of developing and analysing the supply network and processes that will be activated when the development and operations phases of the project starts. As such the methodological guidelines for PSCM analysis should be regarded as a central part of 'front end loading'[58] of a project. The methodology should take the life cycle approach to the project, comprising demand/supply chains for the development and operations phase. The approach should be characterised by a *pre* rather than a *post* analysis.

In itself a supply chain analysis may bring forward new knowledge, or present knowledge in a new way for actors involved in the supply chain. In another research project (Schneider *et al*. 1994) they refer to the benefits that were achieved through applying a supply chain analysis methodology within the network of part suppliers for car manufacturing, as well as for after-sale support of the cars manufactured;

'Application of the supply chain methodology has provided the following results to user companies:

- The identification of a mismatch of strategy between the chain players.
- The recognition that measures of performance in the chain conflicted with satisfaction of end customers.
- Appreciation of the lack of knowledge of chain players about activities occurring elsewhere in the chain that could have yielded business benefits.
- Better understanding of customer requirements further upstream in the supply chain.
- Recognition that certain replenishment policies caused distortion of true requirements.
- The appreciation that, in some cases, different routes were required for materials, order information, technical support and end customer feedback' (Schneider et al. 1994, p.151).

To explore what stakeholders from the industry itself felt about the need for a methodology for approaching the supply chains of the project in development and operations, the project director of a development project stated his wishes with respect to a 'model' related to PSCM as;

- 'A simple model or concept for demand/supply chain management in a project.
- To be applied in the front-end of the project.
- A 'tool' that shows the whole value or demand/supply chain in one, that gives a 'total overview'.
- A structural approach: Understand and present the whole structure, given inherent uncertainty.

[58] 'Front end loading' is a concept that comprises the activities to secure that all elements necessary to explore up-front of a project is necessarily researched and defined to secure a good project development basis.

- Focus to understand the totality, not advanced details.
- A proactive approach – where are the critical elements or areas?
- I.e., a project management tool with a demand/supply chain approach, that is not too advanced, but that address overview, understanding, and guidance.'

Based on these remarks and discussions with a logistics advisor in a petroleum company, we decided that the following list of items should be addressed as part of developing knowledge that could be useful for supply chain management in the project context;

1. An '*ideology*', for SCM in the project context, should be established as a basis.
2. The ideology should derive *five core aspects* that specifically characterises SCM in the project context, or PSCM, i.e. the five most descriptive factors for PSCM.
3. Which demands do these five characteristics describe for methodological guidelines for analysis of PSCM?
4. Should the methodology be applicable for all types of supply chains, i.e. development and construction (substructure/hull, topside), sub-sea, modifications, drilling, and operations?
5. Supply chains versus project phases – the methodology must cover and determine supply chain management activities in each project phase.
6. How to use the methodological guidelines to make PSCM activities become part of the project processes at the correct time?

The two first points were addressed through the PSCM principles, characteristics and concept outlined in chapter six. Then, the third point is addressed in the development of the methodological guidelines. Point number four has been discussed throughout this thesis and comply with the concept and principles of PSCM, in focusing on the project as a business opportunity comprising both development and operations, but without giving to much emphasis on specific areas as e.g. type of construction, sub-sea or drilling. The fifth and sixth point is then discussed in sub-chapter 7.2. However, the guideline is developed to follow the lifecycle of a project, though the methodology will not go more specifically into the project phases than the split between development and operations.

7.2 Methodological Guidelines for PSCM Analysis

The PSCM methodological guidelines are intended for project-specific use. This means that e.g. compared to CRINE Network's SCM methodology, this one is not meant for general supply chain improvements per se, but meant as part of 'front-end loading' of a project. Compared to CRINE's methodology we may say that CRINE has a general supply chain improvement focus, and that this PSCM methodology should have a project management emphasis, but from the side of logistics and the supply chain.

This PSCM methodological guideline is built up of nine basic steps, as illustrated in figure 7.1. Figure 7.1 shows the process flow, as well as the impact from one step on other steps of the guideline.

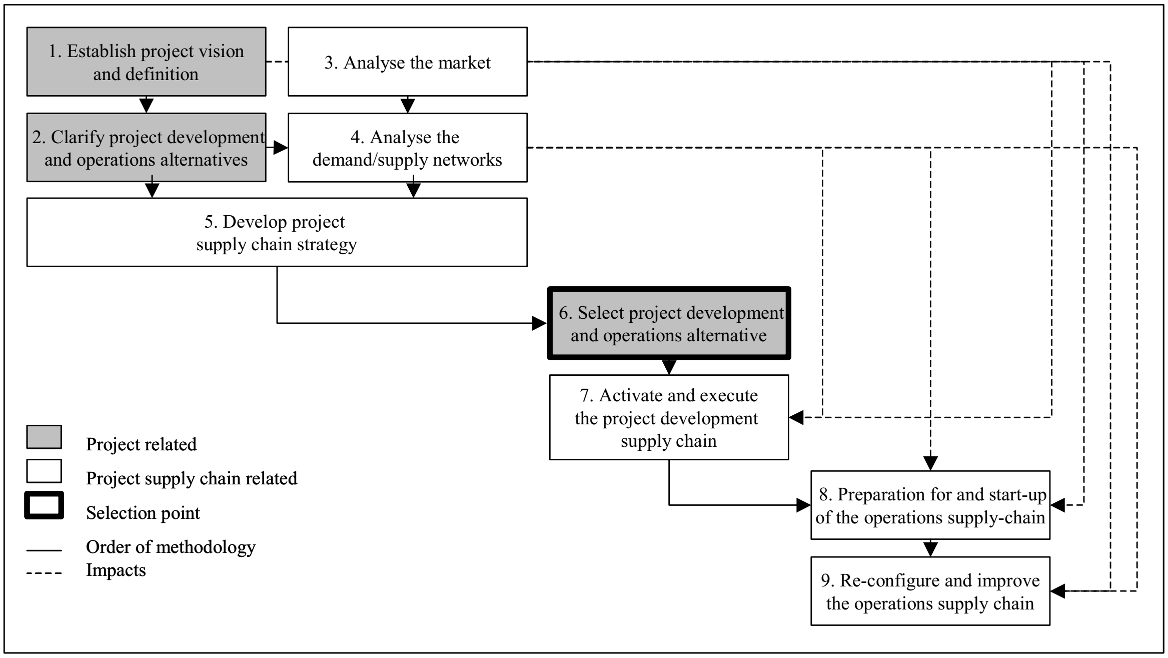


Figure 7.1. The outline of the PSCM methodological guideline.

Each of the nine steps of the methodological guideline is described further below. However, before we start a comment should be given to the process of the guideline itself. The methodological guideline consists of steps that are both related to the project itself, as well as specifically to the project supply chain. Step number one, two and six are related to the project itself, in developing the project strategy and vision, and evaluating and selecting the project development and operations alternative. Step three and four are then related to general analysis of the market, as well as analysis of the demand and supply chain constructions necessary or available for the different project development and operations concepts. Step five is development of the supply chain strategy. However, step five should be seen as done in parallel and as part of the definition and selection of the project development and operations concept. As such steps two, three and four, should be done iteratively with step five. That means that the project vision and definition, the analysis of the project development and operations alternatives, together with the analysis of the market, and the demand/supply chain constructions, should be the basis for an iterative evaluation and selection of project supply chain strategy. The results of step three, four and five, together with step one and two are the basis for selecting the project development and operations concept in step six. Then, in step seven the project supply chain is activated as part of the extended project organisation. It is here necessary with a comment to the supply chain's involvement in the process prior to step seven. Often several 'supply chains' are involved in the development and analysis of alternative project development and operations concept. This may be seen as part of step two, where the 'supply chains' related to the different concepts take part in developing and analysing the concepts together with the project owner(s). Then in parallel to the different (and alternative) supply chains taking part in developing alternative project development and operations alternatives, the project owner(s) and/or operator internally analyse the market and the demand/supply networks related to the alternative concepts. Then in step six, one of the project development and operations concepts are chosen. Then with the project supply chain strategy developed concurrently, the demand/supply chain related to the chosen development and operation concept are selected and activated, and made able to start executing the project development. With the project object development taking place, one has to start preparing the operations of the project object. That is the objective of step eight and nine. Step eight prepares and establishes the operations supply chain, while step nine cover the continuous improvement and re-configuration of the operations supply chain. The shut-down and removal of the installation is not covered.

1 Establish project vision and definition

Up front of the project it is important to establish a 'problem statement' for the project, to be used as a unifying element for the project supply chain. The 'vision' should be a guide for the project development and as such be in accordance with the project strategy.

2 Clarify project development and operations alternatives

The project could be developed and operated based on a portfolio of different technological and organisational concepts. It is therefore important to establish an overview of those alternatives, so that comparative analyses may be done among them for later selection of the best alternative for the project.

3 Analyse the market

This is a collection of activities that should take place project independently, as a normal part of supply chain evaluation and improvements.

4 Analyse the demand/supply networks

The demand and supply chains for the different alternatives in step two has to be mapped and analysed to be able to evaluate their comparative advantages.

5 Develop project supply chain strategy

Here the supply chain strategy for the development and the operations phase of the project should be established and documented. An agile and resilient demand chain strategy for the development phase, and a lean and robust supply chain strategy for the operations phase, that supports and leverages the chosen development and operations concept.

6 Select alternative for project development and operation

This is a selection point, where the outcome is a selected concept for development and operations of the project and the project object.

7 Activate and execute the project supply chain

This is where the project supply chain is selected, then activate and execute the development of the project object. The focus is now on the logistics and materials management involved in development and execution.

8 Preparation for and start-up of operations supply chain

Up-front of commissioning and start-up of operations the operations supply chains must be developed and activated. This must take both the requirements of the project object, as well as the opportunities for use of existing infrastructure and supply chains, and collaboration with other offshore installations.

9 Re-configure and improve operations supply chain

The project object offshore is seldom operating as the only installation being supplied. There is most often a portfolio of installations and the supply need of this portfolio of installations will change over time. To get the best cost/service position for the supply chain, it therefore has to be re-configured according to changes in the supply requirements.

Throughout the methodology the project atlas is used as a common denominator for bridging the steps of the methodology. Through the project atlas we show for each step which elements within the project atlas that is in focus, and how the project supply chain link to this.

7.2.1 Establish project vision and definition

The first stage in a project is to establish and define the business opportunity as a project, a unique business opportunity, in need of inter-organisational capacities and capabilities to be able to realise it. This could be regarded as a definition of a ‘problem statement’, i.e. the project to be solved. The project is a business opportunity for both the owner(s) as well as the companies in the project supply chain, and the problem statement will as such have implications for both those two groups of stakeholders.

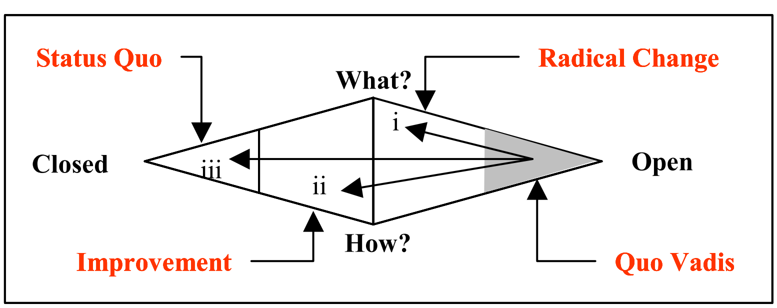


Figure 7.2. The starting point of the business opportunity.

In the project atlas, the "project"[59] owner are in the 'open' end, able to choose whether to go for the potential business opportunity, and develop it into a project, or not, i.e invest his financial means in another opportunity. If the owner chooses to start developing the business opportunity further he may choose among several alternative routes. He may either (i) seek a radical change, e.g. utilising new, innovative technology not used before, (ii) go for a continuous development approach, e.g. well known technology, but a novel approach to project execution processes, or (iii) seek to 'copy' both the technology and project execution processes of an earlier, successful project. Whatever the owner chooses, if he want to develop the opportunity into a project he needs to establish and communicate the vision of the business case, as well as develop and define the business case.

Project vision and concept

The project vision may be regarded as the problem statement of the business case that the project owner(s) have developed for the potential business opportunity. The vision should communicate; *What is the business case, and what is needed from those involved in developing it for it to become a business opportunity?*

An 'instrument' that originated in and is used with success in the movie industry is the 'High Concept'. The 'High Concept' was developed with the purpose of being the bearer and communicator of the 'vision' of a movie as a tool for aligning and focusing the supply chain around the movie's objective and 'message' to the customers.

'A high concept film is one that is based on a succinct and detailed description of the product, including all features of the product that would be valued by the customer' (Goranson 1999, p.40).

The method/technique of the 'high concept' was developed in the movie industry after the movie enterprises in the United States were broken up due to antitrust concerns in the late 1930's. The 'High Concept' evolved to understand and deal with the customer after the prior connection was broken, due to the break-up of the vertical integration in the movie enterprises that included the theatres and the customer contact[60]. When the period with the vertically integrated movie enterprises ended, a system known as the 'packet unit system' developed. This system was based on establishing a unique collection of companies to produce each movie. It may be regarded much like a project, with a prime contractor (the production company) that identifies the market need, establishes the plan and intellectual property that states that need, arranges financing etc, and then the necessary production assets are owned by many small companies that are assembled to produce a film. The 'high concept' is then;

[59] "Project" is put in brackets as the potential business opportunity it is still not defined as a project.

[60] The movie industry in the United States of the nineteen thirties was configured much like the present car and aerospace industries. The market was dominated by a few large stable companies, deeply vertically integrated, including control of distribution through ownership of the theatres. Due to intense competition among the movie enterprises, they developed and applied what today is known as lean principles and practices; flat organisations, pre-qualified suppliers, and versions of just-in-time practices (Goranson 1999).

'… so named because it ties all elements across these media [theatre, TV, video, domestic and foreign distribution] and all elements within the product (story, stars, and such) into one clear statement of philosophy and style. … The underlying assumption is that the customer can be tersely, understandably, and logically characterised; that is modelled. That understanding, however broad and involved, has a simple core, which by itself covers all the important elements of the project. … The notion of High Concept is thoroughly studied in film schools, and consistently practiced by producers, who are organisers of the virtual enterprise. It is also considered difficult to master' (Goranson 1999, p.40).

The methods and techniques concerning the 'High Concept' are something that could be beneficial as a source of new knowledge for the traditional project industries, and especially for seeking to find something that may be used to focus and align, on a high level, the project demand and supply chain.

Some important aspects to remember about the use of High Concept like approaches in establishing a vision (derived from Goranson 1999);

√ Success on a film, including keeping costs low, depends heavily on everyone having the same idea of style and purpose of the product.

√ A way to build and establish a clear definition of the business opportunity, where the strategy anticipates to address the business opportunity, and the ersatz corporate culture of the virtual enterprise [or the extended project organisation/supply chain].

√ A way of modelling the customer's need/desires; managing constraints, and coordinating a coherent, understandable approach.

√ A description of a strategy to reach customers in terms of understandable to the customers, which the producers use to form a profitable link with the customers.

√ A High Concept description should be succinct.

√ A High Concept description almost always builds in prior experience.

√ Familiarity with the precedents is culturally necessary for membership in the community.

√ High Concept is composed by agents.

√ Agents are evaluated based on their experience with and understanding of elements in the High Concept.

√ Trust is relative and High Concept gives a calibrating foreground against which trusted agents can be evaluated.

Goranson (1999, pp.43-44) summarises his discussion about the 'High Concept' to develop agile virtual enterprises, AVE's, or agile supply chains, into three AVE principles;

√ You must have a robust system of agents that autonomously act to configure and optimise their system, not because you so direct them, but because they are acting in their own best interest.

√ You must have a way of providing a common goal to the diverse agents so that their efforts optimally converge on what you want, and what the customer needs. So far, we've been calling that High Concept, but a better term is *feature-based modelling*.

√ You must have a way for all the components of the enterprise to be rewarded and punished by contracts, but you cannot rely on predefined, static business boundaries, nor expensive, static, old-style contracts. You need to be able to have fuzzy business boundaries, even perhaps having the original corporate identities essentially vanish for the project. (Goranson 1999, p.44).

These lead to the principles underlying an agile virtual enterprise, of which the 'High Concept' is one of the principles.

Table 7.1. The principles of an agile virtual enterprise (Goranson 1999).

Agents to certify and indemnify	Lightweight contracts	**A coordinating mechanism (High Concept)**
Trust		

Now we have presented a concept that have a high level bearing in establishing a good basis for an extended project organisation, that is focused towards developing a project aimed at the project as a business case for the owner, and to focus and lock-in the project demand and supply chains accordingly. Then, based on this high-level vision, we have to define the project more formally.

Project definition

Following up on the approach to establishing a vision for the project along the lines of the High Concept presented above, a more formal definition of the objectives of the project is in place. The ACTIVE initiative, Achieving Competitiveness Through Innovation and Value Enhancement, in the British construction industry, states that project definition is;

'Project definition: The need to articulate, test and communicate the commercial, technical and regulatory objectives of a project. … A project will only meet the owner's business requirements and deliver cost effective solutions if the objectives, scope and the basis for performing the work are explicitly defined with a clear success criteria articulated. It is important that this process should be completed before the execution phase of the project' (ACTIVE 1998, VEP 1.2).

ACTIVE further states the following essential activities that need to be undertaken to during project definition;

√ 'Establish and define the project's objectives, based upon the business case made for the project by the project owner, rigorously test project assumptions and review their options.

√ Clearly define the boundaries of the project.

√ Develop and test the scope of the project in sufficient detail to assess technical and commercial feasibility.

√ Develop and define the strategy for executing the project.' (ACTIVE 1998, VEP 1.2)

In more detail that cover the whole project team and project supply chain, i.e:

'In order to ensure that the subsequent project definition and development of an execution strategy are focused on meeting the requirements of a project in full, a **detailed statement which clearly explains the key business drivers, project objectives and potential constraints and variables is required for communication throughout the project team**. The key success factors of the project owner should be stated openly to all participants. The key measures of success must be clear prior to the start of any design, procurement, construction or other activity. Typical project parameters which must be clearly understood before definition proceeds include:

√ The key programme requirements including key events, milestones and any interdependencies

√ Key supply chain relationship requirements

√ Constraints on cost

√ Broad scope of project in terms of functionality and operability, defining inclusions and exclusions

√ External factors which may impact on the project

√ Key technologies which will be employed

√ Product quality output targets

√ Design standards

√ Safety, health and environmental requirements

√ Availability and reliability requirements for plant operating at design capacity

Without definition or appreciation of these parameters at the outset of the work, difficulties and inefficiencies will be encountered during project execution in relation to developing procurement strategies, resource plans, mobilisation plans, arrangements with vendors and subcontractors, and other activities which can directly influence the outcome of the project (ACTIVE 1998, VEP 1.2).

'For supply chain partners working with the project owner, a statement of the boundaries for the project is essential for the accurate determination of scopes of work, budgets, programmes, liabilities, and recognition of interdependencies' (ACTIVE 1998, VEP 1.2).

One may ask whether the notion building a business case vision like a High Concept for a project is just of theoretical interest, or whether one may find examples that show that such constructions, or similar, are used. In the Cleeton project British Petroleum gave a set of key success criteria as the vision or guideline for the project supply chains to develop the business opportunity towards;

'In essence all that was said was that BP would like to have Front End Engineering and Design for a compressor platform and these are the Key Success Factors we wish you to address; Safety, Capital Expenditure, First Gas Date, Availability, Constructability (later incorporated within Capital Expenditures), Fitness for Purpose (life cycle based assessment), Operations Interface (making most effective use of the existing operations team), and External Opportunities (flexibility to incorporate the addition of new gas reception options). … [BP requested] just to demonstrate how these factors would be met, what rates would be charged, and, importantly, who would be performing the work. … In best practice terms these Key Success Factors clearly defined the objectives of the project' (Harrison et al 1996, pp.1-2).

BP's key success criteria, may not directly be seen as a High Concept like vision, but follows many of the same underlying drivers of the High Concept, as well as meet e.g. the requirements set by ACTIVE for good definition of the project.

One may also say that the drive that came with the CRINE and NORSOK initiatives acted as a top-level 'High Concept'. The vision was aimed at the industry as a whole, leaving more or less a 'mass suggestive' effect. As such that 'High Concept' worked well, with respect to uniting the whole industry.

Further readings;

- √ Goranson (1999); Chapters 1-5, 7.
- √ Vollmann et al. (1995). Article.
- √ Harrison et al (1996). Article.
- √ Active (1998). Section 3, AP1, VEP 1.2, and 1.3.
- √ EPCI (1999). Presentation; 'Front End Opportunities'.

7.2.2 Clarify project development and operations alternatives.

The basis for developing the project is the project vision and definition. These are the frames and references that shall guide the project owner(s)'s internal team, as well as the supply chain that take place in developing the alternative project development and operations concepts. In the project atlas one is now in the position of how the open business opportunity shall be realised, and brought into a closed operation position. The question is how to best close the open opportunity, enhancing most value out of the opportunity, at the same time remaining openness and flexibility to deal with the inherent uncertainty of the development process.

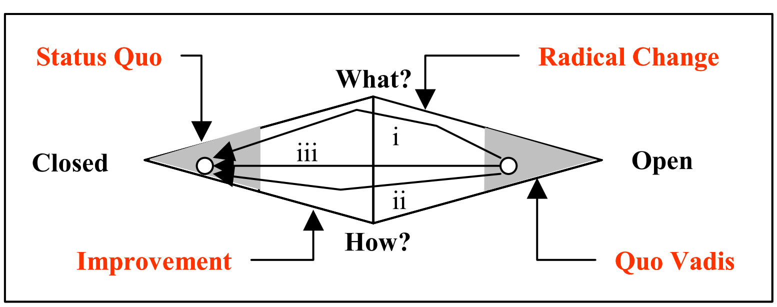


Figure 7.3. Alternative routes and states in project development and operations.

Harrison (1995) presents a decision making process consisting of six steps, where steps two and three are related to searching for and comparing and evaluating alternatives;

2. *Searching for alternatives*. In the decision making process, search involves scanning the internal and external environments of the organisation for information. Relevant information is formulated into alternatives that seem likely to fulfil the objectives.

3. *Comparing and evaluating alternatives*. Alternatives represent various courses of action that singly or in combination help attain the objectives. By formal and informal means alternatives are compared based on the certainty or uncertainty of cause-and-effect relationships and the preferences of the decision maker for various probabilistic outcomes' (Harrison 1995, pp. 37-8).

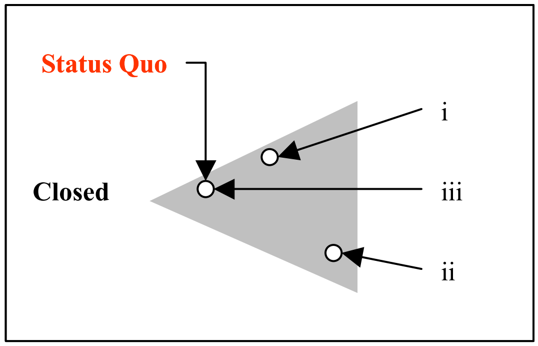


Figure 7.4. Different positions for the operations alternatives.

In the project atlas above, we have one end point for the project development in the operations phase (closed segment). This may not be the case, as each alternative ('route') may end up in different positions with respect to remaining openness in operations, e.g. additional infrastructure (deck space available, weight resources) to take later extensions and/or modifications of the project object into account, and/or additional processing capacity to cover 'adding on' e.g. new sub-sea developments. In figure 7.4. we have shown this by letting the alternatives i, ii and iii end up in different 'positions'.

Comparative value analysis of alternatives

The main criteria for evaluation of a set of development and operation alternatives in these types of projects is the commercial value enhancement the project owners obtain by the different alternatives, corrected for the inherent risk profile of each alternative. The net present value, NPV, criterion is a measure for this. Another criteria are the social economics measures that the national government is seeking through the project. We will leave the latter out of the discussion, except for commenting that it is a part of the evaluation of the project's plan for development and operations, PDO, when handed over to the government by the project owners.

ACTIVE (1998) has defined the value analysis process to consist of two stages, value planning and value engineering;

'The value analysis process comprises two broad stages. The first stage, known as value planning, seeks to verify the critical performance objectives that must be met and then identify conceptual options that best meet them. Once a broad option has been selected, value engineering then aims to optimise capital efficiency by seeking design solutions which maximise benefit (both in financial and non-financial terms) while minimising through-life costs. Value engineering is more technical and takes place during design development when sufficient information is available to compare different solutions to the project's functional objectives' (ACTIVE 1998, VEP 1.2).

The purpose and benefit of the value analysis process is by ACTIVE said to be;

'Value analysis is a value enhancing process for analysing systems, equipment, facilities, services and supplies with the aim of achieving the essential functions of a facility at the lowest life cycle or through-life cost. While cost reduction is the primary goal, the functions of the facility must meet the required performance and standards of quality and safety. The value analysis process is used to identify alternative design solutions or strategies using numerical models to compare through-life costs and benefits, and to assess the optimum level of capital efficiency. In this way, informed and objective decisions may be made regarding alternative development options and the provision of facilities which maximise value. It must be recognised that the potential for improving long term value reduces as the project proceeds through its life cycle and hence the value analysis technique is most effective when applied during the definition stage of projects. Nevertheless there is benefit to be gained by applying the process at other stages of the project life cycle' (ACTIVE 1998, VEP 1.2).

ACTIVE states the following as essential activities of the value analysis;

'Establish performance requirements and project objectives

These should include financial and non-financial parameters, for example costs and revenue data, schedule and resource constraints, and targets for reliability, availability, safety and environmental performance of the facility.

Identify the options and assess life cycle costs

Determine which options are likely to achieve the project's goals and measure their relative value by assessing benefits and technical performance against whole life costs and risks. Select the options which present the optimum value.

Seek continuous improvement

As the project progresses, effort should be made to improve the selected options by continuously comparing functional requirements against objectives' (ACTIVE 1998, VEP 1.2).

For our approach, we may say that there is a three stage value analysis and evaluation process;

1. **Static net present value**, as presented in ACTIVE's approach.
2. **Value of flexibility** – seeking the options and analyse how their use may be optimised actively throughout the project development phase.
3. **Flexible or agile demand chain management** – which is the result when this process is brought into the scope of work development.

Initially, some form of a static net present value analysis is made for each alternative for development and operation of the project and the project object. This could e.g. result in a comparison as given in table 7.2.

Table 7.2. Representation of static net present value measure per alternative.

		Alt. 1	Alt. 2	Alt. 3	…
Risk impact adjusted	Project income	PI1	PI2	PI3	
	Project costs	LCC1	LCC2	LCC3	
Time impact adjustments	Static NPV measure	**NPV 1**	**NPV 2**	**NPV 3**	**…**

The cost side of the project value equation is made up of costs covering the whole life cycle of the project. As rough overview of such costs are given in table 7.3.

Table 7.3. Important elements for life cycle costing.

Main group of costs	Cost elements
Investment costs	Design and engineering CAPEX Spare parts Documentation Logistics and transport Stock-keeping at suppliers
Installation and commissioning	Carry-over work
Operations and maintenance	Preventive and corrective maintenance Consumables (incl. spares) Immediate maintenance / shut-down of operations Repairs Warehousing, logistics, transport
Other costs	Cost of capital, financing Abandonment costs Environmental costs Taxes, legal duties Risk premiums

The value of flexibility is an important aspect in value analyses of the alternative development and operations alternatives. Trigeorgis (1997) presents the real options concept and methods used as a tool in resource allocation, i.e. which possibilities shall a company pursue given one or several possible routes. Route is used as a term to show that the real options concept enables active management. Trigeorgis says that;

'[This] calls for an expanded or strategic investment criterion, reflecting both value components: the traditional (or static) NPV of direct cash flows and the option value of operating flexibility and strategic interaction' (Trigeorgis 1997, p.4).

What is interesting here is operating flexibility as a strategic aspect, and how strategic operating flexibility should be planned and prepared for in advance of development and operations, and allocating and committing demand/supply chains to the project. It is important to remember that it must be thought of in advance, and that this strategic operating flexibility has a cost, i.e. an option price.

'Many of these real options occur naturally; others may be *planned or built in at some extra cost from the outset* (e.g., to expand capacity, or build growth opportunities, to default when investment is staged sequentially, or to switch between alternative inputs or outputs)' (op cit., p.4).

Trigeorgis lists a series of real options that could be used in a project development analysis. The different options are options to defer, time-to-build options, options to alter, options to abandon, option to switch, growth options, as well as multiple interaction options of the ones mentioned. Below follows a description of how each of the types of real options may be defined and understood as options to be used when approaching the topic of project demand chain management. The options are listed as they are presented in Trigeorgis (1997, pp.2-3).

An option to **defer** gives the holder the possibility to wait a certain time period before making a decision, e.g., to choose between two emerging technologies.

Time-to-build options, or staged investments, may in this regard be seen as a series of deliveries. The buyer has an option to abandon his interest in the development if he means that it is not leading to the results he planned with, and may do so at predefined milestones, i.e., maturity dates. This is an option to be used to be able to choose between two or more emerging technologies.

Options to **alter** operating scale may be perceived as an option to buy more or less per time period of, e.g., bulk materials, or may be used to alter the rate of production of an equipment item so that it may be delivered earlier or later. This is as such an option to make use of changes in the market, as well as gain flexibility in speeding up, or postponing the project schedule. This option could be used for purchasing bulk materials or pre-fabricated elements.

Option to **abandon** should in this respect be seen as flexibility to move away from a given technology, when this is not leading to the wanted or promised goal, or it is inferior to another available technology, e.g. in relation to one of the options above. It could also be used for purchasing bulk materials (to secure the availability when needed), e.g. together with a futures contract to secure the possibility to sell the bulk material that is not needed.

Option to **switch** is the possibility to move from one type of technology to another technology, i.e. switch from one supplier of technology to another. This may be seen as one of the options above, but undertaken after the main project has started, i.e. the option is used during the construction of the project's product.

Growth options may be seen as a pre-investment (the prerequisite) undertaken to secure the ability, at a later point in time to be able to pursue a given possibility for 'growth'. With regard to project procurement this option could also be seen in relation to growth in the scope of work or changes under construction of the project's product. Growth may not be due to added possibilities, but changes in the project may, or should, be due to new and better possibilities. The growth option used for changes may as such be seen as an option to switch.

Multiple interacting options where several of the above-mentioned options are used together to make up a targeted, made-to-purpose option to enhance and secure managerial flexibility. These purpose-made options may be constructed out of several 'tools' as long as they give added flexibility, and may be viewed and valued as options related to procurement that give access to the underlying assets cash flow.

Scope of work development

Development of the project scope of work, SoW, is the main *demand chain management* activity in the project. This is a 'chain' activity as it is based on interaction between the operator, his direct supply chain relations, and contractor(s) and his (their) supply chain relations. This is a process that should be given sufficient attention, and where a question raised is better than a question not raised;

'The most successful projects are those where the team has applied a rigorous process for reviewing assumptions and assertions in the scoping exercise. Contractors and suppliers working in the project team are sometimes reluctant to do this on the mistaken assumption that the 'client is always right' but **much value can be added at this stage by a questioning approach by the team**. A good supplier at this stage can often persuade the buyer to check within their own organisation on whether the proposed scoping assumptions are secure. It has been traditional in the industry for operating companies to define requirements for scope of supply in great detail, leaving little room for suppliers to develop ways of meeting requirements more cost effectively. Functional specifications, where the buyer defines functionality requirements but leaves the vendor to define how that functionality is achieved, has been used to great effect within the offshore industry's CRINE initiative as a way of simplifying the procurement process, encouraging innovation by suppliers and reducing overall costs. Where possible, it is recommended that this functional approach should be adopted' (ACTIVE 1998, VEP 1.2).

The scope of work development is started in the project front end, where the focus is on balancing opportunities and risks. This was a topic in a workshop arranged by Epci, the European Institute of Advanced Project and Contract Management. The summary of that workshop is given in Appendix D. In summary the conclusions of the workshop is given below;

'The project front end is;

- *balancing opportunities and risk;,*exploring and acting on potentials, clarifying contextual differences and implications, understand – focus – check.
- *getting the project beyond sanction points and up to "big spend;* financial justification, technical development (opportunity realisation), supply chain involvement.
- *enhancing the ability to master speed and flexibility in project execution;* mental conflicts, classic to generic model, decision making under uncertainty, and
- *enhancing the ability to reach or exceed an expected result;* proactive front end planning, build on experience, seek and understand current challenges, align challenges and means'.

Front end loading is an approach, or a collection of methods that may apply to secure and improve the scope of work development process. Value improving practices are a group of methods within front end loading, that may have a considerable contribution to the value improvement of the project. Figure 7.5 show ten value improving practices and their value impact in the project development life-cycle.

A question is then who should be responsible for controlling the front end loading of a project, the operator or the contractor(s)? Table 7.4 show some results of a study between projects where the operator or the contractor has been responsible for front-end loading. The conclusion form the study is that the operator should control front end loading, as that resulted in reduced cost growth, reduced cycle time, and improved attainment.

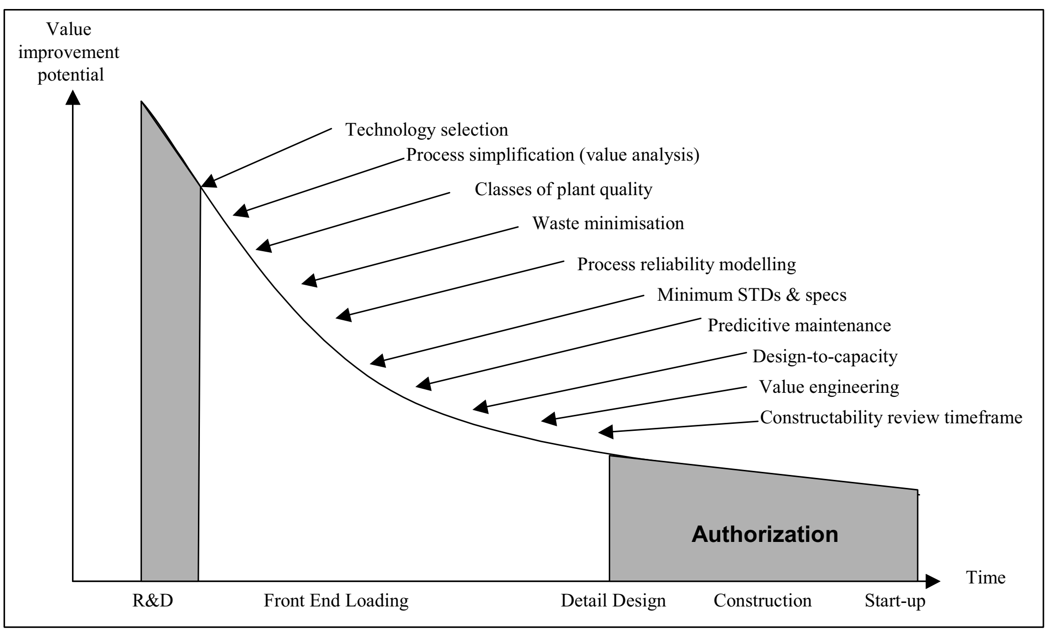


Figure 7.5. Value improving practices (IPA, 1995).

Table 7.4. Operator should control front end loading (IPA 1995).

Outcomes	Contractor FEL projects	Operator FEL projects
Cost growth from authorisation	60%	15%
Cycle time (FEL through start-up)	70 months	54 months
Time for start-up	11 months	7 months
Attainment in the second six months after mechanical completion	41 percent of design	73 percent of design

However, although the operator should control front-end loading, the operator does have an important responsibility in being clear in their definitions and requirements of scope of work and interfaces with the project supply chain. This is important for the demand and supply chain to be able to work and deliver within the functional requirements given, and to meet the financial basis on which the project was sanctioned. The basis for this is established through the project vision and definition, e.g. as described above;

Companies must clearly define the scope of the goods and services to be procured as well as the responsibilities of the contracting parties, including defining interfaces. Scoping will focus on defining functional requirements, thereby encouraging innovative ways of meeting the performance criteria.

Successful contracts clearly define the roles and responsibilities of all the parties to the contract. Clarity of the scope of supply (and also defining that which is not to be supplied) is crucial to effective performance by suppliers. Problems with scoping often have their root cause in inadequate definition within client organisations. Sometimes this is because the overall objectives for the project have not been properly thought through and articulated by the client resulting in scope growth as the contract proceeds' (ACTIVE VEP 3.1.8).

Dealing with innovations and technology development.

As was commented as a challenge in chapter five, the use of technology may prove to be value enhancing for the project, though it may be a risky endeavour to go for unproven technology, in stead of technology proven either within your organisation or outside within the same industry. However, searching for new technology is in the long-term perspective a necessity, and the use of it have to be part of the project decision process or development concept.

Technology selection may be defined as (IPA 1995);

'A formal, systematic process to search for process technology outside your site that may be superior to that currently anticipated for your site.'

Although applying new technology is concerned with a considerable portion of uncertainty, both with respect to ability to make it work and regarding the impact on the project schedule if it does not work and alternatives have to be used, one should remember that the opportunity side of new technology is the driver for using new technology. An illustration of the opportunity side is shown in table 7.5 below.

Table 7.5. Why is technology selection important? (IPA 1995).

Position of firm in its industry.	**Percent of current sales from products introduced in the last five years.**
Most successful in industry	49%
In top third of industry	34%
In middle third of industry	27%
In bottom third of industry	11%

However, technology selection and implementation has to be conducted wisely. As table 7.6 shows, new technology could have a negative impact both on cost growth, the start up time of the installation (thereby affecting the project schedule), as well as the production regularity after production commences.

Table 7.6. Results of using conventional versus new technology (IPA 1995).

	Conventional technology	**New technology**
Cost growth	15%	33%
Start-up time	2 months	15 months
Production (6-12 months)	88%	53%

To be able to meet the challenges that new technology presents IPA (1995) proposes the following list:

√ ‘Identify technological advance correctly.

√ Good engineering will not overcome poor basic data.

√ Don’t short-cut piloting for processes were recycle streams or solids handling issues are involved.

√ FEL for new technology projects will take longer.

√ Start-up planning should begin during FEL.

√ Team continuity is essential‘ (IPA 1995).

Also the ACTIVE initiative for the British construction industry has addressed the aspect of innovations and use of new technology in project development, and how the project supply chain may contribute in that respect. Their guidelines for 'harnessing innovations in the supply chain' are;

'Since most suppliers and contractors work across a number of operating companies, the supply chain provides a rich, and often untapped, source of experience and knowledge which can be harnessed in improving project performance. Whether this experience is available through improved products and equipment or in the methods and processes of project delivery, early involvement of the supply chain at the conceptual and definition stages of projects can often bring considerable benefit.

Unfortunately, many traditional working practices within the industry make it difficult to involve the supply chain early in the project process. Operating companies have been reluctant to involve suppliers and contractors at this early stage, fearing loss of confidentiality and prejudicing subsequent fixed price tendering. Suppliers, on the other hand, are wary of putting forward innovative ideas through fear of lack of protection of intellectual property and the concern that ideas generated at the pre-contract stage will not be rewarded.

Much, however, can be done by adopting a different approach to supply chain relationships and many traditional contractual practices can and must be challenged. Alliance and partnering arrangements make it much easier to encourage the sharing of ideas between parties without loss of commercial protection. Much more has yet to be done to define commercial arrangements which positively encourage an early contribution from the supply chain. The increasing use of integrated project teams does much to foster the introduction of new ideas to facilitate the achievement of project objectives. Within such teams, new ideas need to be encouraged and properly rewarded while confidentiality and intellectual property rights are upheld.

To encourage innovation, consideration should be given to different contractual arrangements, for example:

- √ At an early stage in the project, select a contractor or supplier on the basis of a paid study which culminates in a priced tender. The vendor with the most innovative and cost effective proposal should be rewarded with the contract.

- √ Encourage innovation by linking payment of a fixed sum for bid costs against savings produced by the vendor. The most attractive offer should win the contract but the other vendors could be paid a proportion of the fixed bid sum in relation to their cost difference from the successful vendor.

At all phases of the supply chain cycle it is important that vendors are given positive incentives to be creative and innovative in their proposals since there are often risks in innovation which can lead to caution or conservatism on the part of the vendor.

For the buyer to benefit from an innovative approach there are issues of intellectual property ownership and value which need to be protected if novel solutions and ideas are to be shared in the supply chain. Confidentiality agreements are needed on both sides but this can be difficult at the pre-contract stage where sometimes the novel approach of one bidder is shared, to his disadvantage, with other competitors in the bid process. This practice, besides being unethical, stifles innovation and leads to uncompetitiveness. A way of dealing with this is for the parties to define some form of agreement which will protect the bidders position. For example, vendors might be rewarded for innovation by retaining ownership of intellectual property in exchange for the buyer's free and unrestricted use of the innovation' (ACTIVE 1998, VEP 6.2).

Further readings;

- √ Active (1998). Section 3, VEP 1.4, 1.7, 7.4.

- √ CRINE Network (1999); Chapter 7.

√ Harrison (1995).

√ IPA (1995). Presentation.

√ Lund (1997). Dr.ing. thesis.

√ Mikulski, 1993.

√ Stukhart (1995). Chapter 7.3.

√ Trigeorgis (1997). Chapter 1–5, 7 and 11.

7.2.3 Analyse the market.

Independent of project activities one have to know what the market has to offer, how we are able to benefit from the market, and how we are able to realise the market's offerings? In the project atlas this is about how the market may be of help in realising a potential business opportunity, i.e. the market's opportunities to close the space in between open and closed projects.

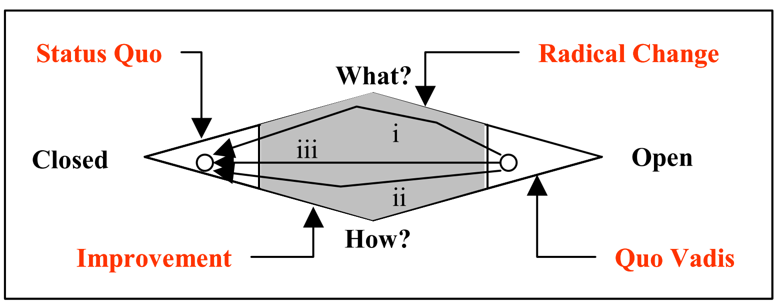


Figure 7.6. The opportunities in the market to realise an opportunity.

Many logistics and purchasing factors are project independent, aimed at research and preparation. Silver (1986) proposes the following list of such factors.

i) 'General information on commodity lead times and costs (including trends)

ii) Supply sources with associated lead times

iii) Quality and capacity surveys of manufacturing facilities

iv) Development of new sources of supply

v) Information on new equipment and materials'.

In this part we rely mostly on CRINE Network's supply chain (CRINE 1999-B) methodology and their section about analysing the market. We have summarised CRINE's focus into a matrix, presented in table 7.7.

Table 7.7. CRINE Network's SCM methodology – analyse the market.

Understand company's position	Best practice.
▪ Existing dimensions and future trends. ▪ Industry competition – forces driving competition in the supply market ▪ The provider's position. ▪ Sources of supply/sourcing options ▪ Provider capability mapping.	▪ Industry mapping ▪ Benchmarking.

CRINE has split the market analysis into two categories, first understanding the company's position versus the market, secondly understanding the company's and the market actor's maturity with respect to supply chain management best practices.

In the first category it is first of all necessary to understand the existing market dimensions of a particular goods or service, as well as future and current trends in the market, as these may impact such an analysis. Then, understanding industry competition, CRINE uses Porter (1990) and his five forces that may drive competition in the supply market, industry competitors, bargaining power of buyers, bargaining power of providers, potential entrants, and substitutes. Then, it is important to understand the provider's position versus company as a business potential. This may be done through a matrix with the two sides of 'account attractiveness' and 'value of business'. For the provider the company (buyer) may then in the matrix be classified as a *nuisance*, a *developing* relationship, to be *exploited*, or as a *core* customer. Then blending the provider's matrix with the role of the goods that company will procure from the provider, a *routine*, *leverage*, *bottleneck*, or *critical* product or service, one may see or estimate the position of each before one come into a specific business situation. Sources of supply should be evaluated, e.g. through the British based 'First Point Assessment' or the Norwegian based 'Achilles'. Finally one should map the provider's capability versus the 'ideal' provider. This is shown in figure 7.7 below.

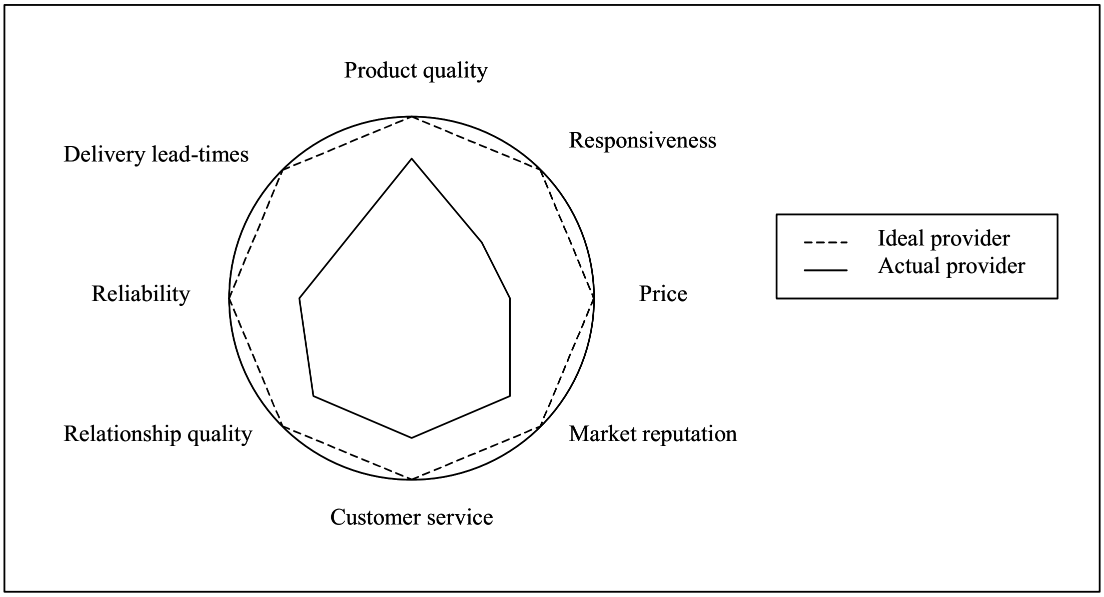


Figure 7.7. Provider capability mapping (CRINE Network (1999)).

In the second category, 'best practice', CRINE proposes initially to use industry maps, which are graphical methods of describing current and future dimensions of competition in a particular industry, and how a given set of companies are placed in the given dimensions. One representation is using a spider diagram with a branch for each factor or dimensions that effect performance. E.g. one may be analysing 'degree of excellence' with respect to; services, terms and conditions, availability, marketing channels, relationship building, assurance testing, international presence, supply guarantee, … others that could vary due to type of industry. Then finally one should benchmark ones supply chain management practices against acknowledged best practices. Benchmarking should be conducted both within ones industry as well as outside. Investigation into the procurement practices of other companies and industries may be useful in providing guidance.

Regarding capability mapping and benchmarking of supply chain operations of providers, CRINE Network's *SCOR's and CAR's* as presented in Appendix B should also be noted. These may be used for improving company and provider's position as supply chain actors and in supply chain management practices. In addition to the SCOR's and CAR's, Goranson (1999) proposes an analysis for actors to become part of an agile virtual enterprise that also may support this type of analysis. This is given in table 7.8.

'If one is creating an information base on potential partners, it should gather these six types of information, each with a temporal modifier' (Goranson 1999, p.69).

Table 7.8. The capability of an actor in a virtual enterprise (Goranson, 1999).

Characterisation of what it does	√ What it adds to the whole √ What it makes	+ Temporal modifier, i.e. how the baseline information is compromised, so that the actor's agility may be situation specifically or temporarily modified.
Characterisation of how good it is	√ Internal agility √ Internal performance (quality, etc.)	
Characterisation of how well it partners	√ In a static situation – to respond to initial change √ In a dynamic situation – to respond to continual change	

Further readings;

√ DTI (1997). Article.

√ CRINE Network (1999). Chapter 4.

√ Active (1998). Section 3, VEP 2.1, 6.2.

√ 1st Point Assessment.

√ Achilles.

√ www.capsresearch.org – Benchmarking of procurement practices. .

7.2.4 Analyse the demand/supply networks

In the project atlas we have now come to analysing the demand and supply chain constructions that the different development and operations concepts rely on. In figure 7.8 this is presented with a focus on the demand and supply chain constructions moving from the project from the opens space to the closed space. In addition it should be mentioned that also the supply chains of the closed space, the operations situation, are object for such analyses.

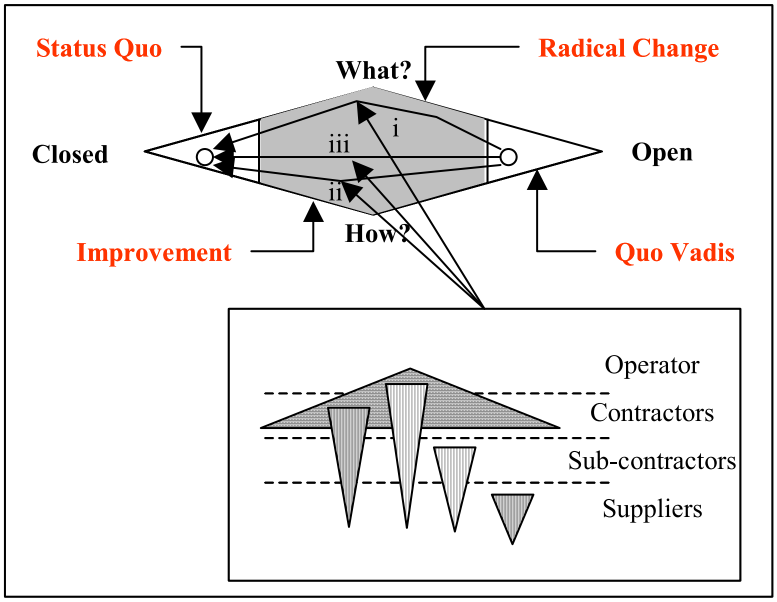


Figure 7.8. Analysing the project's demand and supply chain constructions.

The demand and supply chain constructions covering the development and operations phases of a project's lifecycle is a comprehensive network. As an object of analysis the networks could be approach in several ways, and below we will present an approach and give reference to some methods that we believe may be constructive to use in such analyses. The approach covers the five issues of;

- Mapping the demand/supply chains.
- Relationships in the demand/supply chains.
- Agile development.
- Lean operations.
- Resilient and robust – a vulnerability analysis.

Map the demand/supply chains

Mapping of demand and supply chains are often the starting point of logistics analysis. It may often seem 'easy' and regarded as not useful, because 'we know the supply chain in detail', but do we? However, there are several possible approaches to demand and supply chain mapping. Here we will give a short introduction to three different approaches. First a general supply chain reference model (SCOR, 2000), then a reference model for 'agile virtual enterprises' that are based on and follow a life cycle approach and infrastructure that may be suitable for the project situation (Goransson, 1999), and finally a scheme that give an explanation to several types of value stream mapping originating from lean thinking (Bicheno, 2000).

The SCOR model, or the ‘Supply Chain Operations Reference Model’, is a reference model for supply chain analysis that are developed by the Supply Chain Council, a professional interest organisation for supply chain management, with several hundred member companies from different types of industry.

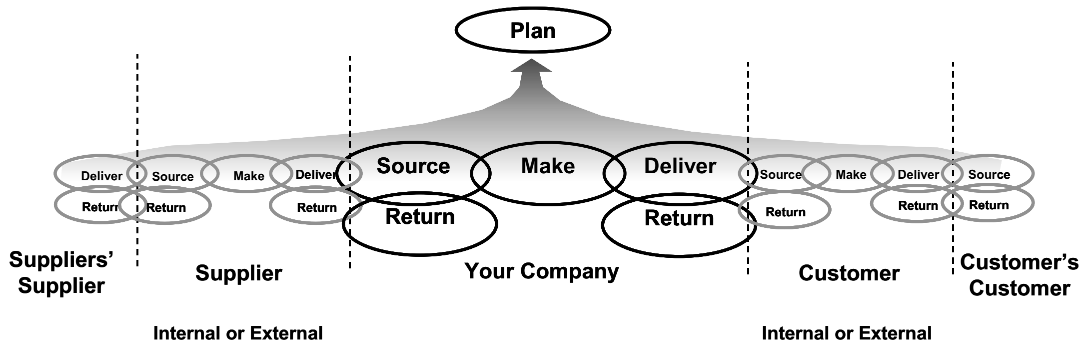


Figure 7.9. The five SCOR processes (Supply Chain Council 2002, SCOR Ver. 5.0).

The SCOR model focus on the flow of goods through the supply chain, covering e.g. the supply chain from your supplier’s supplier to your customer’s customer. The focus is on five processes; *plan, source, make, deliver, and return*. Five processes that cover a natural segregation of the work of the supply chain. This is shown in figure 7.9.

Further the SCOR processes differentiate between three types of products; stocked, make-to-order (MTO) and engineer-to-order (ETO). This is shown in figure 7.10. This grouping of products is related to where the product order penetrates into the supply chain, i.e. the order penetration point. As the SCOR model focus on the flow of goods through the supply chain, the differentiation of the product types is important also with respect to the treatment of the products through the supply chain. This may best be explained by an example. Given that a product is ordered as an engineer to order product, then one may follow how this product is treated down through the tiers of the demand/supply chain, e.g. to find the point in the chain where the product is treated as an make-to-order product, i.e. the point in the demand chain where the customer may no longer specify the product. Such analysis could also be interesting in the project development demand chain to see where e.g. the core technology of a product enters the chain, e.g. to give that leg of the chain special attention.

The SCOR processes are further broken down from the segregation given in figure 7.10, into suggestions for specific processes on a very detailed level. As such the intention with the SCOR model is to bring the best generic knowledge from the participating companies into a set of suggestions for generic supply chain processes, that may be used as a basis for company internal developments of demand and supply chain processes.

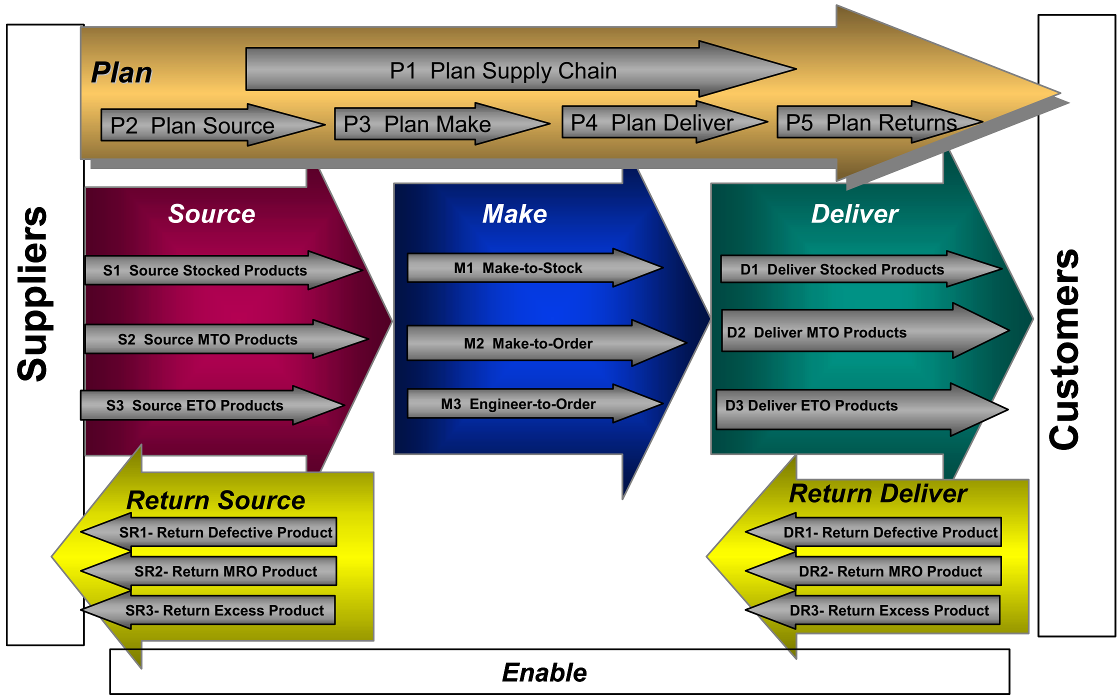


Figure 7.10. Breakdown of the main SCOR processes (Supply Chain Council 2002, SCOR Ver. 5.0).

It should also be mentioned that the SCOR reference model does also give suggestions to key performance indexes, KPI's, related to the different processes of the model. These KPI's may be a good starting point for establishing own KPI's for ones own demand/supply chains.

The second reference model that we would like to draw attention to is Goranson's (1999) 'agile virtual enterprise (AVE) reference model'. The structure of the reference model is given in Appendix F. We will come further back to some specific analysis that Goranson proposes below, but first we would like to draw attention to the detailed structure of the AVE reference model. The structure of the model is developed along two axis, a decision point breakdown, following the life cycle of the enterprise or in our case a project, and the infrastructure breakdown that cover elements that should be given attention to secure a good development. The message that we would like to convey here is that the AVE reference model give a structure that could be used as a check list for analysis of the demand and supply chains in the project context, especially as the model is aimed at the virtual enterprise, where the life cycle cover much the same as the project situation.

Then finally we would like to give an overview of some different types of demand and supply chain mapping, or value stream mapping as it is named within lean theory. The overview is based on a list by Bicheno (2000), but similar lists could have been taken from other authors within the lean manufacturing domain. Based on the listed types of value stream mapping we have tried to relate each to the project situation. This is presented in table 7.9 below.

Table 7.9. Value stream mapping and the project situation (based on Bicheno, 2000).

Overall lead time mapping	An overall mapping to see the general lead-time per stage of a demand and supply chain. E.g. the lead-time for rental equipment could be made up of the following elements; order planning, order generation, order receipt and entry, prepare and pack equipment, pre-transport to base, base-handling, supply vessel, use at base, return to base, and transport back to supplier. This is a longer lead-time than the time from demand is known until demand Is covered, but e.g. for rental equipment the total lead time could be interesting as that could have price and contractual implication versus the supplier. The lead times could either be presented as a Gantt chart, displaying how each element in total add up to the total lead-time, or as a Pareto distribution diagram showing the lead-time elements from the longest to the shortest. The Pareto distribution is important to use to address the areas where there are most to gain in reducing the lead-time, and not addressing elements that are un-important lead-time wise. The lead-time map could be especially important to use for schedule purposes, e.g. schedule compression or activity interaction, or for improving operations response times, e.g. for special services.
Order mapping	Order mapping is done to focus specifically on special customer orders, to be able to uncover elements in the order's demand and supply chain that could improve customer service and/or lead-time. The focus in order mapping is the clerical process, or the full order management cycle from planning to payment and post-completion services. There are to approaches to order mapping. The first is to 'staple yourself to an order', where an analyst follow an order through all its stages, and records the time each stage takes, and if possible the reasons for eventual delays in a stage. The other is 'tagging' an order, i.e. make a tag on an order that follow the order an where employees dealing with the order should record data as they deal with the order. The intention is to collect a representative sample of data that helps tracking variation in both time and routing of orders. For the tagging approach, one should also follow it up with physical tracking to get a better picture of the situation.
Customer mapping	Customer mapping is the process of identifying your customers, and their influence, along the demand chain. This mapping give insight into who makes decisions to activate the demand chain, not only the direct customer, but the 'ultimate' customers, e.g. the operations management of an installation. Customers could for this purpose e.g. be grouped as 'buyer', 'decider', 'user', or 'specifier'. Customer mapping could be useful e.g. as background for establishing supply agreements with customers.
"Learning to see mapping"	The 'learning to see map' draw an illustrative map of both the material flow and the information flow. Such maps are often used to illustrate the current and future state of a process. The mapping makes use of simple boxes and illustrative symbols related to the process, to show the material flow. The information flow may be fitted into the material flow picture through lines with explaining text, and schedule information may be shown by using lines with arrows to explain that process. Lead-time information could also be set into the process picture to clearly show the relation between processes and time. As this type of mapping is very illustrative, it is often termed as a 'process cartoon'.
Process activity mapping	The process activity map is the same as the process flow chart. Most importantly, process activity mapping shall help in identifying opportunities, especially with respect to improving the ratio among value adding and non-value adding time. The mapping should be available for operators to use themselves.

should be available for operators to use themselves.

The process chart lists every step that is involved e.g. in the delivery of a service. Standard symbols are used to indicate ‘operation’, ‘delay’, ‘move’, ‘store, and ‘inspect’. The process chart helps to identify wasteful actions, and documents the process completely. Such a systematic record should help reveal the possible sources of quality and productivity problems. The process is first to document the process map. Documenting the process map should be done based on the current situation and not be based on ‘old’ process maps, as these may give another picture than the current situation as working in practice. What should be mapped is the actual, not the ideal situation. After the process map has been developed, then it should be analysed. The map could both be used for time (valuable time) analysis, as well as if cost data is connected to the processes, a cost analysis could also be made.

Product variety funnel The product variety funnel is useful in understanding where variety is added along a supply chain. This is especially used for retaining flexibility and variety as long as possible in a production chain, but could also be used in a services or product supply chain, e.g. in planning warehousing and base services for the offshore petroleum installations. For production processes variety should be added as late in the process as possible, as this improves responsiveness and flexibility, and reduces inventory. For supply services the situation does also have another dimension. In the supply services context it is also important that variety, e.g. variety for use at several installations of rental equipment, is kept early in the supply chain, and that the supply and return processes are effective so that alternative use is not hindered. Equipment and material stored later in the supply chain, e.g. at a specific base or at the installation should have variety in use.

Quality filter mapping Quality filter mapping aims to pick up the rate and sources of defects along a demand and supply chain. Defects may impact the customer, but it is also wasting resources. The defects should be mapped and linked directly to all operations steps where they occur. The result will as such be a figure showing the supply chain stages along a horizontal axis and number of defects in equivalent units along the vertical axis. In particular, such mapping can highlight defects that are passed over long distances along a supply chain only to be rejected beyond the point where correcting the defect is not economic.

Demand amplification mapping Demand amplification mapping models the amplification of demand disturbances along the supply chain. This type of mapping may be more essential for production oriented supply chains, but could also have benefit for the operations supply context, especially with respect to seeing how the ultimate demand may be visualised better along the whole demand and supply chain, and to address what can be done to improve the demand response along the supply chain.

Push pull mapping Push pull mapping identifies the points or buffers at which supply push takes over for demand pull. Such mapping is useful as the pull point generally should be moved further back along the supply chain, or one should be conscious with respect to where the push pull point is placed. A long term strategy should be established to challenge the push pull points, and long term moving them backwards in the supply chain. The vision is to synchronise the demand and supply chain through conscious push pull points.

Physical structure mapping Physical structure mapping helps set the policy for suppliers and customers rationalisation. Such mapping is a useful basis for periodic changes to the supply system configuration.

Capacity mapping Capacity demand mapping looks at the ratio of capacity demanded to total capacity available. The idea is to identify the physical bottlenecks and constraints along the supply chain. Such mapping is relevant for the periodic reconfiguration of the supply system scheme, both for optimising the standard supply service and preparing for special supply services.

Cost time profile A cost time profile is a graph showing accumulated cost against accumulated time for a supply chain. It gives a visual presentation that has a powerful effect in conveying a message. Could e.g. be effective when analysing the demand and supply chain for rental equipment, where a rental price often is directly linked to time spent from delivery to base until return to supplier.

Relationships in the demand/supply chain

We have earlier mentioned the relationships in the project demand and supply chains as some type of horizontal alliances for the demand setting, and some type of vertical alliances, through frame agreements and contracts, for the supply setting. Example of horizontal versus vertical partnering is shown in figure 7.11 below. As part of an analysis of a project's demand and supply chain structure it could be wise to see how the configuration of horizontal and vertical alliance or partnering will be for the different project development and operations alternatives. E.g. how the use of operator's versus the contractor(s)'s frame agreements and contracts. i.e. vertical alliances, impact the demand and supply chain constructions.

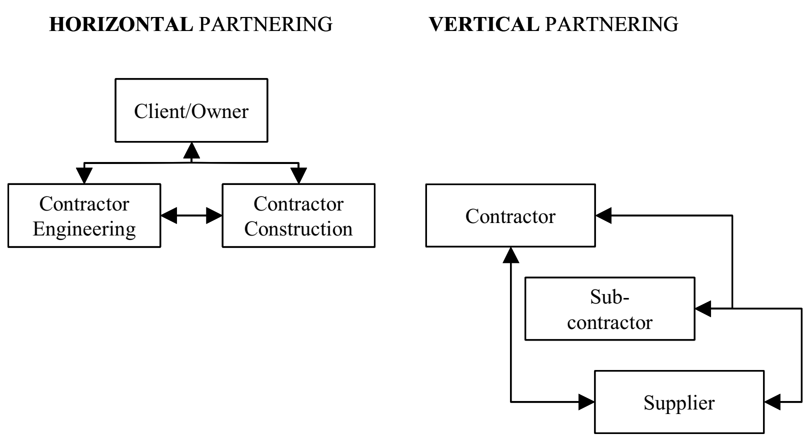


Figure 7.11. Horizontal versus vertical partnering.

The relationship between the operator and contractor(s) will not always take form as an horizontal alliance structure. The choice of formal relationship structure between the operator and the contractor(s) may be dependent both on the business challenge, whether that is simple or complex, and the business culture in the market or between the stakeholders, whether that is characterised by adversarial behaviour or by trust and mutual respect. A matrix to guide the choice of formal relationship structure between the operator and the contractor(s) based on position with respect to business challenge and business culture, is presented in figure 7.12. The matrix is developed by Hetland (1999).

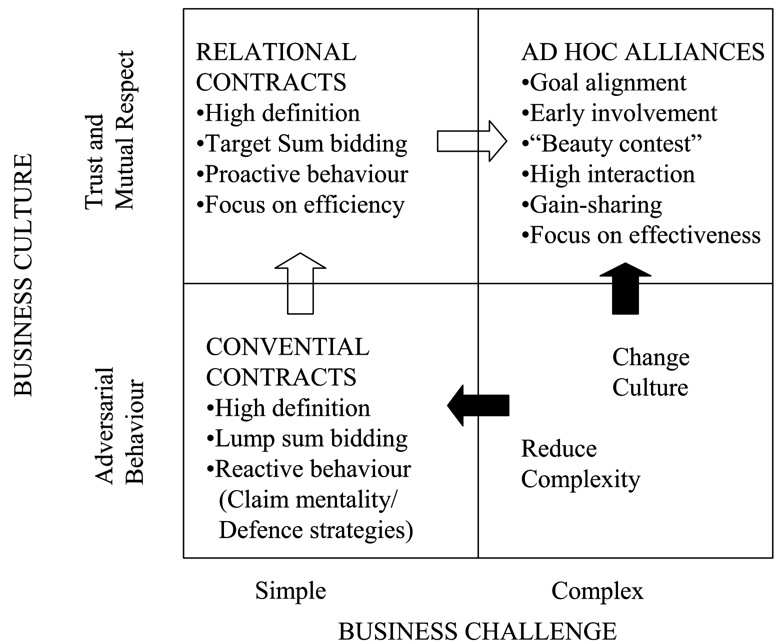


Figure 7.12. Choice of operator contractor relationship based on business challenge and business culture (Hetland, 1999).

As figure 7.12 shows one moves from conventional contracts where the challenge is simple and there may be no or (assumed) adversarial relation between the operator and contractor, to alliance type of contracts when the challenge is complex and the relationship is characterised by trust and mutual benefit[61]. There is one quadrant of the matrix that possess a challenge. That is if the challenge is complex and the culture is adversarial. Then one either must reduce the complexity, e.g. through reducing contracted scope of work, or change the culture. The first could be an example of returning to earlier execution models where the operator had a larger scope of work and interface control, while changing culture could be regarded as what was necessary through the NORSOK and CRINE initiatives.

Figure 7.12 segregated business culture between 'adversarial' and 'trust'. Maybe a better distinction is between 'misaligned' and 'aligned'. The interesting question is whether the contractual relationship between the operator and the contractor is such that there is a common benefit in achieving the clients objectives. A representation of this is given in figure 7.13.

[61] Maybe mutual benefit could be a stronger and more appropriate incentive than mutual respect.

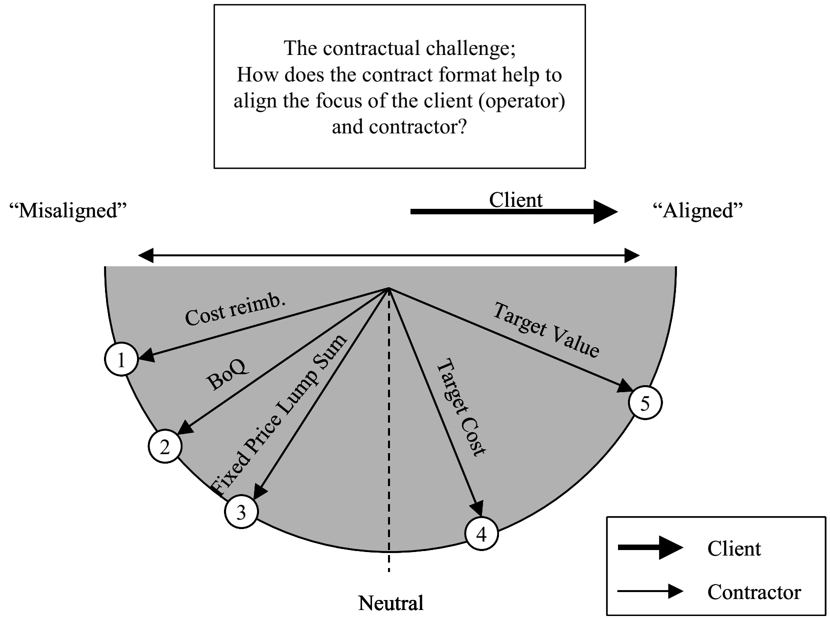


Figure 7.13. Aligning client and contractor through the contract (Instefjord, 1999).

A further progress of the topic addressed through the figures 7.12 and 7.13 are given in Appendix E, which summarises a workshop on contract strategies arranged by the European institute of advanced project and contract management.

Through their supply chain initiative, CRINE Network established two sets of requirements for companies to become interesting partners in oil and gas supply chain constructions. The two sets of requirements are first 'supply chain optimisation requirements', **SCOR's** and secondly 'critical attractiveness requirements', **CAR's**. The SCOR's and CAR's are presented in full in **Appendix B**.

SCORs are those things that a customer (operator or contrator) should be doing to ensure they maximise the potential for the supply chain to provide appropriate technologies for the future at the right time and quality. CARs are those things which make a supplier or a contractor highly attractive to a customer, i.e. they appropriately 'magnetise' the supplier in order to enable him effectively to move closer to the customer. For more details we refer to Appendix B.

Agile development

Agility is in the literature to a large extent conceptually described, missing out on methods to analyse the agile capabilities and capacities of virtual enterprises or demand/supply chains. Goranson (1999) seek to make agility analysable in an engineering oriented way. To bring the concepts of agility into use, this is needed as the methods and techniques of project planning and control were developed and applied in the second phase of the North Sea oil and gas development history as explained in chapter one.

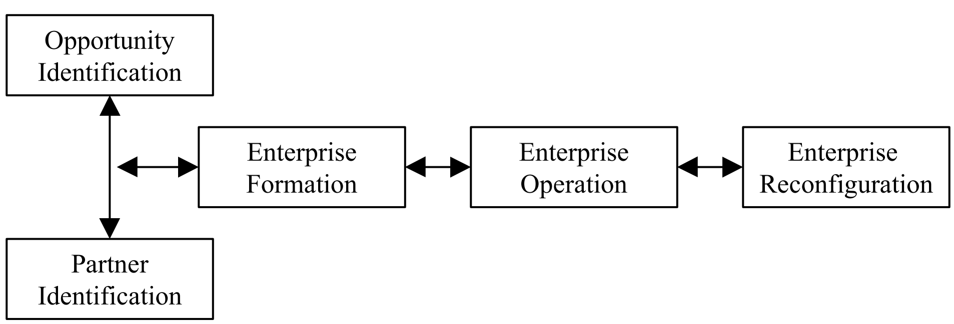
The tools used and proposed by Goranson (1999) are based on a breakdown of the enterprise, e.g. the project organisation, into a set of key processes. To define and focus on a set of few critical processes that will help to define the enterprise's agility barriers and levers, the 'agile virtual enterprise reference model' is developed. To help in analysing the processes a set of metrics is developed based on a theoretical basis of information theory and communicative acts, and with a simplified approach suitable for direct calculations.

The focus for the reference model and metrics that Goransson (1999) propose is on analysing processes to evaluate their agility, their ability to adapt. The method is based on models of ordinary processes within an enterprise or across partners in a demand/supply chain. The result of the method are numbers or functions which indicate the time and cost of change. The results could be used to address change in one of two ways;

1. Comparing a pair of processes, resulting in the time and cost of changing from one to another. This could e.g. be between new, unproved technology and old, well-known technology, and the degrees of freedom available with respect to trying the new technology before having to revert to the old if the new is not delivering results as promised, and the time and cost for such a change compared to the time available, and the value/cost ratio of the inherent opportunity of using new technology.

2. Evaluating a single process against a threat and/or opportunity, or a spectrum of threats and/or opportunities to determine how agile the process is. The metrics can here be used to evaluate the time and cost of adapting from an existing or potential process design, to a new process that can deal with the threat and/or opportunity.

Below we will describe and explain the AVE reference model and the metrics used to calculate the agile 'position'. The AVE reference model is based on matching the opportunity with partners able to realise the opportunity, throughout the life-cycle phases of the opportunity from enterprise formation to enterprise reconfiguration. This



is shown in figure 7.14.

Figure 7.14. Major life cycle categories of a virtual enterprise.

The life-cycle elements of the reference model as shown in figure 7.14. above, is in the reference model termed ‘decision point breakdown’. The decision point breakdown constitutes the rows in the model. The columns of the reference model is termed ‘infrastructure breakdown’. There are four main infrastructure elements, information, social/cultural, legal/explicit, and physical. The matrix given by the decision point breakdown and the infrastructure breakdown (except the information infrastructure) is presented in table 7.10.

Table 7.10. Major headings of the agile virtual enterprise reference model (for the structure of the full model, see Appendix F).

		Infrastructure Breakdown								
		Social/Cultural			Legal/Explicit			Physical		
		Human Dynamics	Community Cultures	Business Culture	Business Processes	Contracts/ Regulations	Workflow	Logistics/ Warehousing	Equipment	Laws of Physics
Decision Point Breakdown	Opportunity Identification									
	Partner Identification									
	VE Formation									
	VE Operation									
	VE Reconfig/Dissolution									

Based on the main structure the reference model is broken further down into twenty-one decision point (life-cycle) processes and thirty-three infrastructure processes, resulting in matrix with a total of six hundred and ninety-three cells. The matrix of the full model is presented in appendix F. The total number of cells in the reference model is due to its use for reference purposes, established to cover both the whole life-cycle of an AVE, as well as the infrastructure elements that could be important from an agile analysis point of view. However, for practical analysis purposes only a smaller number of cells will most often be necessary to achieve the wanted analysis. Goransson refers to ‘twenty high value cells’ that based on their research were seen to be important.

To support the ‘engineering of AVE’s’ Goransson has developed a set of metrics’ that shall help in pre-analysis of the time and cost associated with the potential that a system has to accommodate future change. The metrics’ are based on the cells of the reference model, and the communicative acts that take place between the cells in the model. The communicative acts is based on results from information theory, that calculate the cost and time of adapting an algorithm to address a new problem, but in this case it is used on processes that are the tactical means of a strategy. A graphical representation of the communicative acts process called a Dooley graph is used to enable a simplified calculation of the metrics. The Dooley graph is a way of representing the process of a 'dialogue' among actors taking place in a cell in the reference model, using the utterances between each actor. The type of utterances could either be a question or to inform. The utterances will again be a respond or reply to earlier utterances, or to resolve or complete earlier utterances. The dialogue will in the Dooley graph be represented by nodes for each actor's involvement in an utterance, and directed arrows between nodes that reflect the direction of the utterance between the actors. Through this process of utterances between actors in a process the main important elements to be used in the metrics are the number of nodes, the number of loops between the nodes, and the type of nodes and loops, i.e. how many loops corresponds to a node and vice versa. For a thorough explanation of this process, see Goranson (1999) pp. 157-210.

There are five metrics that may be derived by the use of the Dooley graph. Those metrics are termed distance, time delay, moveability, importance, and frequency. Each metric is explained in table 7.11 below.

Table 7.11. Summary of the intermediate metrics (Goranson 1999, p.186).

Distance	Total number of weighted nodes. This is the simple sum of the number of nodes raised to the power of its type, i.e. the number of loops of those nodes. The metric say that the more actors involved, and the more each actor does, the harder it will be to change the process. The higher the sum of the metric, the higher the cost or time of changing the process.
Time delay	Total number of weighted loops. This is the simple sum of the number of loops raised to the power of its type. The metric say that the more tasks a subconversation has to do, i.e. the more actors involved in the subconversation, the harder it will be to change it. The higher the sum of the metric, the higher the cost or time of changing the process.
Moveability	Topology match, internal. This measures the structural difference between two processes, i.e. ratio of nodes in a process that match the nodes of a 'baseline' process. A greater number indicates a greater match, and a lowered time and cost to adjust.
Importance	Nodes compared to the VE's total. This metric is the ratio of weighted nodes in a process, compared to the weighted sum of all nodes in the whole AVE, or in e.g. a part sub-infrastructure, from the reference model, of the AVE. This gives an indication about whether a given process help to make the total system of process more agile or not, i.e. whether it help the system agility. a process may be more agile than another in itself, though may contribute less to system agility. The higher the number the higher contribution to the overall system's agility.

Frequency	Loops compared to the VE's total. This metric is the ratio of weighted loops in a process, compared to the weighted sum of all loops in the whole AVE, or in e.g. a part sub-infrastructure, from the reference model, of the AVE. The higher the number the higher the cost and time of change.

The aim of using the metrics is, e.g. from a project planning and control point of view, **to develop and build a project demand/supply chain with a specific type and extent of agility**. An example is e.g. that the total development time could be longer than the rate at which new, important technology evolve. Best practice dictates that you build and involve your demand/supply chain early, but as the development evolves, the demand/supply chain should be agile, not artificially limiting the development due to commitments made too early. The metrics should tell you which processes, among those available to you, are more agile, and with respect to the project demand/supply chain, they can tell which supplier's processes give you the agility needed.

Then, in summary the method proposed by Goransson could be outlined as follows;

√ Assess the **spectrum of opportunities or threats**, e.g. based on a context dependent taxonomy.

√ Determine an **agility strategy or candidate strategies**, e.g. based on intelligence about technology development and/or potential partners.

√ Brake down the **related processes** of your enterprise or project demand/supply chain, e.g. using the AVE reference model as a guideline.

√ Within the break-down of the processes identify **the few key cells** that are relevant to the agility opportunity or threat and your possible options in addressing that opportunity or threat.

√ Breakdown of the **communicative acts** between actors through utterances in the processes, e.g. through the use of Dooley graphs.

√ Calculating the metrics.

However, agility has a cost and there is always a limited amount of resources available. Therefore one has to decide how to use one's 'agility budget', e.g. based on the results of the metrics. Examples of how to spend the agility budget could be (Goranson 1999, p.190);

- Increasing you internal ability to support the change, for example, in acquiring specifications related to [alternative materials] so that you can direct un-knowledgeable suppliers.
- As contract termination fees to discontinued suppliers, so that a simple supplier swap is feasible.
- As fees to keep suppliers hot, in which case you are buying capability that you may never use, like an alternative to the existing supplier.
- As funding to help suppliers learn/hire consultants or insource skills.

- As funding for your cost to transfer skills, processes and equipment to a supplier.

Whitney (1995) defined some aspects of agility, which we related to the project context. These are presented in Appendix A.

Lean operations

Whereas the project development phase should have agile characteristics, the project operations phase should possess lean characteristics. Here we presents four lists covering lean *principles, characteristics, types of waste* (muda), and *planning elements*, and their relation to the project operation supply chain. The bullet points of the lists are taken from Bicheno (2000), but could also have been taken from other sources within lean literature.

There are five lean principles; *customer value, the value stream, flow, pull*, and *perfection*. Below in table 7.12 we have listed these with an explanation to each regarding the project operations supply chain.

Table 7.12. The five lean principles and relation to the project operations phase.

Customer value	Customer value from the operations supply system comes when the customer get confidence to the supply system, the correct supply system is periodically established in accordance with the customer's change in needs, and there is a continuous focus to improve the cost and service position of the supply system.
The value stream	The value stream of the operations supply system goes from the demand initiation at the offshore installation, through to return of e.g. rental equipment to the supplier. This value stream should be mapped for the major supply categories.
Flow	The base is a central point in the value stream where the goods coming in from several suppliers are stowed onto several supply vessels, and return cargo shall be shipped back to suppliers. The base is also the point in the value flow where there is a potential for break in the flow of goods through the supply system. This may be due to break load units to separate cargo to diverse offshore installations, or just to assure the content of load units before shipping it offshore.
Pull	A good system for pulling, in stead of pushing cargo through the supply system, should be based on periodic plans and agreements that adjust to the periodic change in needs, and then spread information about this need across the demand/supply network. Then, based on these plans and supply agreements …
Perfection	Each year the consulting company McKinsey makes a benchmark study of a.o. the logistics and operations cost per offshore installation and company in the North Sea basin. This benchmark study establishes a theoretical best position, as well as the best operator in the basin. In a strive for perfection it is important to remember that e.g. in logistics it is not possible to always be no.1, as demand and supply configuration per operator will change periodically e.g. giving some a very cost-effective supply vessel scheme. What is important for perfection is that one optimises within ones periodic limitations, and continuously seek for improvements within the supply chains.

Bicheno (2000) states fourteen lean characteristics; customer, simplicity, visibility, regularity, synchronisation, pull, waste, process, prevention, time, improvement, partnership, gemba, and variation. Below in table 7.13 we have listed these with a comment of each regarding the operation supply chain.

Table 7.13. Lean characteristics and relation to the project operations phase.

Customer	The uppermost customer is each license, i.e. each unique 'profit center'. However, each company to be served by a supply scheme does also want to optimise the supply service for all its licenses, as such each company could also be regarded as a customer. Finally, each installation is the direct customer for the supply service, as it is first and foremost dependent on the direct supply service, not its related cost position.
Simplicity	The services provided through the supply scheme should be simple in the sense that they are predictable. That could e.g. be achieved through a split between standard and special services, where the standard services is a group of services covering a given scope of work and conducted within a specified and fixed schedule. The special services cover speciality services needed on an ad hoc basis, as well as for unforeseen or accidental situations.
Visibility	Visibility of the supply services could be achieved through setting the supply services as an agenda issue for the continuous improvement for each license, e.g. through supply agreements between the license and the supply organisation. Another, organisational, issue that could improve visibility is to have some sort of 'supply operations centre' for each supply region, a centre acting as a single point of contact for all supply services. Then again, for the operations centre all parts of the supply chain should be 'visible', e.g. through systems for monitoring status of orders and tracking movements and localisation of goods.
Regularity	The context of the supply services is such that there will be changes both in the scope and type of services needed, as well as the scope of installations covered, and volumes for each installation. To make the supply services predictable within this context, the services have to be predictable within periodic schemes. This means that the scheme of the standard services has to be adjusted, or optimised, periodically, to fit to the contextual changes.
Synchroni-sation	Synchronisation is achieved when there is 'one-piece' flow through the supply system. To achieve this it is important that all goods coming form suppliers into the supply base is packed into load units that could be directly loaded onto the supply vessel, or into consolidated load units for one installation. Tagging of goods and content of load units from the suppliers is important to achieve this, and if there is mistakes in the tagging that will be a hindrance to synchronisation, as the load units has to be re-checked at the base. Further the timing of when the goods from the supplier arrive at the supply base has to be coordinated with the schedule of the supply vessel so that the base organisation are able to organise and load the goods onto the supply vessels in an effective and secure way. To achieve the latter the demand ordering process from the installation itself has to be in accordance with the time needed for preparation and transport from the supplier to the base.
Pull	The periodic optimisation and planning of the supply services will establish the overall and specific demand of each installation for specific product categories. This will be used to prepare and plan the scope of the supply system. Then again the specific demand of the installations will activate a pull based flow of goods from the suppliers through the supply system to the installation. A reverse pull system should also be in place to secure that equipment to be used only for a short period of time at the installation is pulled through the reverse supply system back to the supplier, so that the use of the equipment will not add more cost than necessary. The latter is the case e.g.

for rental equipment.

Waste Waste could be related to an inappropriate supply system scheme. This should be helped through adjusting the supply system scheme periodically to the changes in demand and supply context. Waste could also mature from a supply system scheme that covers 'all in one'. i.e. try to cover all supply needs, both planned and unplanned, through the same system and administrative approach. By separating the supply system into two, one standard covering the planned demand, and a system or approach covering the special demands. The latter do not necessarily need to be a single system, but another approach in dealing with the specific special situations, either through the standard system or through other, purpose specific systems.

Waste could also be regarded with respect to the consequences of breakage in the supply system, e.g. when an installation has to stop production due to not getting supplies needed. This show that preparing a supply system scheme is a balancing act between 'over'- and 'underproduction'. However, this should be handled effectively through a good approach to special services taking care of special situations.

See further elements of waste in the 'muda' table below.

Process Organising the services along groups of processes that have different characteristics, e.g. the different product groups as such as consumables, rental equipment, and others. Another type of processes that should be separated are the difference in processes for standard and special services. For the latter response time will be an important issue.

Prevention Through a focus on processes and periodic adjustments of the supply services scheme, one should get a proactive attitude to being in front of problems, through focusing on the means of solutions, not the specific problem.

Time Being able to reduce the total lead-time in the demand and supply chains should focus separately on the standard and special services. For the standard services the lead-time of the total demand and supply processes for the different supply categories should be in focus. In addition for rental equipment is the return chain back to supplier important. In addition for special services the response time is important. Being able to establish and produce a special service based on the portfolio of resources available will for many situations be time-critical, as well as may need to be produced through different alternatives.

Improvement 'Improvements' should be made periodically through 'forced' periodic adjustments and optimisation of the supply system scheme. These periodic revisions call for 'innovative' improvements. The analysis leading up to these periodic revisions should also comprise analysis for continuous improvements of the supply system. The focus of the continuous improvements should be made for the different supply processes, but could well originate from functional areas along these processes. The analysis process should also seek to track these improvements, to see the impact of them. This lead up to the fact-based management as described under 'gemba' below.

Partnership Each installation and each company has a demand for supply services. In optimising the supply system scheme one should look for potential synergies in collaborating with other, both on installation and company level, to optimise the supply system for common, shared benefit. This may even mean that the management of the supply system could for given areas, situations, or periods be partly or fully outsourced to other petroleum companies, or logistics service providers.

Gemba Gemba stands for 'management based on facts and managerial presence'. With respect to fact-based management, the cost-position of the North Sea operations, included the logistics and supply operations, is benchmarked yearly by a consultancy company (McKinsey). This give high level facts that are acknowledged among the petroleum companies to give a comparative status. This benchmark study should again be supported by internal analysis so that one know the reason for one's position, and may predict how this may change, both due to improvements, as well as contextual changes.

Presence need direct involvement in the supply chain, decisions based on first hand knowledge, often starting by supply chain mapping, 'see to learn'.

Variation Variations are a normal part of supply services, and should be treated as such. This means that special services, as commented above, should be planned and prepared for in advance as standard services are, though with the difference that the execution of them will not follow fixed schemes. As such the special services could e.g. be planned for through a vulnerability analysis.

Among the lean characteristics presented above we found waste. Reducing waste, in its different forms, is one of the main focuses of lean thinking. Below we present six types of waste as presented in Bicheno (op cit.) and relate each to the operations supply chain.

Table 7.14. Types of waste (muda) in the project operations supply chain.

Over-production	Overproduction in the operations supply context may mostly be related to making use of more resources than optimally needed to cover the demand requirements. This could be related to the demand side, e.g. in the planning process from the customer's side increasing the demand estimate to bring some slack into the system. Another may be that the supply vessel size is not suited to need, e.g. there is lack of suitable vessels in the market. Also not utilising the potential for supply synergies across installations or companies, could be a source for overproduction. In addition, external factors may have an impact on the scope of resources used for the supply operations. On the Norwegian Continental Shelf each license has in its concession requirements about how the supply arrangement shall be, including which base to be used and level and location of onshore support organisation. Such concession based requirements could add considerably to the 'overproduction' in the system.
Waiting	Waiting in the operations supply context could both be related to goods waiting in the system, e.g. rental equipment waiting to be shipped back to the supplier. This could also be regarded as temporarily unnecessary inventory. Another form of waiting could be supply vessels waiting for inbound goods. This could happen due to incidents or accidents earlier in the supply chain, or could be a system failure e.g. due to a mismatch in aligning lead-times along the supply chain.
Transporting and unnecessary motion	Waste of transporting could e.g. mean non-optimal or not situation adapted supply vessel routes. That means not adjusting the supply vessel routes, the size or number of vessels as the supply demand changes. Unnecessary transportation could also mean supply vessels that have to return back to an installation due to that the installation was not ready to handle inbound goods when the vessel arrived on its scheduled time.
Inappropriate processing	Inappropriate processing could mean re-packing load units at base, instead of packing directly into customer specific load-units at supplier. This does not mean loading the supplier load-unit into load unit for supply vessel, e.g. container. Another, more directly waste of processing resources and time is the need for extra check of content of load-unit versus tagging at base. This could e.g. be due to suppliers not being correct in tagging the orders, or putting several orders, for several customers into the same load-unit, with only one customer specific tag. This could lead to the customer not

getting the goods needed, thereby initiating a new supply need.

Unnecessary inventory Unnecessary inventory could be related to several elements;

- e.g. short-term due to early ordering, e.g. due to doubt about the supply chains ability to supply on time,
- keeping additional spares than required e.g. due to doubts about suppliers' ability to supply when needed,
- keeping rental equipment longer than needed, e.g. due to a non-effective or non-existing return process,
- or not having a process to periodically remove items from inventory that are no longer needed.

Defects Defects in the supply system could e.g. be load-units that are defect when arriving at the supply base, so that they are not able or allowed to be loaded onto the vessel or lifted onboard the installation offshore. Missing or to old certificates on the load units could also be regarded as defects.

Lean thinking does not happen by itself. To start preparing for lean thinking and realise its potential some elements of planning could be worth while to bring along. Below we present seven lean planning elements as listed in Bicheno (op cit.) and relate each to the operations supply chain.

Table 7.15. Lean planning elements and the project operation supply chain.

Scenarios Scenarios are often used to prepare for different possible situation s in the future, and how one may go about dealing with such situations. For the context of the supply service scenarios may especially be useful for dealing with a differentiation between standard versus special services. Planning a standard supply services scheme is rather straight forward given a static demand for a given period of time. Based on this a standard supply scenario may be developed that cover the time-phased demand of each installation, set into a fixed set of supply vessel routes and schedules.

However, the supply situation will both be impacted by events and special situations that do not fit into the standard supply scheme. The question then becomes whether one should try to cover all situations through 'stretching' the capability and capacity of the standard supply system scheme, or whether one should separate and deal with special situations in another, 'special' supply system scheme, adopted for different and specific situations, and planned through scenario developments. Then it will be easier for all stakeholders of the supply services to see impacts and consequences of situations that come on top of the value optimisation of the standard supply services. In addition the special situations will be own 'objects' for value optimisation.

Time pacing Time pacing in this respect may be seen as adjusting the supply system scheme to periodic changes in supply requirements. The supply service scheme cover several installations, often in different phases of the project operations life-cycle, and thereby with differing supply demands. As an installation come into a new phase with respect to supply demand, there may (will) be changes to the optimal configuration of the supply system scheme, and this should be reflected through periodic re-planning and re-configuration to optimise the supply system scheme to the new supply demands.

Periodic shut-downs, maintenance and modification projects including extra supply needs, will also be a subject for time pacing. Such time pacing should however be treated through the supply system for special situations.

Value focused thinking

Value focused thinking is to a large extent driven by the yearly North Sea Operations benchmarking studies. In these the operators get a relative measure of their own position versus other operators, per installation. If one through the planning processes aims to understand the mechanisms that produce value, and the cost structure and cost drivers related to this, the benchmarks could be used as a top-level driver for uncovering value. Examples of value improvements that could be directly related to the benchmarking exercise is e.g. operator collaboration in supply base services and supply vessel utilisation. Such collaboration will increase the value/cost ratio of producing the supply services through leveraging on the potential for synergy through shared resources that exists in the supply chain cost structure. However, what is important to remember in value-focused thinking is that one should start improvement work as free from constraints as possible, e.g. not only see potential in improving already established partnerships and collaborations, but analyse based on the full set of opportunities, including ending established collaborations and establishing new ones, if that enhances value contribution the most.

Policy deployment

Policy deployment means the few, critical breakthroughs or goals required to be achieved to meet the overall development plan. The policy deployment should be customer focused. Two high-level, critical breakthroughs needed for development of the operations supply chain is first the ability to commit the customer into taking proactive part in developing, planning, and following up the operations supply chain schemes. To be able to realise the benefit in ‘optimised’ supply schemes, customer commitment is an absolute necessity. The other critical breakthrough needed to make optimal use of resources for supply services adopted to the changes in the demand situation is collaboration among installations and across operator companies. This gives a much wider set of opportunities to optimise within, but need to establish a form of consensus within the business that such is beneficial.

Cross-functional management

A good example of cross-functional management within the operations supply chain is e.g. regional supply chain operations centres that cover all operational demand/supply activities within one supply region, e.g. related to one supply base. Such operations are known e.g. from other transport network management contexts, e.g. the air transport industry. Representatives from all functions are co-located in one room, supported by technology to give their customers and supply chain stakeholders a single point of contact.

Target costing

Target costing in this context could e.g. be related to the costing differentiation between standard and special supply services. The standard services should have a cost-minimising aim. The standard supply services scheme should be the services that aim to meet the estimated and planned supply demand requirements within a given period of time, and for a given supply scheme configuration. To achieve this it is important that it is true commitment to the system from each customer, and that the customers accept and adhere to the level of service that they are given true the standard system. The target costing of the standard supply system scheme is as such proactively engineered based on a periodic optimisation of the supply system scheme to fit the predicted demand.

For the special supply services the customer, and activator, of such need to pay the additional cost of establishing and operating such services when needed. However, it should also be some form of incentive for the operational managers of the overall supply system to make additional use of special supply services when such are established and if this is cost and service effective.

> In sum the target costing should aim to price standard versus special services so that there is a true incentive in choosing and following the scheme of the standard services, as well as a disincentive in breaking the standard scheme, and an incentive to paying an additional price to get special services when such is required.

To facilitate and support lean thinking in the operations supply chain we have above listed lean principles, characteristics, types of waste and planning elements, and related these to the operations supply chain. The literature on lean thinking is rich and comprehensive, and we suggest the interested reader to look into e.g. Bicheno (2000) as he presents good lists of references for further reading.

Resilient and robust – A vulnerability analysis

A supply chain must be able to keep up its mission, i.e., it has to be robust with respect to factors that may 'disturb' the supply chain from fulfilling its mission. This is related to the logistical service element. Another aspect of the logistical service element is the supply chains ability to retain to do its mission if it has been brought out of 'balance', i.e. the resilient aspect of service. The mission of the supply chain may itself be object to changes, and then the resilient characteristics or abilities of the supply chain must be leveraged. This was seen in Copacino's (1997) approach to differentiate between reliable, resilient and creative supply chain management elements.

Whether it is the robust or resilient characteristics that are most important or if it is a combination of the two will be contextually dependent. But as important parts of the logistical service element, robustness and resilience should be addressed in a supply chain or SCM analysis methodology. An example of this is presented in the CMSO methodology (Schneider *et al*. 1994), which emphasised robust lean supply chains for the automotive supply industry.

Before we proceed to a methodological approach to a vulnerability analysis, let us define some related terms.

Table 7.16. Definitions related to resilience and robustness (Asbjørnslett et al., 1999).

Mission	The system's ability to deliver products and services according to demand. In addition to make contemporary good performance, it is also part of the system's mission to prepare for its position in tomorrow's market. The mission covers both the systems vulnerability to deliver, as well as the vulnerability of the larger system due to the performance of the given system.
Resilient	A systems ability to absorb change without catastrophic failure, i.e. its ability to return to a stable state (still persist).
Robust	A systems ability to resist shock and return to do its intended mission and gain the same market position as it had before the shock.
Damage tolerance	A measure of a systems robustness w.r.t. a specific damage, i.e. the reduction in reliability of a system that has a specific damage but has not failed.
Threat	A stable, latent, adverse factor that may manifest itself in an accidental event.

Risk	Combination of the frequency, or probability, of occurrence and the consequences of a specified hazardous event.

A vulnerability analysis is aimed at a system's ability to up-keep its mission, i.e. the survivability of the system. This is different from a risk-analysis which focus on the consequences of human, environmental and property impacts of an accident.

Table 7.17. Differences between a risk and a vulnerability analysis.

Risk analysis	**Vulnerability analysis**
Focus; Human, environmental and property impacts. What can go wrong? How likely is it to happen? What are the consequences?	**Focus**; The survivability of the system. Extended set of threats and consequences. Are there adequate resources to mitigate and bring the system back to stability? When will new stability be reached?

In this respect a vulnerability analysis needs to focus on a greater set of threats than a risk analysis. The threats could be the direct causes of an accidental event, or they could be threats to barriers or safety functions that should prevent or reduce the consequence chain of the accidental event in developing. After the direct chain of consequences following from the accidental event has stabilised, the risk analysis ends, but then the vulnerability analysis focus on how one may bring the system back to a position in which it may up-keep its intended mission. This is presented below.

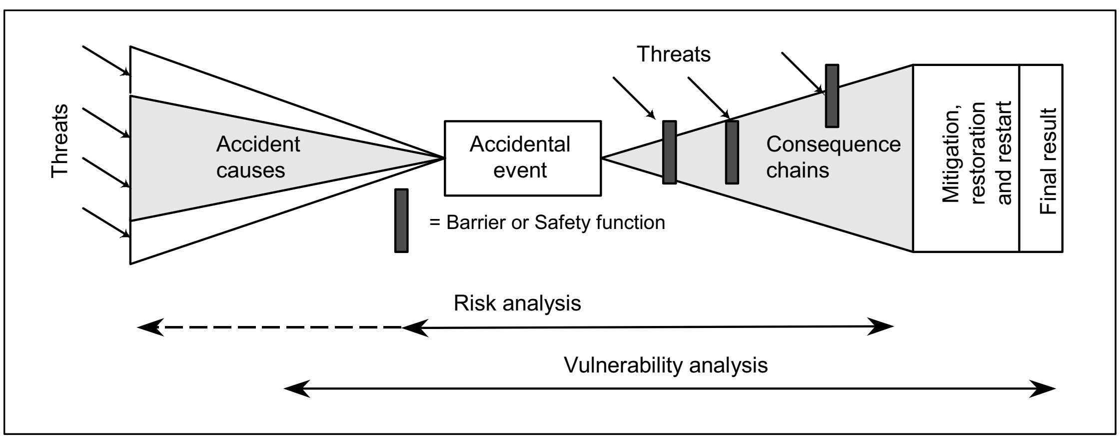


Figure 7.15. Difference between a risk analysis and a vulnerability analysis.

For analysis purposes, both robustness and resilience comes within the confines of vulnerability. The methodology described below outline the main elements of a vulnerability analysis that is suitable for analysing systems as found in the supply chain context[62].

The vulnerability analysis is based on a taxonomy of factors or threats that may contribute to the vulnerability of the system. The taxonomy is then used as basis when approaching the system through an input/output model that view the input and output from the system as either wanted or unwanted. On the input side there are required input and hostile input. The required input is what is needed to make the system function, and the hostile input is one part of what may threaten the system. On the output side the wanted output is related to the systems products and/or services, i.e. the mission of the system, and unwanted outputs that may naturally follow from the systems internal processes or due to internal malfunctions.

The vulnerability analysis is made up of two parts. The first part shall establish an overview of the potential scenarios, their immediate effects, and resources, systems and plans for mitigation, restoration, rebuilding etc. The second part is a quantitative analysis to establish an internal ranking of the scenarios, ranked by how critical they are (emergency to attend to).

Table 7.18. Vulnerability analysis part 1; Establishing scenarios and their attributes.

Threat	Scenario (Emergency)	Likely? (Yes/No)	Potential immediate affects?	Resources/systems/plans for mitigation, restoration, rebuilding, etc.		Remarks
				Internal	External	

The sequence of the analysis follows a potential route of an accident[63]. Identify threats, based on a taxonomy for the specific context in question, and describe scenarios. Rule out those scenarios which are not likely to occur (yes/no). Identify and describe potential immediate effects. Establish which internal and external resources, systems and plans are present to mitigate, restore or rebuild after an accident. The result is a list of scenarios that give a rough, overall picture of the vulnerability situation of the project demand/supply chain system.

[62] For a more detailed description about the vulnerability analysis methodology see Asbjørnslett *et al*. (1999) and Einarsson *et al*. (1998).

[63] The use of the term 'accident' shall here be regarded as both a wanted change, e.g. new technology, or unwanted change, e.g. due to the fall out of an established supply chain.

Table 7.19. Vulnerability analysis part 2; Quantitive assessment based on scenario criticality.

<table>
<tr><th colspan="2">Scenario (Emergency)</th><th rowspan="2">Likelihood of scenario</th><th colspan="4">Consequence of scenario</th><th colspan="2">Resource to mitigate, rebuild, restore, etc.</th><th rowspan="2">Total</th></tr>
<tr><th>No.</th><th>Description</th><th>Human impacts</th><th>Environmental impacts</th><th>Business impacts</th><th>Property impacts</th><th>Internal</th><th>External</th></tr>
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</table>

The second part of the vulnerability analysis establishes a criticality ranking of the scenarios. Each input is given a weight from four to one (the lower the rank, the better). The ranking of the scenarios are based on the sum ('Total'). Selective analysis can be performed by e.g. adding a factor to selective inputs. Time is an important factor with respect to all consequences, e.g. for the project context both in the development phase to secure schedule adherence and in the operations phase to re-establish production. The result is a list of critical scenarios that may be used 'backwards' to guide actions, e.g. how to reduce the likelihood and consequences of each scenario. With respect to reduction of likelihood measures to avoid or reduce a threat and measures to reduce the probability of an accidental event should be addressed. Then, with respect to reduction of consequences, measures related to design and passive barriers, then operations and active barriers, and finally measures to mitigate and restore should be addressed.

The result of the analysis should help in a proactive way to address how to deal with threats, events and consequences before they occur.

A good example of resilience (unplanned?) is the Sleipner substructure accident, were a new substructure had to be built after the original one sank, to secure the deliverables of the project object (1st mission – project development execution mission), and secure the committed deliveries of gas by the project object (2nd mission – project mission).

Further readings;

√ Asbjornslett et al. (1999). Article.

√ Bicheno, 2000.

√ CLM (1995). Chapter 9.

√ Cooper (1997). Article.

√ CRINE Network (1999); Chapter

√ Goranson (1999); Chapters 7, 9-12, and 14.

√ Lambert (1998). Article.

√ Schneider et al. (1994). Article.

√ SCOR (2000).

7.2.5 Develop project supply chain strategy

In the project atlas the project supply chain strategy shall guide both the development phase as well as the operations phase of the project demand/supply chain.

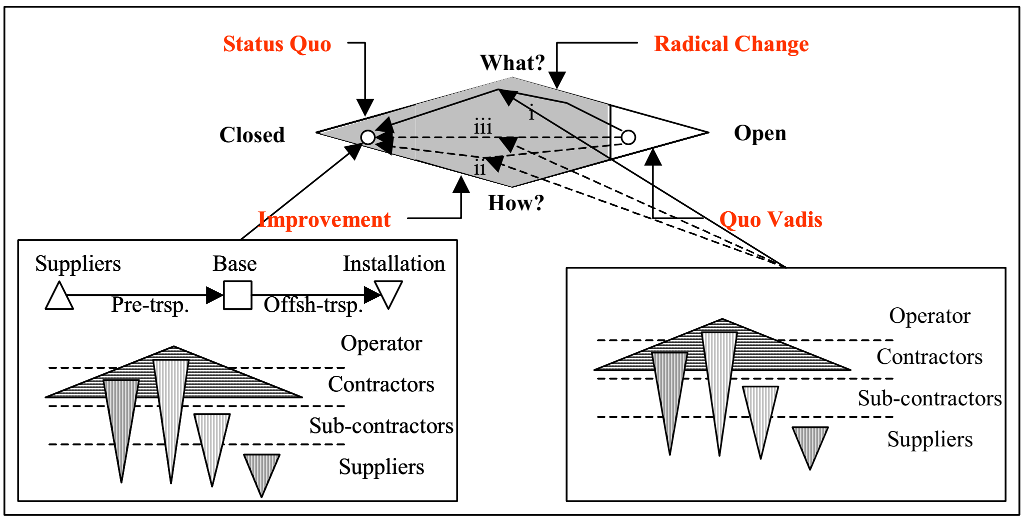

Figure 7.16. Develop project demand and supply chain strategy.

Here we have deliberately chosen the PSCM strategies, agile and resilient demand chain management and lean and robust supply chain management, for the development and operations phase respectively. Alternative strategies could be a lean supply chain management strategy for the development phase, e.g. as some operators propose with predefined 'packages' of technological solution and project supply chain. For the operations phase we believe that there will be one variant or another over the strategy chosen here, i.e. lean and robust supply chain management. The strategic choices will mostly be related to the operator's involvement and commitment as supply chain manager of the operations supply chain, i.e the spectrum of options between being fully in charge and operating every step of the supply chain himself, or fully outsourcing the supply chain management activities, thereby creating an outsourced gap between the suppliers and the operator's own project object in operation. This is in accordance with the proposal as set forth in the conclusion of chapter five;

Stage 4: Approach an **open project**, with a **rich (open) supply chain**.

Approach a **closed project** with a **lean (closed) supply chain**.

The supply chain strategy is the responsibility and task of the operator, but the rest of the demand/supply chain should be involved as the strategy should be open, and used as part of the project vision and definition as laid out in part one above. The strategy is also to be established concurrently and in interaction with the four parts above.

Further readings;

√ ACTIVE 1998. VEP 1.7, 3.1, 5.2, 6.1, 6.2, 7.2, 7.4

√ Burton et al. (1999). Article.

√ CRINE Network (1999); Chapter 7.

√ Harrison et al. (1996). Article.

√ Trigeorgis (1997). Chapter 8–9.

7.2.6 Select project development and operations alternative

In the project atlas we have now come to the point where both the development and operations strategy is to be committed to through selecting project development and operation alternative. This is a selection point where each company among the license owners have their own agenda in optimising the outcome as part of their own portfolio of stakes in licenses.

'[A decision] is simply a moment in an ongoing process of evaluating alternatives for meeting an objective. It is the moment when a decision maker selects the course of action that appears most likely to result in the attainment of the objective' (Harrison 1995, p. 27).

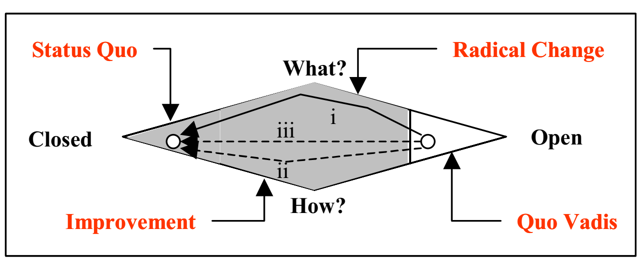

Figure 7.17. Select project development and operations concept.

In this decision point there are a set of stakeholder interests that has to meet and be aligned. Among the directly involved stakeholders are the government of the nation where the petroleum resources are located, the license owners, the company(ies) that shall develop and operate the license as Operator(s), and the actors of the demand and supply chain of the industry.

The nation's interest are with respect to the long term development of the continental shelf and depletion of the hydrocarbon resources, e.g. future opportunities in the field region, growth national and regional of suppliers, future development of related onshore industry due to field development (e.g. base and supply activities, or industry using gas or oil as feed-stock). The nations interest in the development of the license is formalised in the concession process. The programmed[64] decision process in the oil and gas context;

1. Concession round – concessions to develop a field are given to licensees and operator(s) for development and operations is (are) nominated.

2. Development and operations alternatives are researched and decided upon (supply chain actors may be selected, committed and work commenced pending on approval of PDO).

3. Plan for development and operations (PDO)[65] are sent to the Governments for approval.

Especially point two above should be noted with respect to project supply chain management as this enables the project demand and supply chain to commence the work, pending on the approval of the concession. However, the risk for sunk cost if the concession is not approved has to be covered by the project owner(s).

This formal concession process and the underlying interests of the nation, handled by the Government, has to be acknowledged by the companies in their decision making process, or as Harrison states;

'Because organisations exists within the society's economic system, managers need to be responsive to the total society's decisions and the reasons for them' (Harrison 1995, p.17).

The interest of the licensees' lies among others in the potential for synergies across own operator licensees with new field development. The operator(s) have interest in developing and benefiting from synergies across several of the operator's own operated installations. While the demand and supply chain's involvement and interest lies in developing own solutions, products and supply chain capabilities and competence.

Further readings;

√ Harrison (1995).

[64] Programmed according to Herbert A. Simon in Harrison (1995, p.17).

[65] In Norwegian; Plan for utbygging og drift, PUD.

7.2.7 Activate and execute the project development supply chain

In the project atlas the focus is now on the execution, or the project planning and control domain. The focus should as such be on logistics and materials management. This may typically be presented as a check list set-up, and we will here present two check lists from one source (Kerridge, 1987), some general considerations from a researcher (Silver, 1986), and some experiences from an alliance project (Harrison et al., 1996).

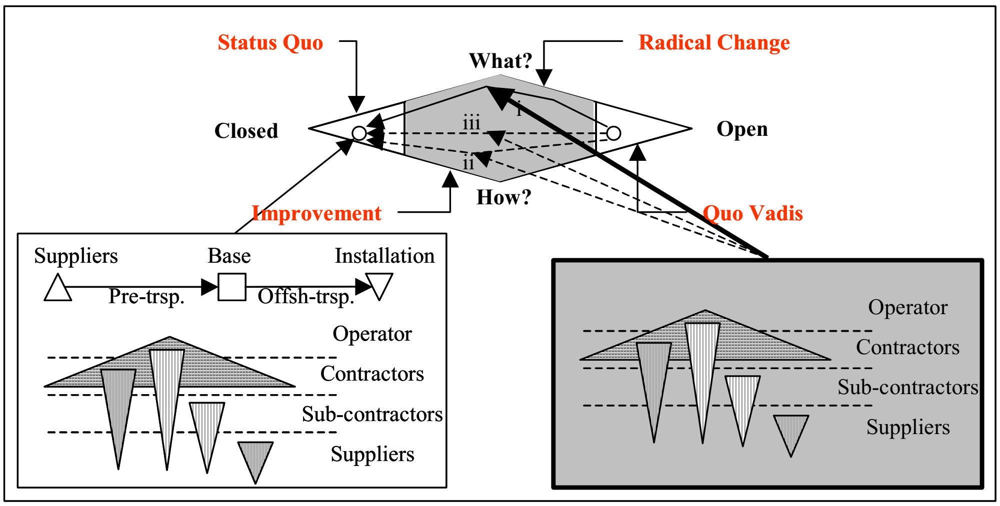

Figure 7.18. Activate and execute the project development supply chain.

Silver (1986) has given the following list of procurement and logistics activities in project development phases;

‘**Feasibility**: estimate cost of major items, estimate availability and lead times of critical items.

Bid preparation: Identify long lead items, do logistics study, develop list of vendors for project, determine an order of magnitude budget.

Planning (owners): Contribute to specifications of requirements, pre-screen contractors, evaluate bids, take part in negotiations, review material management organization and procedures of selected EPC’s, develop material management plan for owner procurement/ logistics.

Planning (contractors): Prepare project procurement plan of execution, firm up long lead items, interface with scheduling, identify oversize equipment.

Detailed design: Have design done as quickly as possible on long lead items, work with engineers in the timely development of requisitions, review inspection needs with engineering, advise engineering of weight and size limitations from the standpoint of logistics.

Procurement: Receive requests for quotations, prepare and process purchasing/subcontract requisitions, receive and evaluate bids, write purchase orders, expedite, inspect, arrange and monitor transportation, prepare material receiving reports, maintain appropriate documentation, (owner) monitor contractor’s material management activities.

Construction: Check when installation of key equipment is possible and how it will be handled, influence construction schedule when appropriate, receive goods, warehouse and manage inventories on site.

Commissioning: Dispose of surplus, roll over history of equipment to operations (ability to track back to vendors and specifications), ensure availability of spare parts, operating and maintenance instructions, make appropriate back-charges to suppliers for field corrections' (Silver, 1986).

A more thorough check list for materials management in project execution is given by Kerridge (1987). Kerridge's check list is presented in table 7.20 below. For a full and specific discussion of each bullet point in the check lists see Kerridge (1987).

Table 7.20. Materials management checklist – Materials of construction.

Material cost optimisation	Engineer vs. procure vs. construct Vendor engineering Component standardisation/rationalisation Shop vs. field fabricate
Material responsibility	Material take-off (MTO) Requisitioning Purchasing Expediting Inspection Installation
Material control planning	Quantity take-offs (prelim/intermediate) Material quantity trending Growth allowance Construction allowance Surplus material disposal Spare parts
Material sourcing	Local vs. world supply Mill vs. stock supply Package deals Sole source negotiations Blanket orders Package plant Modular design Project financing constraints
Material shipping	Protective packaging Containerisation Assembly and marshalling
Material scheduling	Field need date Critical material items Early vendor selection Schedule vs. cost considerations Early bulk ordering
Subcontracts	Subcontracted engineering Subcontracted material supply Combined subcontracts
Field material control	Field warehousing Field material purchasing Damaged/missing material replacement

Kerridge has also established a check or reference list over materials management responsibilities in the project execution phase. That list is presented in table 7.21 below.

Table 7.21. Material management responsibilities.

Engineering	Material selection and specification
	Material quantities by drawing, by line and by item
	Material quality control
	Technical and drawing review of vendor information
	Application of material identification codes
	Material cost control with regard to quality and quantity
	Material quantities and requisitions to schedule requirements
Procurement	Vendor selection
	Issuance of inquires and commercial review of bids
	Purchase orders, subcontracts and purchase order changes
	Vendor expediting and inspection
	Transportation logistics
	Specification of packing, tagging and identification requirements
	Material cost control with regard to overall cost and unit rates
	Delivery of materials to schedule requirements
Construction	Establishing onsite required dates for all materials
	Setting erection sequences
	Field receipt, inspection and/or rejection
	Field warehousing
	Field identification coding and tagging
	Issuance of material shortage, damage and excess notifications
	Purchase of field sourced materials
	Installation of materials to specifications and drawings
	Installation to schedule requirements
Project controls	Establish scheduled dates for material acquisition cycles
	Issue approved budgets for materials – quantities, unit rates, costs
	Maintain approved equipment list
	Establish material tagging and identification codes
	Monitor, track material performance (quantities and costs)
	Issue material status/exception reports
	Receive, verify invoices vs. purchase orders
	Pay approved invoices

In addition to Kerridge's check list a sum up of purchasing and materials management from an alliance project should be mentioned (Harrison et al., 1996).

√ Bulk steel procurement was better carried out by the fabricator, and not by the design office, as the fabricator is better placed to perform material take-offs, knowing his own approach to nesting and hence judging cut and waste.

√ Late arrival of quality vendor documentation (as usual on a project).

√ Look at the procurement process to take into account data which could be provided at order, data which is unavailable until the item is built, and that the vendor has also to go through a design, procure and manufacture cycle.

√ For significant packages, have much closer peer-to-peer interaction in the early stages of an order, rather than waiting until drawings appear and it is too late.

- √ offer appropriate incentive schemes – delaying payment only works if the amount are significant, and penalties are difficult to enforce, particularly if the item is delivery critical.
- √ Make greater use of long-term call-off supply agreements – especially as individual projects get smaller and their ability to influence becomes more marginal.
- √ Establishing and maintaining a good relationship between engineering, procurement and the construction site(s) pays off many-fold (Harrison et al., 1996).

Logistics and materials management in project execution is a comprehensive field, where both the ‘devil is in the details, but so is also salvation’. In the references under further readings you will find a comprehensive coverage of the topic, from different approaches and industries.

Further readings;

- √ ACTIVE 1998. AP7.
- √ Burton et al. 1999.
- √ CAPS 1997, I and II.
- √ CII 1988.
- √ CRINE 1999-B.
- √ Harrison et al. 1996.
- √ IPA 1995.
- √ Kerridge 1987.
- √ O’Brien 1995.
- √ Pahkala, 1997.
- √ SBI, 1995.
- √ Stukhart, 1995.

7.2.8 Preparation for and start-up of operations supply chain.

The main structure of the operations supply chain was established through the concession for the license that the project was developed to exploit, as well as when the concept for development and operations were chosen. Spare parts programmes and related supplier contracts are also part of the scope of work of the development phase. However, the operations supply chain has to be configured, planned and established before operations commence.

The project is now brought into a closed mode and the focus is on the operational supply chain, from suppliers via pre-transport into the supply base, supply base operations, offshore transport, and the demand situation at the offshore installation. This is shown in figure 7.19.

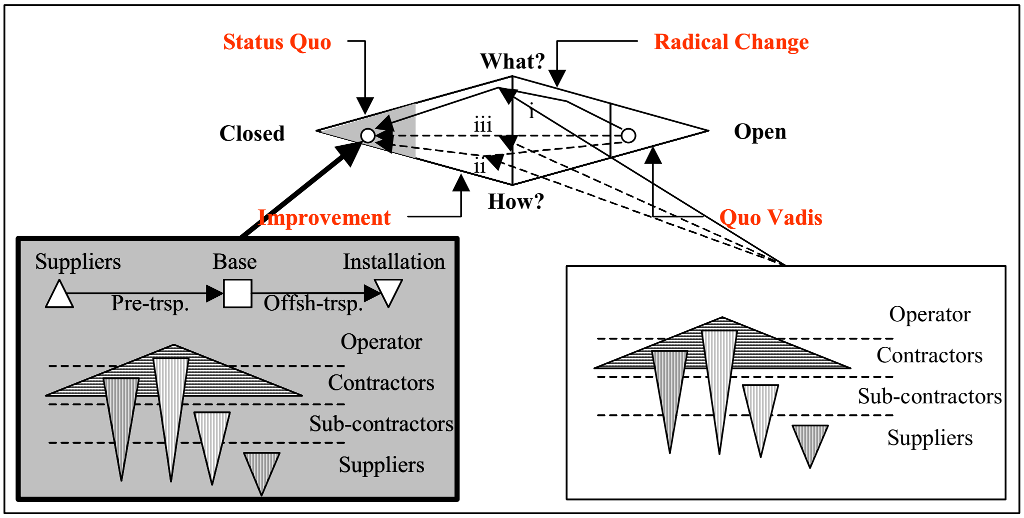

Figure 7.19. Preparation for and start-up of operations supply chain.

Operations programmes

The demand requirements have already been established for the offshore installation, through spare parts programmes, number of personnel located offshore. In addition one now have to plan the operations programme, including drilling programmes. This will impact the deck space needed for drilling tubes, equipment, and general operations supplies, as well as bulk products such as concrete, drilling chemicals, etc.

Good planning and communication of the operations programmes are a prerequisite to be able to establish a cost-effective and robust supply services scheme.

Supply categories, supply volumes and service requirements

The operations supply chain cover several categories of supply. The supply could be grouped into the following six categories:

- Food and consumables.
- Operations supplies.
- Drilling material.
- Drill-tubes.

- General bulk.
- Operations chemicals.

Each category will have its specific demand characteristics and supply service requirements, therefore they should be treated independently for planning purposes, but collectively for developing the total scope of the supply services infrastructure and resources. E.g. could the volume demand for supply of food and consumables be treated as a constant, except for e.g. maintenance periods with increased manning offshore. Drilling equipment, or more specifically all rental equipment, will also have a return process, as it is important to bring the rented equipment back onshore after it has been used offshore to prevent unnecessary costs through increasing the rental period.

Approaching the different service requirements per supply category has many similarities with the CMSO methodology (Schneider *et al*. 1994) and could be used accordingly for the operations supply chain categories.

Establish supply chain

The supply chain infrastructure has partly been established through the concession and the development and operations concept. The localisation of the supply base(s), and suppliers for spare parts has been established, as well as drilling and maintenance and modification contractors would also be committed to. Then one have to establish the warehousing nodes and transport modes to link the supply chain together.

Storage of spare parts, consumables, equipment and bulk material could be at warehouses at suppliers site, at base, or offshore. The criticality of the goods and the lead-time from storage to offshore use, the potential for shared use and synergy will decide where the different goods should be stored.

For all goods stored before the supply base in the supply chain, pre-transport is needed to bring the goods from the supplier or external warehouse and to the supply base. In addition, the same mode of transport or transport system may have to be used for 'post-transport' back to the supplier or external warehouse, e.g. for rental equipment.

The supply base must be equipped to handle the goods needed for the installations it is set to serve, e.g. storage of drill-tubes, storage tanks for different types of bulk products, repair shop for small repairs, and if required a sub-sea equipment pool.

To bring the goods from the supply base to the offshore installation in a cost-effective manner an appropriate supply vessels scheme is needed. First the total demand for supply vessel capacity, both with regard to deck-space and bulk storage capacity has to be levelled. This should be done to optimise the number and size of vessels needed to cover the whole supply operation, both for the specific installation and for other installations that go in the same supply vessel scheme. When the overall capacity is established one need to plan the sailing routes and schedules of the supply vessels, so that it will cover the service requirements of the specific installations, e.g. needed frequency of vessel calls per week, as well as give the installations a fixed and known schedule to plan from. The schedule must also meet specific time related requirements of the installations, e.g. installations that are closed during night hours for vessel calls. The vessel capacity levelling and the route planning and fixing of schedules need to be revised periodically to optimise the supply vessel scheme as requirements changes.

Then the loading of each vessel needs to be planned on a daily basis. This cover both planning of the deck space and the bulk tanks. Specifically stowage and segregation plans need to obey the rules for dangerous goods, as well as prepare for safe and easy un-loading and loading offshore in accordance with the route of installations that are called.

So in summary for the supply vessel operations, there are three main elements;

- Capacity levelling
- Route planning and fixing schedules
- Deck and bulk planning – stowage and segregation.

Operations supply chain management

Operations supply chain management is an important role for the operator. Much of the scope of work in the operations supply chain may be outsourced to actors that have specific functions as their core business, but the management role of the supply chain should be kept as the operator's role and responsibility. Below we list and comment some elements that we mean are relevant for the management role.

Customer supply agreements

The customer, i.e. here the offshore operations organisation, is maybe the one actor and stakeholder in the operations supply chain that could contribute the most in the continuous development of the supply chain, and the management of it. To make the customer a committed part of the supply chain, that understand and take a responsible role in the continuous development and improvement of the supply chain, supply agreements should be established between the provider of the supply services and the customer(s).

Standard and special services

Some of the actors within the operations supply context has said that '10% of the supplies on a daily basis are controlled or controllable, 90% is a "surprise"' – this put a considerable amount of stress on the standard supply system, and necessitates that the situation is turned around so that one get a 90/10 situation in stead of a 10/90 situation. This should be achieved through better commitment from all actors in and stakeholders to the supply system, as well as separating clearly between standard supply services to cover the planned situations and special supply services that cover requirements and situations that will put to much strain on the standard system. This means that the standard supply system should cover the 90% controllable situations + 5% of the special, uncontrollable situations, and that special supply configurations should cover the remaining 5% of the special, incontrollable situations so that these does not destroy the 'optimal' standard supply system. Special requirements e.g. due to incidents in the supply chain, specific one-off demand etc., should not penalise all customers of the supply system depending on the service level of the standard supply system scheme.

A differentiation between standard and special services may be seen as optimising a lean basis, with an agile top. Establishing the special services as a specific element, to be treated separately, but not necessarily executed separately, shall also secure that the standard operations are kept as an element for optimisation on its own, not to be overly disturbed by 'special' requirements and ad-hoc 'requests'. This should also contribute to focusing the customers, i.e. the offshore installations, on utilising the standard system to its full extent, and thereby improve their own cost position with respect to logistics services.

<u>Operations supply centre</u>

Each installation could come in contact with the supply chain through several points of contact. They could either go through the procurement part of the onshore operations organisation, the base organisation, or directly to the suppliers. These points of contact with the supply chain could also be reached through various means, e.g. phone, fax, e-mail, or through information and communication systems. All these contact points and means make the supply ordering and contact process rather diverse, with many potentials for mistakes and with the potential for loosing overview of the supply situation.

Such an operation supply centre should be organised with various functions co-located to facilitate short communication lines and 'hands-on' management from the team operating the centre. Communication wise, the centre should be supported by technological means so that all order and supply information is routed through the centre, and with 'single points of contact', e.g. specific phone and fax number, e-mail and system access so that a 'one-number' principle lead directly to the centre, but with multiple line access to avoid bottlenecks.

Such an organisation would enhance the 'visibility' of the supply chain operations. Both for the customers and suppliers interacting with the demand and supply chain through a single point of contact, and for the supply services that bring the operational management of the demand and supply chains into one cross-functional unit. It should be noted that the intention should not be to have one centre for all supply operations on the continental shelf, but one centre per supply base.

Further readings:

√ Bicheno (1999); Chapters 'Philosophy', pp.12-29, 'Planning', pp.30-40, 'Analysis and mapping', pp.67-109, 'Improvement' pp.110-134, and 'Suppliers and distribution', pp.178-183.

√ CRINE Network (1999-B). Chapters 1-6, and 8.

√ Fagerholt et al. (2000); Article.

√ Schneider et al. (1994). Article.

√ Statoil Operations Supply Strategy, 2002.

7.2.9 Re-configure and improve operations supply chain

After the project object or installation is set into operations, and operations programmes develop, the supply requirements will change. So will the supply requirements of other installations, both of the same operator, as well as for other operators. As the supply requirements change with time, this has to be paid attention to, to continuously develop and improve the operations supply chain along lean principles. In the project atlas the focus is now not only on the operations supply chain of the one installation, but also on synergies with other installations.

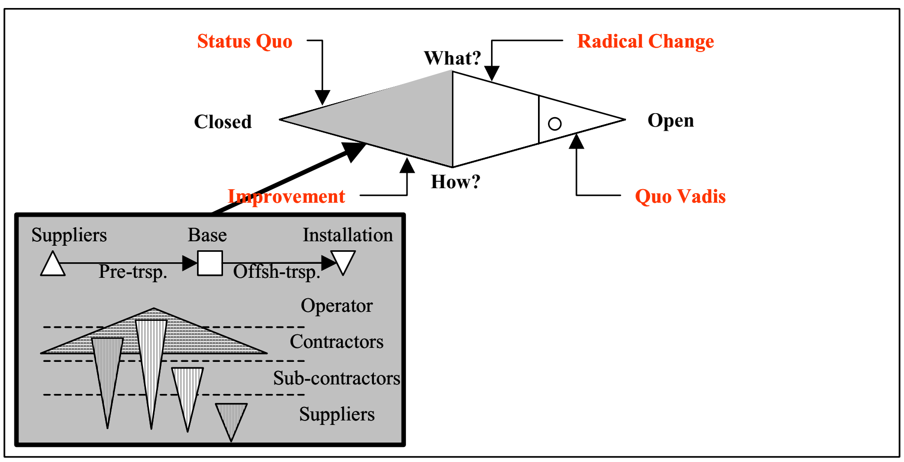

Figure 7.20. Reconfiguration and continuous improvement of the operations supply chain as the supply context changes.

A question in this respect is what is changing. There could be:

√ Changes in supply volumes and requirements, e.g. due to end of drilling programmes, or changes in production programmes.

√ Installations in the same supply system configuration close down.

√ New installations, or modifications, that commence operation.

√ Changes in the supplier base, old ones are terminated, new ones established.

√ Changes in supply requirements across supply regions.

Given such periodic changes, what should be done to adapt to them and to make sure that one are able to optimise to the changing situation and draw benefit from new opportunities;

- √ Analysis of the changes in the supply demand requirements. Both for the installation in focus, but also across installations within the supply region, for existing and potentially new partners.
- √ Mapping of changes in the demand/supply chains.
- √ Analysis of resource utilisation; suppliers, pre-transport, supply bases, and supply vessels.
- √ Analysing potential for new synergy driven collaboration across operators.
- √ Address limiting factors.

Demand analysis

Periodic updating of the demand for supply services per installation is the basis for adjusting and adapting the supply services. The demand analysis is especially important to set the scheme for and optimise the 'standard' supply services.

Supply chain mapping

Above we gave reference to a set of approaches to mapping the demand and supply chain. Most of these have continuous improvement as their aim, and the project operations supply chain as it was mapped when it was established may be used as a baseline. However, as the operations supply chain develop with the progress and development of the offshore operations and supply requirements, there is needed to do revised mapping of the operations supply chain.

The mapping should be the basis for the continuous development activities of the operations supply chain. The continuous development activities comprise improvement of the supply processes as part of the operations supply chain management activities, both for standard and 'special' services, adapted and improved utilisation of the supply infrastructure as the supply requirements and cross-installation supply configuration changes, as well as understanding the potential for and initiating synergies across installations and operators.

Optimised utilisation of infrastructure and resources

Along with the offshore oil and gas field developments, the infrastructure of the operations suppliers and the supply bases are being developed. Much of these developments are due to regional, geographic reasons, to be able to supply and reach the offshore installation(s) with a supply vessel from a supply base, within time- and cost-effective acceptable limits.

The supplier and supply base infrastructure is also part of the concessions of each field development. This is often the Government's way of securing regional benefit of offshore field developments. However, there may be situations where the onshore supply infrastructure has to be the target for reconfiguration to secure the profitability and lifespan of the offshore installations. As such the conditions stated in the concessions may have to be challenged. This is further addressed below.

Collaboration and alliances

Changing supply requirements does often open up for co-operating with new partners to exploit new potentials of synergy. E.g. new supply requirements could mean that new supply vessel routes and schedules could be improved through establishing collaborative sailing schemes with other operators, or others than the operators one are presently collaborating with. This presumes an understanding among operators that the basis for collaboration will change, and that periodic analysis and adjustments to the collaborative configuration have to be made, including termination of old collaborations.

Limiting factors

In realising the potential for supply synergies across installations and operators, one will eventually find potential for synergies in the scope of work and structure of the supply bases. This could e.g. mean that some services could be located at one or a few bases, or e.g. that the operations of several bases within one region could be gathered at one or a fewer set of bases, e.g. as the supply volumes are reduced and fewer bases are capable of covering all supply operations in one region. This could mean substantial improvement in the supply cost position.

However, the scope of work and supply structure of the supply bases for the Norwegian Continental Shelf is part of the concession for each installation. This means that e.g. it is specifically stated in the concession from which base each installation shall be supplied, and there is also stated what scope of work shall be covered from each base for each installation, as well as the amount of personnel resources of different categories, e.g. procurement, that shall serve a specific installation from a specific base. This will eventually become a limiting factor for realising supply potential as the supply requirements are reduced.

This means that the concession based requirements for the supply services structure will eventually become a cost disadvantage for operations of the offshore installations and should therefore at one time be evaluated against the initial intentions of the concession. This means that even the concession requirements should be a factor for revision as the supply situation of the offshore installations change.

Further readings;

√ See under 7.2.8 above.

7.3 Summary

Above in the introduction to this chapter we stated that:

'Methodological guidelines should as such meet the aim of the future research proposals set out by Lambert *et al*. to '*guide managers in the effort to develop and manage their supply chains*', in this case in the project context. Given that a project's supply network is not fully developed the methodological guidelines should help to build an understanding of important aspects to address up-front. The methodological guidelines should as well be of help in the process of developing and analysing the supply network and processes that will be activated when the development and operations phases of the project starts'.

The guidelines given above should help in this. They are not comprehensive in all aspects, it could also be improved in its form, but should help in understanding the process as well as address some constructive elements in demand and supply chain analysis for the project setting. That was also the intention.

8. Conclusions

This chapter concludes this thesis by asking whether something new has been brought forward through this work, assessing how the objectives are met and assessing the applicability of this work.

8.1 PSCM – ”Old wine in a new bottle”?

Within the wine industry, old grapes have been ’exported’ to new areas, developed and resulted in good wine. Though the grapes are ‘old’ they still have ’capacity’ to develop and make good results in a new area, and be acknowledged by the consumers – often based on a quality to price ratio. In this thesis supply chain management may be regarded as grapes. The new area, the ‘Promised Land’ for supply chain management to make a contribution, is the project-oriented context and within project management. As old grapes in a new area makes a wine that have similarities with wine based on the old grapes in their area of origin, it still has its own characteristics that make it unique. The same may be said about project supply chain management in the project context.

There are many similarities between supply chain management in the repetitive, continuous business and industrial context and in the project-oriented context. Though, there are certain characteristics that are more important, or should be given more emphasis in the project-oriented context than in the business or industrial context, and vice versa. Therefore, project supply chain management may be said to be “new wine in a new bottle”. On the other side, if the wine is seen as a remedy or cure or to improve something, project supply chain management may be “old wine in a new bottle”. The wine, now seen as supply chain management, i.e. the remedy, is old, but it needs a new bottle, here seen as a format, to fit the remedy to the project-oriented context. In either way, supply chain management has become a necessity. Organisations focus more on their core competence and out-source the rest, there is a need or desire to be able to plan and execute faster, though at the same time relying more on the external supply chain than before. Thereby the supply chain becomes the competitive unit, not only the individual company.

However, project supply chain management is only one approach to fit supply chain management to the project-oriented context in such a way that it leads attention to what is important in the different phases of the project or the life-cycle of the project object. As business value for all supply chain actors is the aim, the right analogy to use should therefore be “new wine based on old grapes in a new area gives value to both customer and suppliers”. To summarise, ‘old wine in a new bottle’, is not to be regarded as just brushing up some old ideas, but rather a necessity to bring ideas, concepts and methods from one domain of knowledge and application to another. That could give results and benefit both to the ‘adopting’ domain of application, as well as the ‘parent’ domain of application.

8.2 Recapturing the objectives

In chapter two the objectives of this thesis was summarised as to;

- **'Develop** principles and concepts of logistics and supply chain management in the project context.
- **Demonstrate** these principles and concepts through theoretical and empirical examples.
- **Apply** these principles and concepts, through methodological guidelines for analysis.'

Now it is time to ask whether we have obtained these objectives? The first objective, *to develop*, is obtained through the development of the PSCM concept and guidelines. The second objective, *to demonstrate*, is done to some extent through the text, but we still miss a full demonstration through one or more case studies. That is a weakness with this research. The third objective, *to apply*, has been covered as it is formulated above, 'through methodological guidelines for analysis'. However, the PSCM development, both the concept and the guidelines, should have been applied to a real case, to test and revise elements of both the concept and the guidelines. We have not been able to do this, and it must therefore be left for further studies.

We did also formulate three part objectives to support the main objectives;

1. 'Determine if there exists present work or approaches that are suitable to use with respect to developing and proposing the use of logistics and supply chain management within the project-oriented context of the oil & gas industry, through a survey of existing research on project management and supply chain management.
2. Determine competitive aspects or elements of logistics and supply chain management that are more important than others to relate to and use within the project context as found in the oil & gas industry.
3. Structure and adapt existing theory as a guidance to practical use – formulate a concept (or 'frame of mind') and develop methodological guidelines for an approach to logistics and supply chain management within the project context of the oil & gas industry.

Below in Table 8.1 we have summarised how and where these part objectives has been covered in this thesis.

Table 8.1. The fulfilment of the part objectives set for this thesis.

Part objectives, covered in;	
1	This is covered in chapters 3 and 4, specifically in the earlier developments in sub-chapter 4.5.
2	This is covered through the outlining of the oil and gas supply chain challenge in chapter 5, preceded through the theoretical outlining in chapters 3 and 4.
3	This is covered in the development of the project supply chain management concept in chapter 6, and the methodological guidelines in chapter 7. The methodological guidelines in chapter 7 are sought developed along the life-cycle of a project.

If we return to the aim of this study as set by Arbnor & Bjerke's (1997) systems approach and presented in chapter two, we have *determined* the type of the system, not fully *described* the system in detail, but given a *guide* in how to approach to see the system from a logistics point of view.

The basis of this research has been theoretical studies, and empirical input and reflections about demand and supply chain issues given by several actors related to the project demand and supply chain in the petroleum industry around the North Sea basin, as well as open empirical sources of information. The studies of the project-oriented supply chains and the other sources of empirical material may be regarded as one 'case'. This is due to the nature of the research, which are conceptual development as well as methodological outlining. The 'case' as such is not specific projects and supply chains per se, but the 'industry' of the project context, its actors and processes that are involved in the 'problem' and context to be studied. This may be said to be in line with the research approach as given by Arbnor et al. (1997).

'Let us only say that it is important to understand historical material from its own contemporary perspective, which often requires extensive studies of the spirit of the times in the environment of the system being moulded' (Arbnor & Bjerke, 1997, p. 241).

8.3 Usefulness of the project supply chain management concept

'The requirement [for validation in the systems approach] is not so much that definitions must correspond with existing theory or be operational, as that they are perceived to be important and relevant to the creator of knowledge as well as to other participants from the real system engaged in the process of creating knowledge' (Arbnor & Bjerke, 1997, p.234)

As outlined in chapter two and above, we have not been able to demonstrate or apply the PSCM development versus one or more real cases. But following Arbnor & Bjerke's comment above, we will here relate the PSCM development to some theoretical and empirical sources that we have had access to. On the theoretical side we relate the PSCM developments to the earlier approaches to logistics and supply chain management as given in chapter four, and the areas for further improvements post-NORSOK as given in chapter two. To discuss the PSCM developments against practical challenges in the industry we use the results of two industry workshops that we arranged, given in appendix D and E, and some challenges and recommendations that we got in interviews with actors and stakeholders in the project demand and supply chain of the petroleum industry.

8.3.1 The PSCM development versus theory

PSCM versus earlier approaches

Here we will compare the earlier approaches to logistics and supply chain management in different project contexts, as outlined in chapter four, with the project supply chain management concept and guidelines, as presented in chapter six and seven.

Silver (1986 & 1988) is the first author we found to address the logistics and supply chain management challenges of the project context of the petroleum industry. Silver raises some questions or challenges related to the subject. Among them he raises the aspect of uncertainty and the design change process, which is the basis for the agile and resilient demand chain management perspective of the development phase in the PSCM concept, supported by the agile development aspect in the PSCM guidelines. It is also an aim of the PSCM development that it shall contribute to the degree of a more proactive attitude towards logistics and supply chain management in the project context, as Silver questions.

The supply chain management initiative of the CRINE Network was established two years after this research commenced. CRINE Networks treatment of the subject is comprehensive and interesting, and the PSCM development has many similarities with their objectives. The contribution that the PSCM development bring along that CRINE Network does not address is the distinction between the characteristics and approaches to the two phases, development and operations, of the project life cycle, that should help in focusing the difference in the challenge. Further, the PSCM guidelines bring in addition to CRINE Networks methodology, another perspective on the project vision process, and its relation to the project supply chain, the guidelines to agile development, as well as the specific guidelines to the operations phase. The resilient versus robust dimensions of the service aspect is neither addressed by CRINE Network. However, CRINE Network's supply chain management initiative comprised a broad industry initiative, and as such has covered more practical elements that we have been able to in this study. The CRINE Network initiative has also been established as an independent entity through the Logic-Oil establishment.

Burton et al. (1999) address the aspect of strategic supply initiatives in the oil and gas industry, and its relation to financial advantage. This is an element that is not covered through the PSCM developments. One relation may though be found in the operations phase, e.g. collaboration between installations and operators for supply vessel services and supply base services. Operator frame agreements and contracts do also fall within this category, but has not been treated specifically in the PSCM developments.

The PSCM development does neither address the specific material administration part of the development phase of the project, as e.g. Kerridge (1987-I & -II), CII (1988) and Stukhart (1995) does. Especially CII and Stukhart's contributions are comprehensive in this field. This field is also partly covered in the textbooks on project management, planning and control, Harrison (1992), Lock (1994) and Rolstadås (1997), though not to the same extent as the aforementioned authors. In relation to the text-books on project management, planning and control, the PSCM development could contribute with a new perspective on the challenges of management of the project and its demand and supply chains.

Three more authors, Byggforskningsrådet (1991), SBI (1995), and O'Brien (1995) address aspects of logistics and supply chain management within the construction industry. Compared to Byggforskningsrådet's industrial approach in trying to copy repetitive industrial logistics processes to the construction project context, the PSCM development break with that approach in separating between the one-of-a-kind development phase, from the repetitive operations phase. The total cost aspect as addressed by SBI, and further specified by O'Brien has not been specifically addressed in the PSCM development. However, the PSCM development is founded on the assumption that the underlying driver for the demand and supply chains contribution to the project should be value focused, through cost effectiveness in the development phase, i.e. cost is a generator of future value, not only a cost, and cost efficiency in the operations phase, i.e. the focus on the lean concept.

Pahkala et al. (1997) and Kanjii et al. (1998) address the total quality management aspect that underlay the lean development within supply chain management. This is only partly and indirectly addressed in the PSCM developments, as part of the guidelines for the operations phase.

Vollmann et al. (1995) introduced the demand chain management concept. This concept is taken directly into the PSCM development, and used specifically to address the development phase, as the demand management processes in this phase are regarded as the key driver for understanding the supply chain management challenge of this phase. Therefore we have used the term demand chain management specifically. We have also used horizontal partnering for the type of demand chain partnering between operator and a set of contractors and main suppliers in an alliance as Vollman et al. uses, as well as vertical partnering for the supply chain partnering from the contractor and downwards into the supply chain, as e.g. Schultzel et al. (1996) does in their description of Bechtel's multi project supplier agreements.

Vollmann's use of demand chain management could be furthered by the discussion of the differences between 'agile' and 'lean' approaches, and their reliance on the English and French engineering traditions[66] respectively. From Goransson's (1999) discussion of these one could argue that 'supply chain management' is a wrong term to use for the development phase. It could rather act as a 'contradiction in terms', as the most important part of the development phase is to enable value enhancement based on an agile, extended, or 'virtual' enterprise, within a short scope of time available for developing the project. This is in line with the commercially oriented, solution seeking English engineering tradition. A good example of this could be British Petroleum's Cleeton project (Harrisson *et al*. 1996), conducted as an alliance, where the prime objective for creating the alliance was to become able to enhance the value of the project and make it financially viable. The project, with British petroleum as Operator, that Vollman et al. comment in their article is developed in the same period and tradition as the Cleeton project in Harrison et al.

Compared to the earlier theoretical approaches the PSCM development has generally contributed with some new thoughts and perspectives, and specifically with the focus on the different characteristics of the development versus the operations phase of the project life-cycle, and some of the related methodological guidelines. There are however many aspects and areas that not has been covered by the PSCM development, especially the detailed studies of the material management processes.

[66] See Goranson (1999) for a discussion of the origin and differences between the British and French engineering traditions, and how these influenced the development of the North American engineering schools and their engineering tradition.

PSCM versus post-NORSOK recommendations

In chapter one we pointed to some of the main areas for improvement post-NORSOK, as presented by Kaasen (1999). These were the five areas of attitude and cooperation, better quality early, decision processes in development projects, support for further improvements, and level of activity.

For the first, attitude and cooperation, the PSCM concept and guidelines as developed here have a rather small contribution. There are however a couple of elements that could be useful. One is the first element of the PSCM guidelines in establishing a project vision. Establishing a project vision may unite the project supply chain, and especially regarding collaboration about contractual risk, which need the right attitude among the project stakeholders about the project's degree of openness. Another is use of the PSCM concept to build understanding, and thereby attitude about the challenge of the project demand and supply chain context and one approach to deal with this.

The second, better quality early, is a challenge for the more concurrent processes of the contemporary development and execution practice. The PSCM concept may help in this through the sharper focus on the need for agile capabilities in the demand processes and resilient capacities in the supply processes of the project development phase. Better quality early may as an alternative lead to a return to the earlier practices of the relay type of development and execution processes, were one may get improved control of the demand when orders are placed and the supply chain involved, but at a cost of longer duration. The PSCM development regard it as important, as a support to 'better quality early', that one see and acknowledges that in practice it is not possible to control all uncertainty, i.e. risk and opportunity elements, before committing the supply chain, and that one has to take account of this and be prepared and able to handle the remaining uncertainty in an 'engineering type' of approach. This is the basis for the agile and resilient demand chain management aspect of the development phase of the PSCM concept. This is also the aim of the 'agile development' part based on Goransson (1999), in step four of the PSCM guidelines.

The third, decision processes in development project, was related to the real function of the plan for development and operations, PDO. When the regulatory framework is such that one is allowed to make commitments with the project supply chain before PDO approval, then in practice the PDO is only a formal milestone for the demand and supply chain management in this project context. The PSCM development has no impact on this.

For the fourth area, support further improvements, the PSCM development in itself may contribute with a new way of thinking and bringing other dimensions into the improvement processes. As such the PSCM development could be one element in challenging established practice, and supporting further improvements. For the operations part of the PSCM concept and guidelines, they could directly contribute in establishing a basic fundament for continuous improvement, especially through step eight and nine of the PSCM methodological guidelines, but also with the concept's focus on lean and robust operations. The PSCM development could also contribute as part of competence development in being a framework to analyse previously executed development projects in, and for projects in operation.

For the fifth area, the level of activity in the industry, the market analysis part of the PSCM guidelines could be used. An even better source would be CRINE Network's methodology on this aspect. They have a good analysis of buyer versus provider positioning.

To conclude, the PSCM development does not cover all areas for further improvements post-NORSOK, but contribute with some elements that could give a constructive contribution, among others, to the ongoing improvement efforts of the competitiveness of the project context of the petroleum industry. These contributions does both bring new elements to and build on the earlier approaches presented in theory, as well as may give a contribution to the areas for further improvement post-NORSOK.

8.3.2 The PSCM development versus the industry's challenges

As stated above, we had to move away from developing three descriptive case studies. However, empirical material was collected through interviews, participation in meetings, as well as through two workshops that we arranged. The two workshops were related to topics that have impact on supply chain management within the project context of the petroleum industry. The first workshop was related to the project front end, the other to contract strategies. Below we will first discuss the PSCM development in relation to the front-end workshop, then the contract strategies workshop, and finally in relation to empirical input collected in some interviews.

Both workshops gathered representatives from several petroleum companies and contractors. The summary presentation of the front-end workshop is given in Appendix D, while the questionnaire and summary of the contract strategies workshop is given in Appendix E.

PSCM versus project front end workshop

The objective of the project front-end workshop was to establish recommendations for improving the awareness of the importance and challenges of the project front-end. The workshop was based on the assumption that the main objective of the project front-end is to develop the opportunity that the project shall realise, while concurrently reducing the inherent risk. Risk come as a result of something. This something is related to obtaining or reaching an expected end result, where the expected end result is the developed opportunity. The front-end must therefore balance the development of opportunities against risk reduction.

The main messages from the participants of the workshop was summarised into the following:

1. *Balancing opportunities and risks*; exploring and acting on potentials, clarifying contextual differences and implications, and understand-focus-check.

2. *Getting the project beyond sanction points and up to "big spend"*; financial justification, technical development (opportunity realisation), and supply chain involvement.

3. *Enhancing the ability to master speed and flexibility in project execution*; mental conflicts, classic to generic model, and decision making under uncertainty.

4. *Enhance the ability to reach or exceed an expected result*; proactive front end planning, build on experience, seek and understand current challenges, and align challenges and means.

Let us now relate these 'conclusions' from the workshop participants with the PSCM development. We refer to Appendix D for more details under each of the four points above that we bring into this discussion.

Regarding the first point the focus was on being able to act on potentials, when they were present, i.e. one should have agile capabilities and capacities. Developing opportunities is also a matter for the supply chain, or more precisely the demand chain in this phase, in developing the demand for supplies for the project object development. As such, developing the opportunity and reducing risks is a matter to be managed by the demand chain construction, involving both operator(s), contractor(s), and even suppliers of major or critical items. Another element under this point is the need to understand the project's position with respect to degree of openness. We have in the PSCM guidelines, used the project space as help in visualising this. Understanding the project's degree of openness, and relating this to the choice of execution model and demand and supply chain involvement, was also discussed in chapter five under the challenge of the oil and gas supply chain.

The second point addresses first the element of financial justification, and the stepwise process through sanction points. In the guidelines we referred to evaluation based on real option concepts that could fit a stepwise sanction process, and that at the same time could cover uncertainty, and take elements of flexibility into account. With respect to the technical side the focus was on how requirements change over time, which need support of an agile approach to the demand processes. It was also remarked that technological choices lead to commitment, and that if these are to be changed the supply chain should be resilient to be able loose up commitments made, and seek and make required new commitments. This point is only indirectly mentioned in the PSCM developments. Also in this point the involvement of the supply chain was mentioned as an important part, i.e. not the operator as one demand actor, but the operator and the 'supply chain' actors as a demand chain construction.

The third point, address first the engineering roles of the demand chain management construction. We discussed this in chapter five, in the roles of the intra-organisational project supply chain actors. Then the focus was on the transfer from a classic, relay oriented development process, to a more generic, concurrent process. In a generic, concurrent process one should prepare for flexibility, being able to manage both uncertainties and risks. The workshop participants stressed further that this necessitates decision-making under uncertainty, making decisions in spite of lack of complete information. The question then became how one could become confident about such a context? In the PSCM development we have taken the demand chain focus on this management setting, as outlined by the workshop participants. We have further pointed to the need for agile and resilient capabilities, capacities and methods, both directly and as sources of knowledge about how to cope with the given project context.

The fourth and last point focus on enhancing the ability to reach the expected result, i.e. being able to take the developments into the execution phase, and being able to manage the development all the way to and commence operations as planned. The focus is further on having a proactive attitude towards front end planning. As Silver (1986 & 1988) questioned the reactive versus proactive attitude, the workshop participants stressed proactive planning, including the project demand and supply chain. Being proactive includes planning for and managing moving targets, and aligning challenges and means, as we stated in chapter five, under the challenges of the oil and gas project supply chain. Our answer in the PSCM developments became, agile and resilient demand chain management for the project development phase.

A final point or message from the workshop participants was 'planning for success'. The message was that one should aim for;

'a good model of how to "move through" in a rational way, i.e. aligning and balancing based on an understanding of scope of work and the way of execution'.

The PSCM development follows the messages and meet some of the aspects as laid out by the workshop participants. The PSCM development, with the concept and guidelines, may therefore be **one contribution to a 'good model'** for developing the project together with the demand and supply chain, taking the inherent uncertainty, comprising both opportunities to be developed and risks to be managed into account. This should in the development phase be based on a conscious focus of the demand processes and demand chains, understanding the required agile needs and preparing for agile capabilities in a proactive way, including the demand chain, and resilient capacity in the supply chains.

PSCM versus the contract strategies workshop

The objective of the contract strategies workshop was to address and discuss the types and roles of contract strategies, in relation to the project context and the attitudes of the participants and stakeholders in the project value chain. As an assumption the workshop rested on a split between three generic groups of project strategies, namely;

1. Risk reducing strategies.
2. Opportunity seeking strategies.
3. Value enhancing strategies.

Up-front of the workshop the participants in the workshop got a questionnaire to use as preparation for the workshop, and to be discussed in the workshop. We will here discuss the PSCM development in relation to some of the main messages in the feedback that the workshop participants gave.

The mission of a contract strategy was seen to be a ‘communication tool’ internally and with the market, to signal the given approach to procurement and demand and supply chain management. In relation to the project management activities the contract strategy shall align and co-ordinate the project demand and supply chain with the project objectives, and supporting the project strategy. As such the contracts strategy shall be a ‘tool’ for establishing and managing the project’s inter-organisational demand and supply chain. Then how does this fit with the three generic project strategies and the PSCM development?

Of the three generic project strategies, the PSCM development seeks primarily to address opportunity seeking strategies. Value enhancing project strategies could both be risk reducing and opportunity seeking, as to balance out the realisation of the business opportunity that the project shall undertake and the inherent risks, as stated by the project front-end workshop. It should be noted that risk reducing project strategies were the ones felt necessary to use, but that the portfolio of contract strategies should be elevated. It was also said that the portfolio of different contract strategies should be elevated carefully. This is due to being sure that the division of risk among the project demand and supply chain, that a given type of contract strategy lead to, does not bring any stakeholder into a position not manageable. As the workshop participants stated, risk drives behaviour. If we relate this to the project strategies then one may say that the risk reducing strategy is a ‘safe’ choice for minimising and handling risk in the short term, i.e. for the given project. However, for the longer term, opportunity seeking project strategies drives further development, which supports long term competitiveness. As such the opportunity seeking strategies should, balanced against risk reducing strategies for parts of the project, be elevated with a good division of risk between the actors. This supports the common objectives between the operator and contractors, as future projects are their mutual source of future business. Therefore to meet both short and long-term needs a balanced attitude and ability should be developed to being able to handle both risk reducing approaches and opportunity seeking approaches, including the right type of contract strategy.

A risk reducing project strategy could be regarded as a lean approach. If the ‘lean supply’ philosophy should be carried out as a supply chain strategy for the development phase, then one may think of two scenarios. The first is the case of copying. A new project is developed based on copying an existing project and project object. This is a scenario that is much discussed, as it will always be considerable differences between two developments, both with respect to supply requirements and process, which make the ’copy’ into a ‘prototype’ of its own, i.e. the ordinary project situation. The other scenario is the one where an operator orders a product, i.e. a ‘project object’ from a fully integrated contractor. Then there are again two possibilities. The operator gives the contractor full freedom to develop based on the contractors own demand and supply chains. This may give lean supply execution both cost and time wise, seen from the side of the development phase. However, this may not bring with it a lean supply set-up for operations. To overcome the last one the operator often want the contractor to use the operator's supply chain, i.e. the operator's long term contracts and agreements. Then there is hardly possible for the contractor to achieve its intention of lean supply for the project object developments, but the operator come closer to achieving lean supply in the operations phase. Therefore, in sum it is possible to achieve lean supply in the operations phase, but that must be handled through taking the specifics of novelty and uncertainty in the project situation into account in the project development phase.

To be able to reuse approaches to project and contract strategies, it was stated that the principles that underlay almost all projects had to be addressed. Such principles were seen to be the primary conditions for re-use and continuous development, with secondary conditions that could be taken further from one project to another, but with correction for specialities in the new project context. The PSCM development is based on the opportunity seeking strategy as part of a value seeking project strategy. The development is based on a set of principles derived from the challenge of the project demand and supply chain, and the characteristics of the project. Related to contract strategies, in hindsight we believe that these should have been more strongly focused, and that this could have been a help to improve the PSCM development, through the use of a concept that most actors and stakeholders in the project demand and supply chain are familiar with.

PSCM versus comments from interviews with industrial representatives

Here we will discuss the PSCM development versus a set of interviews we have conducted with representatives related to the demand and supply chain of the project context of the petroleum industry. The representatives are from operators, contractors, and an interest organisation for the industry. The focus of the discussions is how their comments support the PSCM development.

The first interview we refer to was with a representative from an operator. This is another representative than the two referred to in the introduction to chapter seven. The representative's position was as head of procurement and demand and supply chain relations development within an operator, i.e. petroleum company. The interview was based on a discussion of the relations between the operator and the operators project specific demand and supply chains, and how a PSCM development should focus to become a basis to address this. The main message from the interview was that the PSCM development should be based on some underlying principles for demand and supply chain management in the project context of the petroleum industry. Based on the principles a concept should be developed that pursue these principles. Then methodological guidelines should be developed that they do not intent to be specific, but rather could act as a framework for developing more specific methodologies for demand and supply chain management in this project context. These recommendations were also in line with the recommendations from the supervisor of this research. We have followed these recommendations in the PSCM development, and believe that the PSCM concept meet these recommendations in a good manner, and that the PSCM guidelines meet them to some extent. However, especially the guidelines could have been revised and improved if they could have been applied in a specific setting. If they had been tested out, i.e. applied, in some specific project settings, than this could have given important information about their relevance for specific developments, as well as given a basis for revision of the guidelines. Therefore, the inability to test the guidelines is a shortcoming of this research.

The second interview we refer to was a set of interviews with a representative from an interest organisation of the Norwegian petroleum industry. The representative is a senior representative with long experience from working within a contractor company, and has followed the developments within project development and execution models within the industry for many years. The setting of the interviews was around a meeting he had with representatives from the British CRINE Network. As a basis for the discussions he referred to what was estimated to have the main contribution for further improvements in competitiveness for the Norwegian petroleum industry. The main contributions were estimated to based 50% on technology development, 30% on work process development, and 20% on change of contextual limitations. Being able to make use of technology development in project development has a relation to the work processes, and technology development will impact the demand processes and demand chain processes. Technology development could either take place between project, i.e. the contemporary principle, or in a project, either partly or fully, which was the ‘old’ principle. The ‘old’ principle of technology development within the projects, lead to longer duration of development, as well as brought more risk into the project. However, what should be remembered is that although the contemporary ‘established’ principle is that technology development shall take place between projects, in practice this will be challenged, both from the operator’s and contractor’s side. This lead to a degree of moving targets, or openness in the project, which change throughout the project development. A development and execution model that is based on moving targets is OK as such, but have to be reflected in the decision processes of the development and execution model. This requires a good communication between operator and contractor(s) and the rest of the supply chain. The representative gave example from a contemporary project, under development in 1999, where new demand in a rather large scale came up after demand decisions and specifications had been made and supply chains were activated. Then resilient processes had to come into effect, that revised the demand, closed down the existing supply chain, and established a new supply chain. These comments are important to remember when addressing the PSCM development, because although the contemporary principle is to conduct technology development between projects, in practice this has been hard to achieve. Therefore, in the development phase of the PSCM concept, we have focused on this through a specific awareness on the demand chain and the demand processes, the need for agile capabilities and capacities to meet such moving targets, and the need for resilient approaches and capacities towards the supply chains, to be able to secure the logistics service aspects for the project. We believe that we met this representatives comments in the PSCM development, however there are many aspects that was mentioned that we have not covered extensively, as e.g. the role of standards where e.g. NORSOK and CRINE has chosen quite different approaches, or the use of systems to support these processes, e.g. as the First Point Assessment system used by the British petroleum industry or the Norwegian Achilles system.

Then we would like to refer to an interview with a senior vice president of procurement and supply chain management with a major engineering and construction contractor. This representative supported the view above, with technology development as the main contribution to future competitiveness for the Norwegian petroleum industry, quote: ‘Price adjustments will not be most important in the future, but the ability to bring forward new technology that give stepwise improvements in both CAPEX and OPEX’. He further focused on the demand development and specification process that lay behind making new technology available to use in a project. The contractor develop technology and solutions with their supply chain, and when this is brought into a project there is often a requirement that the operator’s supply chain agreements and contracts shall be used, leading to changes and often starting a process of moving targets in the demand development process. This leads to a focus on criticality in the project, with respect to two elements, new technology and project execution. The criticality will have a balancing challenge of applying new technology, an opportunity and a source of added risk, versus the criticality of keeping the project development schedule. If new technology, leading to a process of moving targets shall not disturb the execution of the project, then this has to be acknowledged and treated correctly. The development and execution models should therefore take the practical reality into account, not only the aim of letting contractors use their own technology, solutions and supply chains, when this is not possible in practical project development together with the operator. As above, the PSCM development tries to address this and principally give an outline for this in the PSCM concept.

An interview with the procurement responsible in a development project confirmed this focus on moving targets even further. He said that, quote: ‘It seems that engineering representatives from both the operator, the contractor and even suppliers try to exceed each other in smartness, even after a contract is placed. This leads to many changes, and have to be dealt with in an [agile] way to deal with the moving targets in the demand processes, as well as dealt with in a [resilient] way when consequences have effect down into the supply chain, and in some cases even necessitates change of supply chain’. The focus further was that a PSCM development had to take this into account, so that it could be possible to address this as a basis for dialogue between the engineering and procurement representatives.

As the messages from the interviews with the representatives from the petroleum industry above show, we have tried to guide the PSCM development along the challenges and recommendations given, so that the requirement for validation of the systems approach according to Arbnor & Bjerke given above are met. The PSCM development followed the messages that were seen as important and relevant from the side of the industrial representatives for demand and supply chain management development in the project context of the petroleum industry. We as creators of knowledge feel the PSCM development address important and relevant subjects, but still regret being able to demonstrate and apply the development through real cases.

8.4 Closure

In the early phase of the work with this thesis, a project planning and control executive from a petroleum company said;

‘Logistics? There is no logistics in a project! Well, we have some barges, so maybe there are some logistics after all, but that is not much!’.

As part of the developments within the project context of the oil and gas industry as presented in table one in chapter one, it is our hope that the results from this thesis may inspire and strengthen the supply chain management developments in the oil and gas industry. For the development phase, new projects may draw lessons from this work, as for the operations phase even ongoing projects could have potential for supply chain improvements.

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Appendix A – Findings in agile manufacturing.

Appendix A presents a list of observations of situations, operating patterns and problems that has been found at an early stage in the U.S. agile manufacturing research programme (Whitney 1995). This is presented in the table below, together with some reflections based on the project-oriented context of the oil and gas industry.

MIT's research findings (Whitney 1995)	Relation to the project-oriented context
pattern of the web	The project development execution process is becoming more concurrent, thereby getting more agile characteristics, e,g, as seen in figure 6.5.
environment	How well do you manage your portfolio of suppliers, so that they are manageable as part of a 'web'? E.g. operators and contractors use of frame agreements and frame contracts, to develop long-term relationships. Through several and different options of operator/contractor(s) constellations, this make a considerable (agile) web environment. However, a project specific web will be project unique.
production	Ability to bring specific requirements and choices made on a high level tier in the project supply chain down into lower tiers, and the result back again in accordance with the requirements. As e.g. in Whitney's discussion of assembly as the proactive part to establish better manufacturing and demand/supply models, due to its position as 'proof of pudding' with respect to seeing whether theory and practice match in bringing everything together when needed and of correct quality at the fabrication and construction sites.
Growth of hierarchical supplier relationships	Do the top-tier actors in the project supply chain, e.g. the operator, want to control all lower supply chain tiers, or do they only 'control' the first tier below themselves? E.g. through the use of frame contracts and frame agreements that penetrate several supply chain tiers below themselves, as well as the option to 'control' contractor's and subcontractors' choice and use of suppliers, the operators grow hierarchical supplier relationships.
Loss, omission, obscurity, or misinterpretation of information	E.g. the increased focus on use of standards, e.g. the NORSOK standards, as well as use of functional specifications could help to ease this. Further information is an important part of the supply chain, to secure that all specification and certificates necessary for commissioning to take place are available together with the supplied goods or equipment. I.e. the proof of pudding of the information supply chain.
Lack of first time capability	In the project context a product or an assembly has to be a 'first time performer', as it is a one-time undertaking. This is central for the project context, and as such an aspect that separates the project context from the repetitive manufacturing context. However, the agile manufacturing approach has the same basis as the project context, as reflected in Goranson's (1999) Agile Virtual Enterprise Reference Model.
Lack of visibility into the	This is the same for the project context. The consequences may in the

cost or performance consequences of a design or production choice	project context be seen in the design of incentive schemes that shall try to capture and distribute risk and profit among the actors. However, this is an important aspect that is sought to be covered in the selection of development and operations alternative, based on a type of value criterion, e.g. NPV.
Local solutions	The situation that only present, local connections are dealt with when problems occur. May lead to reduced 'lean' ability in the operations phase due to local 'smart' solutions, e.g. is change of operatorship a situation that could be an offer for such solutions.
Complexity of the product	The ability and difficulty of gathering all the knowledge and competence, located in the heads of geographically and culturally dispersed people, to capture the design and construction processes needed to realise a product, increases with increased product complexity. The products developed in oil and gas development projects are often very complex, often separated into programs, projects, sub-projects, and modules to become manageable throughout the 'web'.
Long design cycles	The problem with long design cycles is that people, and thereby knowledge and competence, moves around, organisations changes, and that the project demand/supply chain corresponding to long-lead items has to be committed early, and much development have to take that into account.
Inadequacy of current design methods	The move from the 'relay race' of the previous development and execution models of the North Sea oil and gas industry, to the concurrent, early demand/supply chain lock-in of the CRINE/NORSOK models, showed that further improvements have to be made to them.
Need for more attention early in the process	The front-end is the most important phase also of a project. The uncertainty is then highest (most open project situation), but so are also the opportunities available for designing value into the project. The project context do among other apply front end loading, as one methodology to improve the quality of the front-end processes.
models	Cost estimating techniques are well developed in the project context, however should models that calculate the value, cost and time impact of changing from one process or technology to another be further developed. This is important for enabling the use of methods for agile approaches.

Appendix B – CRINE Network's SCOR's and CAR's.

Appendix B presents a set of supply chain optimisation requirements, SCOR's and critical attractiveness requirements, CAR's, for companies to become interesting partners in oil and gas supply chain constructions. The SCOR's and CAR's are developed through the British Department of Trade and Industry supply chain initiative (DTI, 1999).

SCORs are those things that a customer (operator or contrator) should be doing to ensure they maximise the potential for the supply chain to provide appropriate technologies for the future at the right time and quality.

CARs are those things which make a supplier or a contractor highly attractive to a customer, i.e. they appropriately 'magnetise' the supplier in order to enable him effectively to move closer to the customer.

Supply Chain Optimisation Requirements (SCORs)

SCORs are those things that a customer (operator or contrator) should be doing to ensure they maximise the potential for the supply chain to provide appropriate technologies for the future at the right time and quality.

Table. SCORs that operators and contractors should do to optimise the supply chain.

Operator	Contractor
Communications	
- Give suppliers more opportunity to talk to them - Maintain links with the industry, keep in touch with the supply chain - Give clear forecasts, 5 year demand horizon - Explain new organisation structures and who does what, to suppliers - Listen to suppliers and contractors (including constructive criticism) - Discuss with contractors and suppliers the role of each party with respect to the supply chain activities - Provide feed-back to suppliers on equipment provided and how they can do better	- Tell suppliers who to talk to within their organisations about different issues - Provide feed-back to suppliers on equipment performance, how they could do better etc - Keep an open door to suppliers - Ask operators how they used to manage supplier relationships and learn from this - Publish details of projects won and what technologies are sought - Publish details of procurement mechanisms - Tell suppliers what is expected of them - Give suppliers a forum for open discussion - Listen to and act on constructive criticism - Improve dissemination within organisations as to what suppliers can offer and who to contact
- Do not insist on performance bonds from small suppliers - Adequately motivate contractors to take on supply management role - Adequately reward contractors for bringing forward new innovation - Ensure fair and open gainshare contracts - Be a good customer (this gives an operator an edge) – pay on time, be open and easy to do	- Get suppliers involved in FEED and bid stages - Do not ask for performance bonds - Operate 2-way supplier/customer assessment - Recognise and reward good suppliers - Look for value rather than the lowest unit cost - Keep tender lists down to sensible numbers

business with - Support 'First Point Assessment' - Insist on a flow-through of good contractual relations with contractors - Operate 2-way supplier:customer assessment - Recognise and reward good suppliers - Mutually set target costs on gainshare contracts - Adopt functional specifications - Be prepared to consider companies and technologies that do not have track record - Adequately reward contractors for costs incurred entering design competitions - Use standard CRINE contracts	of companies - Be aware of supplier difficulties when faced with larger, fewer contracts - Address the lack of trust between contractors and suppliers (IPR etc) - Consider framework/partnering arrangements with suppliers - Recognise that squeezing suppiers and not paying on time etc affects the availability of that supplier service in the future - Support First Point Assessment - Treat suppliers as you expect to be treated as operators - Be a good customer in terms of paying on time, not insisting on achievable targets - Appoint account managers (single point of contact) for suppliers or groups of suppliers - Use standard CRINE contracts
- Publish details of R&D budgets and evaluation criteria for investing in suppliers ideas - Tell the world what their technology requirements and priorities are, and how they might change - Continue to sponsor JIPs - Retain capability to be an informed buyer or ensure contractors have this capability and an incentive to act as such - Encourage a spirit of continuous technical improvement - Arrange technology forums/brainstorming sessions to develop step changes open to UK suppliers only - Use functional specifications	- Publish details of what R&D support they are willing to give - Support JIPs and other collaborative initiatives - Source best technology, not just use own sub-divisions, e.g. access specialisms in the market - Publish criteria for considering applying new technologies/innovations - Increase in-house ability to be an informed buyer - Keep abreast of new technologies/technology suppliers in the market place - Use functional specifications

Table. Operator SCOR's.

Communications	Procurement	Technical
- Give suppliers more opportunity to talk to them - Maintain links with the industry, keep in touch with the supply chain - Give clear forecasts, 5 year demand horizon - Explain new organisation structures and who does what, to suppliers - Listen to suppliers and contractors (including constructive criticism) - Discuss with contractors and suppliers the role of each party with respect to the supply chain activities - Provide feed-back to suppliers on equipment provided and how they can do better	- Do not insist on performance bonds from small suppliers - Adequately motivate contractors to take on supply management role - Adequately reward contractors for bringing forward new innovation - Ensure fair and open gainshare contracts - Be a good customer (this gives an operator an edge) – pay on time, be open and easy to do business with - Support 'First Point Assessment' - Insist on a flow-through of good contractual relations with contractors - Operate 2-way supplier/customer assessment - Recognise and reward good suppliers - Mutually set target costs on gainshare contracts - Adopt functional specifications - Be prepared to consider companies and technologies that do not have track record - Adequately reward contractors for costs incurred entering design competitions - Use standard CRINE contracts	- Publish details of R&D budgets and evaluation criteria for investing in suppliers ideas - Tell the world what their technology requirements and priorities are, and how they might change - Continue to sponsor JIPs - Retain capability to be an informed buyer or ensure contractors have this capability and an incentive to act as such - Encourage a spirit of continuous technical improvement - Arrange technology forums/brainstorming sessions to develop step changes open to UK suppliers only - Use functional specifications

Table. Contractor SCOR's.

Communications	Procurement	Technical
- Tell suppliers who to talk to within their organisations about different issues - Provide feed-back to suppliers on equipment performance, how they could do better etc - Keep an open door to suppliers - Ask operators how they used to manage supplier relationships and learn from this - Publish details of projects won and what technologies are sought - Publish details of procurement mechanisms - Tell suppliers what is expected of them - Give suppliers a forum for open discussion - Listen to and act on constructive criticism - Improve dissemination within organisations as to what suppliers can offer and who to contact	- Get suppliers involved in FEED and bid stages - Do not ask for performance bonds - Operate 2-way supplier/customer assessment - Recognise and reward good suppliers - Look for value rather than the lowest unit cost - Keep tender lists down to sensible numbers of companies - Be aware of supplier difficulties when faced with larger, fewer contracts - Address the lack of trust between contractors and suppliers (IPR etc) - Consider framework/partnering arrangements with suppliers - Recognise that squeezing suppiers and not paying on time etc affects the availability of that supplier service in the future - Support First Point Assessment - Treat suppliers as you expect to be treated as operators - Be a good customer in terms of paying on time, not insisting on achievable targets - Appoint account managers (single point of contact) for suppliers or groups of suppliers - Use standard CRINE contracts	- Publish details of what R&D support they are willing to give - Support JIPs and other collaborative initiatives - Source best technology, not just use own sub-divisions, e.g. access specialisms in the market - Publish criteria for considering applying new technologies/innovations - Increase in-house ability to be an informed buyer - Keep abreast of new technologies/technology suppliers in the market place - Use functional specifications

Critical Attractiveness Requirements (CARs)

CARs are those things which make a supplier or a contractor highly attractive to a customer, i.e. they appropriately 'magnetise' the supplier in order to enable him effectively to move closer to the customer.

Table. CARs Contractors and Suppliers should have to be attractive to Operators and Contractors.

Contractors	Suppliers
People	
- Culture fit with client - Open behaviour - Professionalism, so as to be able to put trust in company - Good middle management - Overall quality of personnel - Leadership qualities - Good vertical alignment of management ethics - 'Can do' attitude - Full time staff rather than large proportion of agency staff	- Professionalism and reliability such as to engender trust - Easy to deal with - Adequate resources and back up - Depth of quality personnel throughout company
Marketing	
- Ability to communicate well - Taking trouble to find out exactly what client wants in order to understand his needs - Ability to think like an operator (put oneself in his shoes) - High degree of visible strategy and planning - Awareness of life cycle issues - Knowledge of operators business	- Keep operators and contractors informed of new products - Present ideas in terms of financial benefit to the customer - Ability to communicate well - Track record of satisfied customers and market reputation - Understanding of market place and market conditions
Technical	
- Leaders in their industry area	- In-house quality of products and services

- Familiarity with operations processes - Quality systems and reliability - Design for safety - Track record of successful performance - Good finishers - Recognition of own limitations - High level of technical competence - Commitment to continuous improvement - Environmental awareness in design and operations - Innovative technology - Awareness of innovations available in the market place	ensuring high quality products and services - Competitive on a world scale
Operations	
- Value for money - Willingness to join alliances, develop mutual relationships - Track record of successfully maintaining long term relationships - Innovative approach to projects, bright ideas - Positive and focused - Site safety management - Trouble shooting and problem solving - Objectivity - Alignment with project/client objectives - Willingness to put reputation at stake - Support of client - Willingness to link profit to performance (take risks) - Reduced delivery times and delivery on time - Capacity/plant availability - Good relationships with the supply sector	- Flexibility to react quickly to changing market conditions - Speed and quality of response to customer requirements - Reduced delivery times and accuracy of deliveries, on equipment and projects - Post delivery support/spares and service support - Anticipating and solving problems - Evaluating and recording performance (and making visible to customers) - Track record in delivering to time and cost - Good working practices (e.g. safety and environment) - Delivering of promises with minimum involvement of client (i.e. zero expediting, progress chasing) - Financial stability

Table. CARs Technical Suppliers and Commodity SMEs should have to be attractive to Operators and Contractors.

Technical Suppliers Only	**Commodity SMEs Only**
- Multi-tasking personnel - Cultural fit with customers (sharing same company values) - Good management at all levels plus commercial skills - Develop good working relationships with customers - Energy, dynamism, willingness to 'go the extra mile' - Low personnel turnover rate/core of experienced personnel who understand the company	-
Marketing	
- Visibility, in general - Ability to understand customers' position - Focused and targeting marketing, rather than blanket selling - Openness - Be part of a larger trade association	-
Technical	
- Track record of innovative products that work - Design capability - In-depth technical knowledge of own sphere, ability to answer detailed questions - Strategic or project/operations critical products - Understanding of local conditions for a particular project or development - Provision of specialised skill sets missing from contractors and now not normally found	- Wide range of products and willingness to extend range

in operators	
Operations	
- Value added products and capability - Innovative approach to projects and ways of working - Good co-ordination, project management skills (e.g. visible planning systems) - Alignment and focus on the objectives of the project - Willingness to work together to find solutions to problems - 'No job too small' attitude - Provision of independent and unbiased advice - Willingness to join and/or contribute to operator:contractor alliances	- Unit cost - Stock-holding or evidence of ability to supply on demand

Table. Actions for SME's to develop specific CAR's

	Actions														
CAR's	Joint industry bodies	Raise industry profile	Improve communications with	Quality improvement initiatives	Technology scanning	Access to R&D funding	Seek R&D partners	Improve market knowledge	Strategy & business planning	Rationlise product offerings	Self assessment vs market needs	Staff training and development	Improve own supply chain	Enterprise restructure	Cut overheads/ outsource
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Quality/quantity retention of personnel												x			
Cultural fit with customers	x		x												
Management and commercial skills								x				x		x	
Keeping customers aware of new products		x	x												
Presenting financial benefit to customers	x		x								x	x			
Good communicators	x	x	x					x			x	x			
Reputation and visibility	x	x	x												
Market/customer understanding	x														
Competitiveness on a world-wide scale	x	x		x	x			x							x
Targeted marketing			x					x	x		x	x			
Product/service packages	x		x			x	x	x		x	x				
In-house quality systems	x		x	x					x		x		x		
Continuous improvement culture	x		x	x					x		x		x		
Strategic or project/operations critical products	x		x		x	x	x	x							
Specialist skill-sets	x		x		x		x	x	x						
Value added products/capability					x	x	x		x		x		x	x	x
Participation in operator/contractor alliances			x				x	x							
Innovative approaches/ideas	x		x		x		x			x			x		
Strong project management skills/system									x			x			

Reduced lead times for delivery									**x**	**x**			**x**	**x**	
Willingness to work together to solve problems	**x**				**x**		**x**	**x**			**x**				
Speed/quality of response to customer requirements	**x**		**x**	**x**		**x**		**x**	**x**	**x**	**x**		**x**		
Post delivery support			**x**								**x**	**x**			
Performance evaluation	**x**		**x**					**x**				**x**			
Reliability			**x**	**x**				**x**	**x**	**x**				**x**	

Appendix C – CRINE's supply chain strategy setup.

Appendix C presents a set-up for documentation of supply chain strategy as given in CRINE Network (1999-B). The set-up consists of five elements to be documented;

- Vision
- Supply Scope
- Provider/Customer Relationship
- Source Selection
- Performance Measurement

VISION – Describe;
The high level objective of your supply chain initiative The scope of your initiative The key people and processes that are involved Cost/benefit statement
SUPPLY SCOPE – Describe;
The good or service you are purchasing How it is used The main customer contacts The expected volume, and the historical expenditure trend The expected changes in scope (e.g. technology, specifications, demand) The strategy – local, regional, corporate, global How long the customer will require the good or service Lease options (where appropriate) The current market conditions (e.g. price, elasticity, supply and demand, economic trends, provider profitability, cost of production)
PROVIDER/CUSTOMER RELATIONSHIP – Describe;
What kind of relationship best suits this good or service How the identified strategy works towards creating the identified relationship If there is a commitment to communicate openly with the provider/customer about the plan, and stick to the plan

How long are you committed to the relationship How the strategy will change if the relationship creates less value than is available in the marketplace
SOURCE SELECTION – Describe;
The right number of providers Whether the plan rationalises (i.e. “right sizes”, and not necessarily reduces) the provider base to maximum leverage How the business will be allocated How the providers will be selected How the providers will be evaluated Whether the good or service be sole, multiple or parallel-sourced Whether you need back-up providers, and how reliable the supply is Whether you have explored contract consolidation or outsourcing options
PERFORMANCE MEASUREMENTS – Describe;
Whether you need a measurement or continuous improvement process If providers should be involved in developing the performance measurement system, and how they should be involved The elements (for all involved parties) which should be measured Whether all stakeholders mutually agree to the measurement elements Whether the measurements are meaningful/specific Whether the measurements are realistic to capture Whether the measurement elements are tied to performance targets Whether measurement frequency and review method have been established Whether measurements for market comparisons have been considered The measurement elements designed for continuous improvement and corrective action

Appendix D – Epci Front End Opportunities workshop.

Appendix D is a summary presentation from a workshop arranged by the European Institute of Advanced Project and Contract Management. The topic of the workshop was the project front end, and its focus on balancing opportunities and risks. The workshop was arranged and documented by the author.

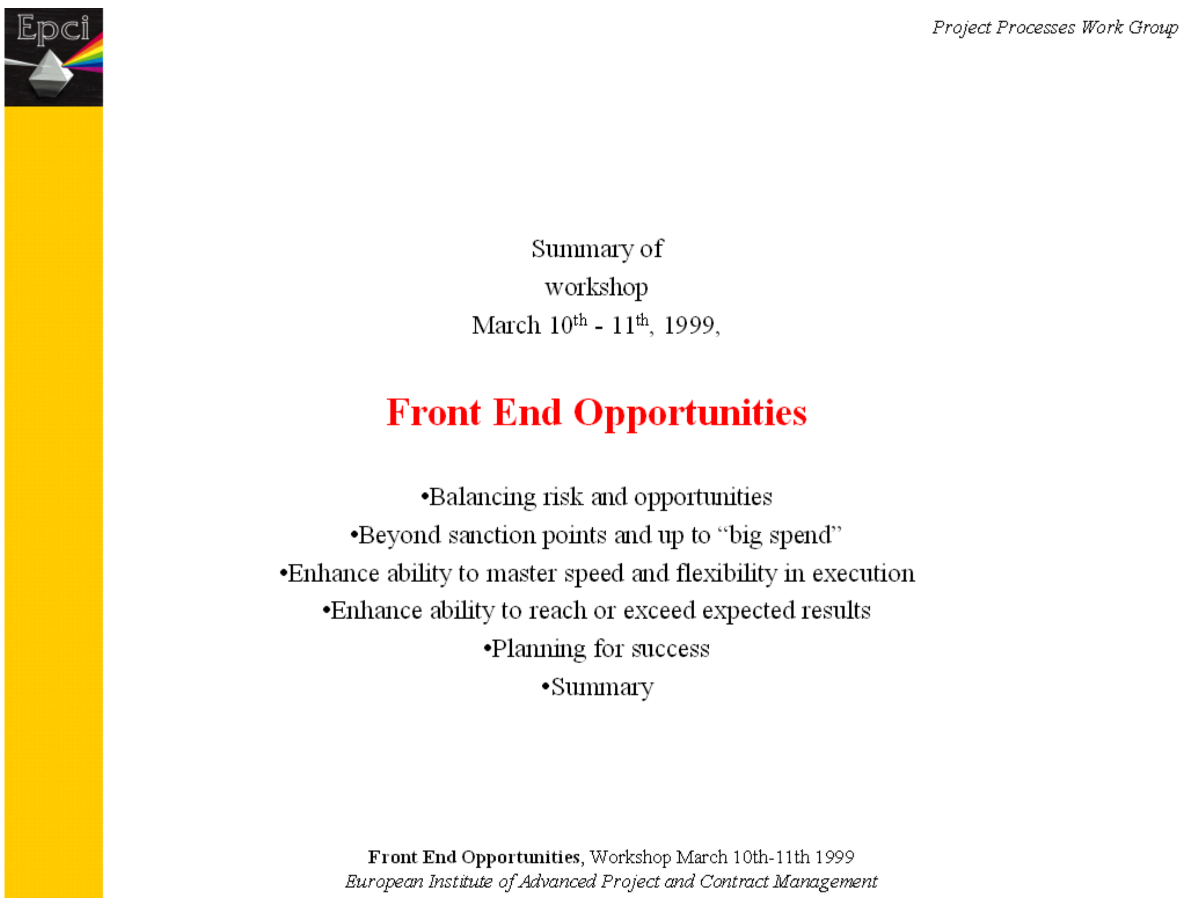

Figure App. D-1. Workshop Front End Opportunities, Foil 1 of 7.

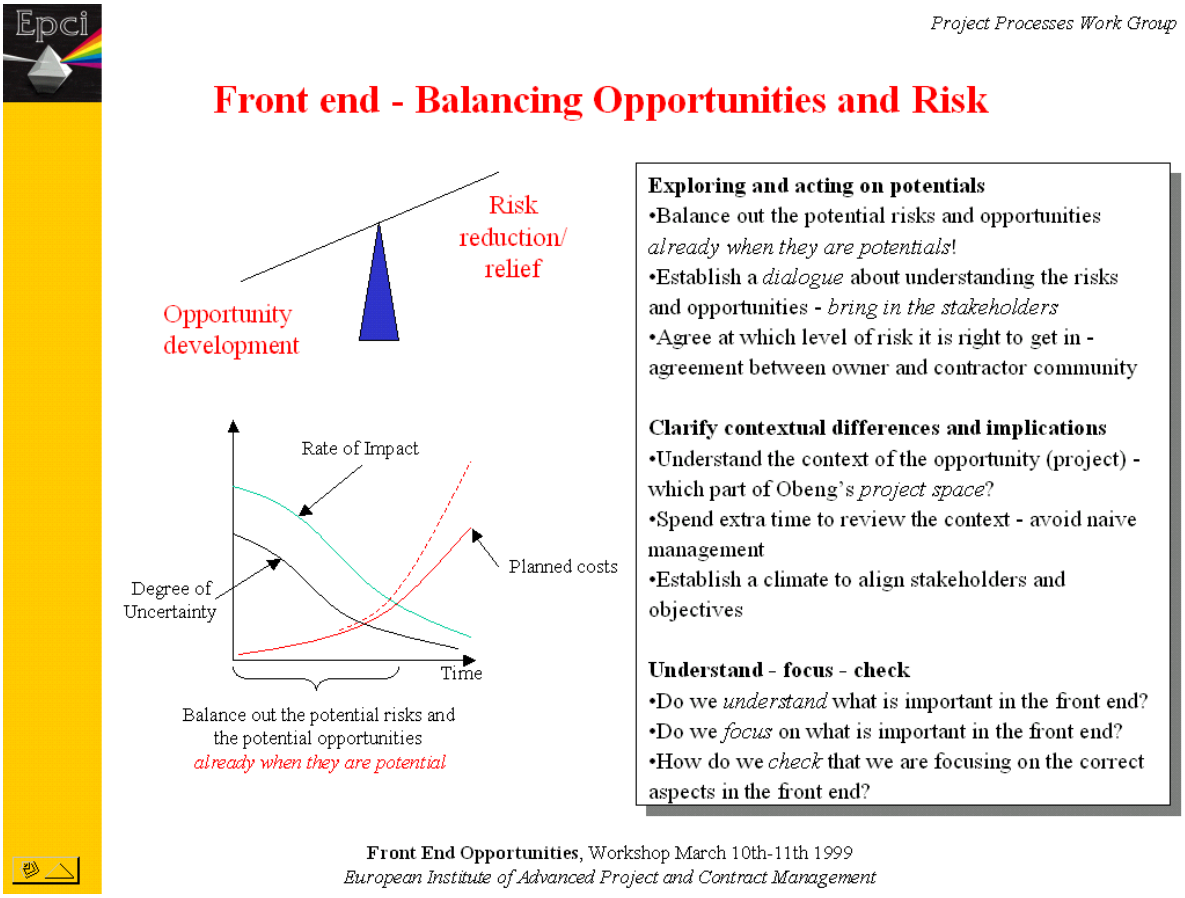

Figure App. D-1. Workshop Front End Opportunities, Foil 2 of 7.

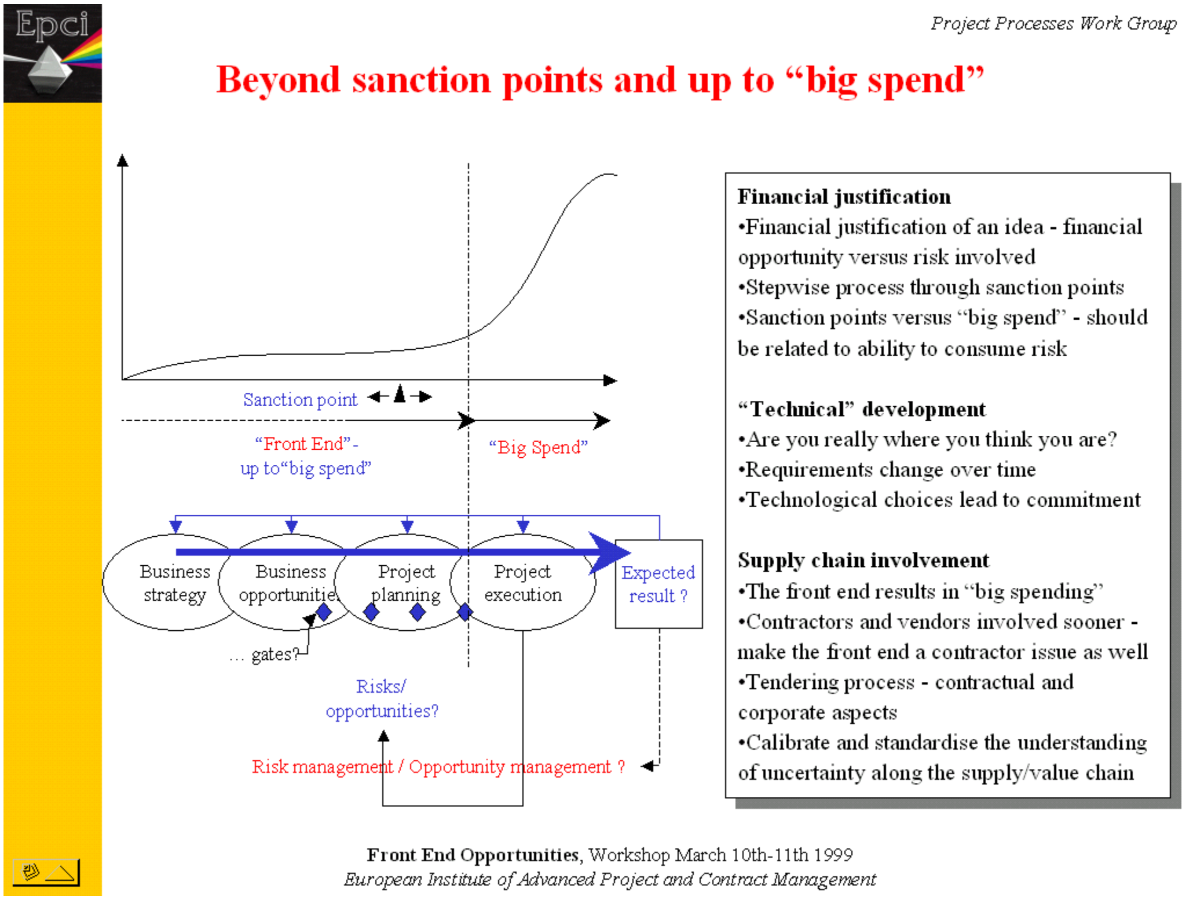

Figure App. D-1. Workshop Front End Opportunities, Foil 3 of 7.

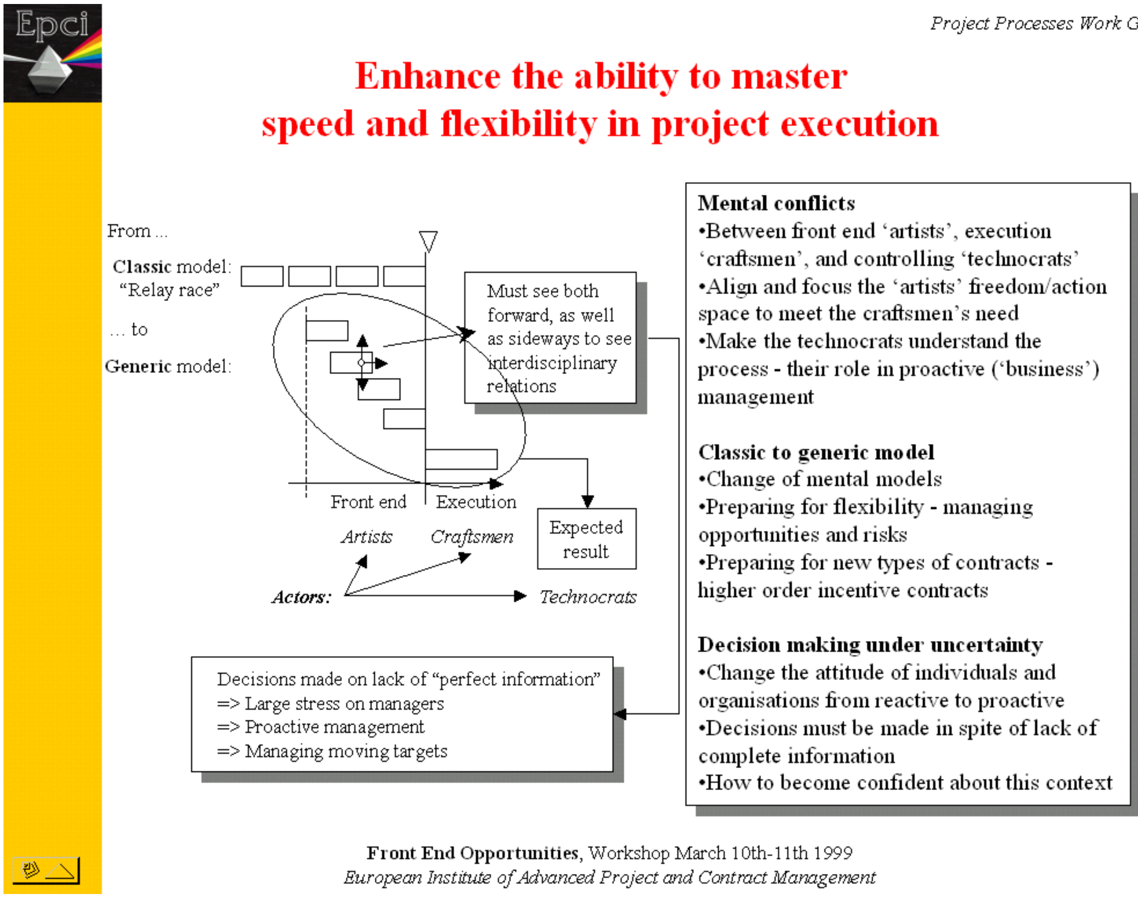

Figure App. D-1. Workshop Front End Opportunities, Foil 4 of 7.

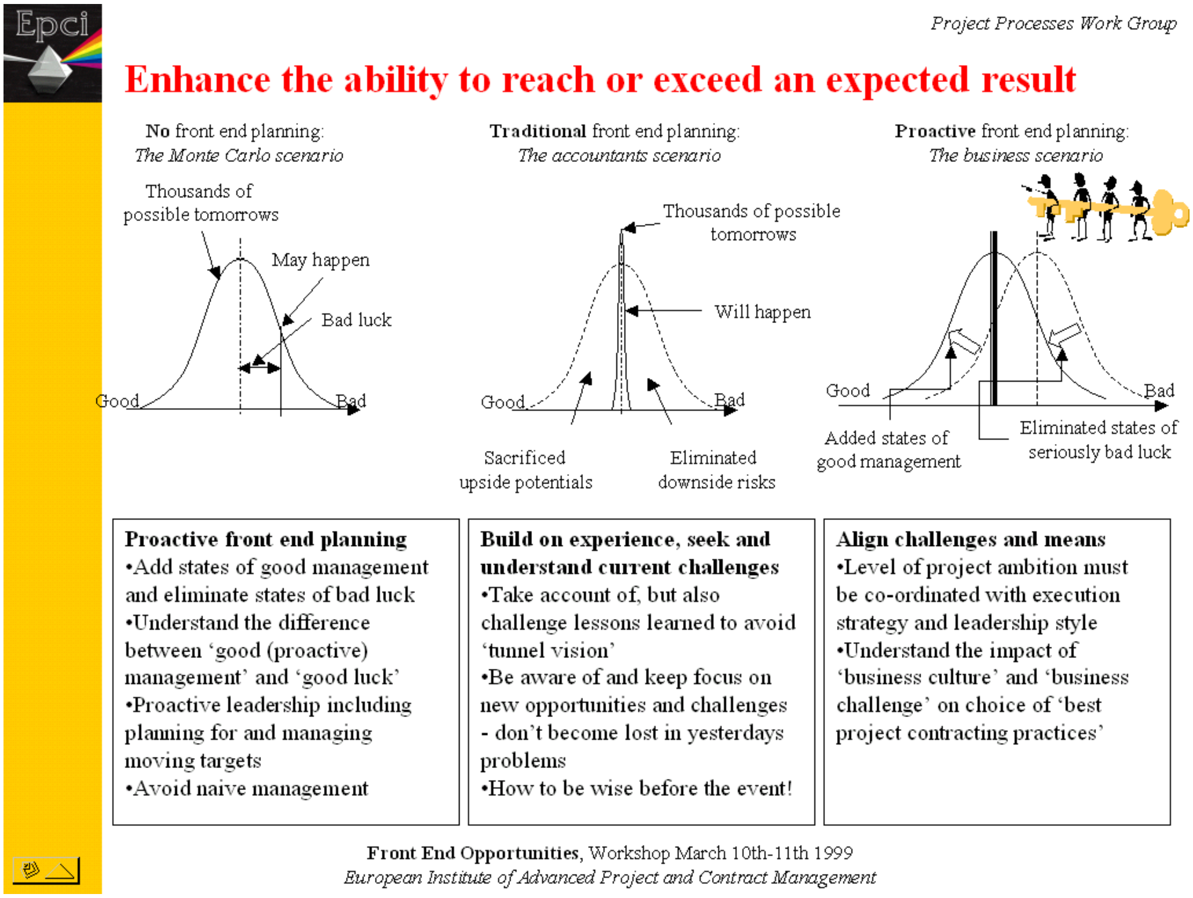

Figure App. D-1. Workshop Front End Opportunities, Foil 5 of 7.

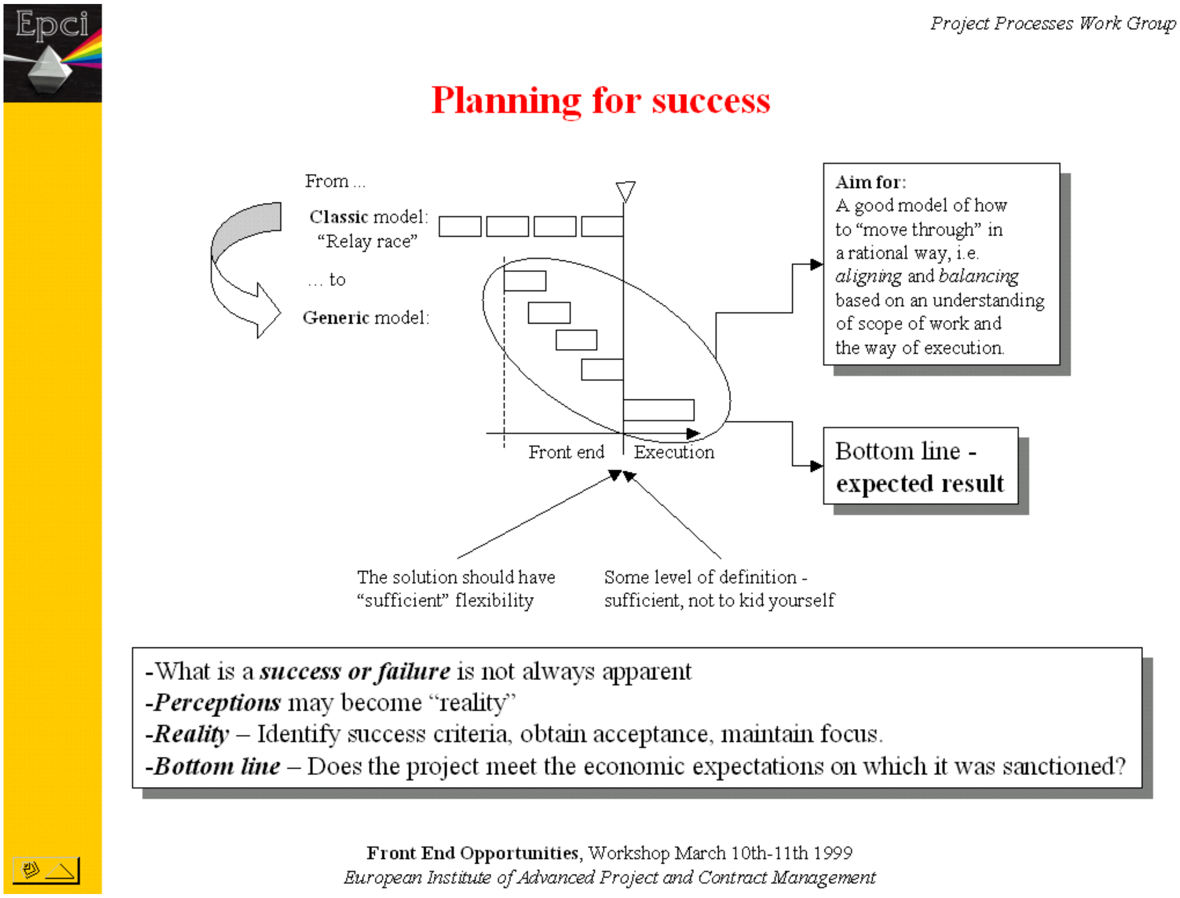

Figure App. D-1. Workshop Front End Opportunities, Foil 6 of 7.

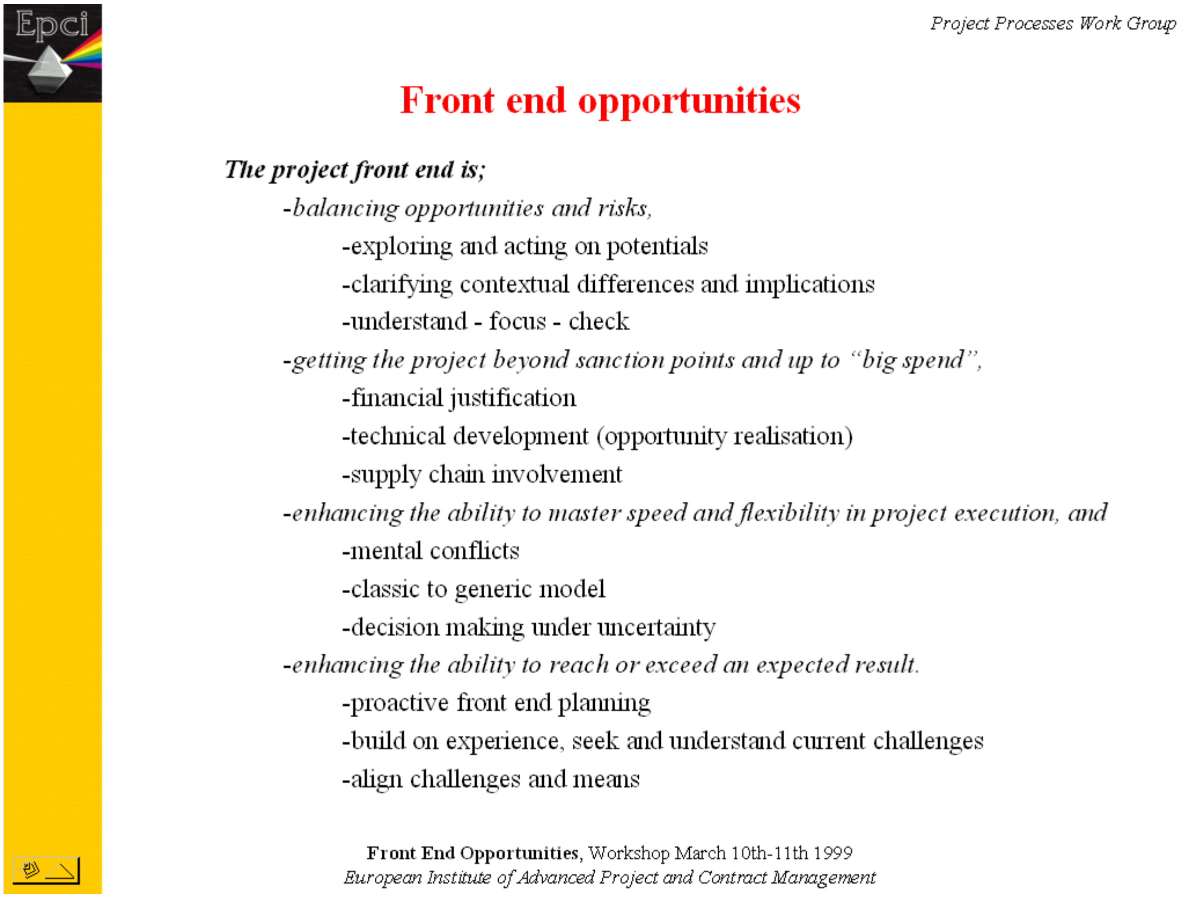

Figure App. D-1. Workshop Front End Opportunities, Foil 7 of 7.

Appendix E – Epci Contract Strategies workshop.

Appendix E is a summary of a workshop arranged by the European Institute of Advanced Project and Contract Management. The topic of the workshop was contract strategies. The appendix show the questionnaire used up-front of the workshop, as well as the summary of the feed-back from the questionnaire and the workshop. The questionnaire and the workshop was prepared, arranged and documented by the author.

Workshop

CONTRACT STRATEGIES

> 'Contracts are used to procure people, plant, equipment, materials and services. Contracts are therefore fundamental to the management of almost all engineering projects. The type of contract should be selected only after consideration of the nature of the parties to the project, the project objectives and the equitable allocation of duties, responsibilities and risk. This chapter outlines the main components of the process used to determine how the project will be procured, usually referred to as the **contract strategy**'
>
> (N.J.Smith, 1995, *Engineering Project Management*, p.188. Blackwell Science Ltd., Oxford).

Interview guide to background document.

The questions below will be the basis for this interview. The questions are meant to be *guiding*, i.e. they shall act as a basis upon which the framework related to contract strategies is to be discussed in the workshop.

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1. GENERIC PROJECT STRATEGIES

One may state that there are three generic strategies underlying project development and execution. These three generic project strategies are:

- Risk reducing strategies
- Opportunity seeking strategies
- Value enhancing strategies

• Which type of project strategies do you consider is most used by the company you represent?

• Do you believe it could be of value to try to follow another project strategy than the one most currently used? If so, where do you see the potential for improvements?

- What could be potential drawbacks of using another project strategy?
- What kind of measures would be necessary to focus on if other project strategies were to be pursued?

2. CONTRACT STRATEGY MISSION

- What *is* a contract strategy, and company's preferred contract strategy?
- What is the basic *mission* of the contract strategy?
- How is the contract strategy related to project and project management activities?

3. TYPES AND USE OF CONTRACT STRATEGIES

- Is there a *portfolio* of different contract strategies?
- *When* and *where* are the different contract strategies useful – given project type, project context, market situation and cultural locations?
- Could you give your subjective perception of where different contract strategies would be placed in relation to the three project strategies listed above?

4. RATIONALE FOR CHOICE

- What have been the reasons behind the choice of a given project strategy (or strategies)?
- Do you have any examples?
- What have been the outcome of the given project strategy (or strategies)? (Your experiences/perception).
- Did it (or they) work out for the assumed reasons or not?

5. THE MATCH BETWEEN THE ELEMENTS

- How does the selected contracting strategy match the environment experienced during execution? I.e. the 'match' between the;
- Project's context or external environment, the
- Project strategy, and the
- Contract strategy?
- How does the contracting strategy support the project objectives?

6. SUCCESS FACTORS

- What are the 'factors' that determine the success of a contract strategy – as seen both from a client's and contractor's point of view?
- What are the success factors of the client's attitude?
- What are the success factors of the contractor's attitude?

7. ARE THERE COMMON OBJECTIVES?

- Are there common objectives among the actors in the project value chain?
- Are there elements or aspects that may be improved in each actor's approach to contracting strategies?
- How could these be leveraged?

8. RE-USE AND POTENTIAL FOR IMPROVEMENT

- Is it possible to 'copy' a 'successful' contract strategy from one project to the next?
- Or is the combination of contract strategy and project context unique so that more basic aspects have to be addressed? If so, do you have examples of relevant aspects?
- Then, how should we proceed to bring more knowledge about this area, to make up 'guidelines' for contract strategies in the project context for the future?

9. INCENTIVES

- Do you have any experience from the use of incentive-based contracts?
- What kind of incentives and/or incentive mechanisms do you believe to be best to support a win/win situation for both clients and contractors?
- Could incentive mechanisms be counter-effective?

Thank you for letting us share your time, knowledge and experience, and for taking part in preparing this 'Contract Strategies' workshop!

September 17th 1999

The Epci Project Processes Workgroup

CONTRACT STRATEGIES

Proceedings,

Epci workshop,

23-24 November 1999

EXECUTIVE SUMMARY

This is the summary of a workshop on ‘contract strategies’ arranged by the European Institute of Advanced Project and Contract Management, Epci, November 23-24, 1999.

The workshop was based on a set of nine subjects related to contract strategies. A questionnaire related to these nine aspects was distributed to the workshop participants and others prior to the workshop. The nine subjects and the questions related to each subject are presented in Table 1.

Table 1. The nine initial contract strategy subjects.

1. Generic project strategies.	4. Rationale for choice.	7. Common objectives.
2. Contract strategy mission.	5. The match between the elements.	8. Incentives
3. Types of contract strategy.	6. Success factors.	9. Re-use and improvement.

An initial approach taken up-front was that project strategies, or the strategic guidelines underlying the decision making in the project, might be characterised and divided into three categories;

1. *Risk reducing strategies*
2. *Opportunity seeking strategies*
3. *Value enhancing strategies*

Dependent on the underlying approach taken to project strategies, whether explicit or implicit, the contract strategy and other project management activities will be influenced. Below the input and reflections from the contributors and participants in the workshop are summarised.

The approach made up by the *generic project strategies* was regarded as a constructive approach. Risk reducing strategies were the type mostly used, or felt necessary to use, but the trend is towards emphasising value enhancement aspects within the project per se, as well as within and among the actors of the project supply chain. A value enhancement approach necessitates that both risk reducing and opportunity seeking strategies are pursued in a balanced way dependent on the project context.

Taking new project strategies into use demands that one understands the impact that change of strategy has in relation to each actor's commercial aspects, and not to 'loose focus on value enhancement and profitability at the same time'.

The *mission of the contract strategy* is to be the project's guidance, communication and alignment tool for establishing and operating the project's supply chain. As such the contract strategy is the basis for carrying out the project's procurement, from the lowest supplier tier, through all supply chain tiers and actors till the final 'assembly' of the project product. The contract strategy will communicate internally and externally with the market the approach taken to procurement and supply chain management in the project. As a guidance to and together with the other project and project management activities, the contract strategy shall 'increase the probability of meeting intra- and inter-organisational project objectives'.

The *types and use of the contract strategy* reflects the potential to elevate the use of the portfolio of contract strategies available. Though there is a portfolio of different contract strategies, they are perceived to be under-utilised to their optimum, which may lead to a loss of value enhancement and profitability due to a mismatch between strategy and context. As the contract strategy as a basis will drive different behaviours within the project supply chain, the possibilities within the portfolio of contract strategies should be elevated carefully. Especially understanding how the use of the strategy to impact the division of risk among the actors drives behaviour.

When it comes to the *rationale for choice* of a strategy it is very much seen as following and adapting to the choice made by the client. Important in this respect is the client's approach to the actors in the project supply chain, and the division of roles, work and risk among the actors and the client's ability to manage the project supply chain as an entity, given the project context. The context of both the project and the supply market will impact the ability and necessity of managing the project supply chain as an entity. Especially with respect to the need for speed or the inherent complexity in the project that will need different governing mechanisms within the project supply chain to elevate inherent capabilities and value contributions.

Matching the contract strategy with the context and the objectives of the project could easily become a theoretical exercise. Therefore the contract strategy should match the project's context and environment as far as practically feasible with options for additional flexibility as required. The contract strategy should aim to support and meet the project objectives through reducing imbalances along the project supply chain, aligning and committing the supply chain to deliver, to increase the likelihood of project success.

Then, what are the *success factors* of clients and contractors attitude in the project supply chain. The client should be non-adversarial, commercially oriented and fair, and be the supply chain manager of the project supply chain, i.e. have the ability to manage contractual interfaces, enable the supply chain to perform through giving it sufficient freedom to act, though setting guidelines to meet objectives. The contractors' attitude should be characterised by being non-adversarial and co-operative, pro-active, as well as integrity to deliver in accordance with promises.

Common objectives between clients and contractors are based in the project as a mutual source of present and future business. The contract strategy and formats of payment may help to address and balance sources of risk and profitability, but managing the total risk that is comprised by and that will influence the success of the total project supply chain and its actors should be elevated as a common objective. The success lies not with each actor, but in supply chains competing against other supply chains. Therefore a supply chain management framework should be developed to suit the project context. The contract strategy should be regarded as the strategic 'tool' to develop and manage the project supply chain, that through transparency into the project supply chain help to elevate the understanding of common business objectives, with 'visible' incentives and remuneration linked to 'visible' performance.

Incentives used should reflect an understanding of the dependency to the project context, and dynamic in reflecting changes in the project context that may distort the function of the incentives. The incentives should be linked to areas where the project supply chain actors would be in a position to influence, and towards essential business parameters that are possible to commit to. All in all the incentives should be aimed at "making the important measurable, and not the measurable important". Incentives could also be counter-effective if they are too complex and focused on details, unrealistic and static, and is felt to address things that doesn't matter,

The potential for *re-use and improvement* for contract strategy from one project to the next lies in addressing the **principles** that are underlying more or less all developments. Such principles are both generic as well as company specific, and may be regarded as the primary conditions to be re-used and improved over time. Around these primary conditions there are secondary conditions that have to be adjusted to the "specialities" of the given project context. To better understand these principles an approach would be through improved understanding of the business processes (work and commercial processes) within and between the project supply chain actors. Such process analysis could bring with it increased understanding among the project supply chain actors. Through elevated understanding the primary and secondary conditions underlying the development of the contract strategy could be addressed and be used as guidelines for developing contract strategies in given project contexts.

Table App. E-1. Some messages per questionnaire topic.

Topic	Questions asked
1. Generic project strategies	✓ Which types of project strategies do you consider is most used by the company your represent? ▪ *Risk reducing*: The most preferred or 'needed' (due to principal/agent relationship) strategy. ▪ *Opportunity seeking*; What is it? ▪ *Value enhancing*; The underlying driver, which are emerging in new approaches. ✓ Do you believe it could be of value to try to follow another project strategy than the one most currently use? If so, where do you see the potential for improvements? ▪ Improved understanding of each actor's commercial aspects along the supply chain – transparency. ▪ Improved awareness and handling of uncertainty elements, both risk and opportunity. ▪ Improved awareness and conscious choice with respect to alignment of project strategy to project type and context – due regard to all considerations applicable to a particular project. ✓ What could be potential drawbacks of using another project strategy? ▪ Need for intra- and inter-organisational development – to handle the resistance based in organisational structures and systems. ▪ Actor's or stakeholders biased reactions due to lacking knowledge and experience with respect to operating in a novel way. ▪ Are there drawbacks or just lack of competence and experience? ✓ What kind of measures would be necessary to focus on if other project strategies were to be pursued? ▪ Linking inter-organisational value enhancement with intra-organisational profitability and risk. ▪ Transparent measures along supply chain to ensure that actors and stakeholders targets and objectives are clear, visible and understood.

	▪ Dynamic measurements that reflects changing needs over time.
2.Contract strategy mission	✓ What is a contract strategy? ▪ The ‘tool’ for establishing and managing the project’s inter-organisational supply chain. ▪ Guide and alignment; enabler in project execution with respect to aligning project execution along the inter-organisational project supply chain, as well as aligning project and actors’ objectives. ▪ Plan or statement to establish the means for procuring goods and services. ▪ Selection basis for and evaluation of context dependent parameters underlying a successful contract. ✓ What is the basic mission of the contract strategy? ▪ Guidance for carrying out procurement. ▪ Communication tool internally and with the market, to signal approach to procurement and supply chain management. ▪ Enabler to align and ‘optimise’ inter-organisational value enhancement and intra-organisational profitability given inherent opportunities and risks. ▪ Increase the probability of meeting intra- and inter-organisational project objectives. ✓ How is the contract strategy related to project and project management activities? ▪ Complementing the project supply chain with the project objectives. ▪ The strategy is a formal and governing document that other, tactical and operational project management activities must be in accordance with. ▪ The basis and framework that other project management activities are developed to support and meet.
3. Types and use of contract strategy	✓ Is there a portfolio of different contract strategies? ▪ Yes, but,

	▪ The question is whether the variety of such a portfolio is utilised to its optimum. ✓ When and where are the different contract strategies useful – given project type, project context, market situation and cultural locations? ▪ The precondition is that the contract type, reimbursement mechanism and incentive structure will drive different behaviours within the actors in the project supply chain. ▪ The choice of contract strategy is in large dependent on to which extent *what's* and *how's* of the project is defined, i.e. the knowledge and experience with respect to what to be done and how it is to be done, and the contextual influence on these. ✓ Could you give your subjective perception of where different contract strategies would be placed in relation to the three project strategies listed above? ▪ Well defined what's and how's lead to risk reducing strategies, well suited for securing delivery in accordance with promises. Fixed price type of strategies, lump sum, with strong risk transfer motivation between actors is characteristic. ▪ Less defined what's and how's may open up for creativity and utilising the full potential of the project supply chain, especially in opportunity seeking contexts. ▪ Value enhancement strategies will have to utilise risk reduction and opportunity seeking strategies targeted in parts and phases of the project.
4. Rationale for choice	✓ What have been the reasons behind the choice of a given project strategy (or strategies)? ▪ Client versus contractor driven. ▪ Speed versus complexity. ▪ Market context. ▪ Division of work among actors/supply chain build-up. ▪ Ability to manage the project's supply chain as an entity.
5. The match between the elements	✓ How does the selected contracting strategy match the environment experienced during execution? I.e., the match between the

<table>
<tr><td></td><td>project’s context or external environment and the contract strategy, and
▪ Macro – Political, economic, regulatory, technology, socio-economic, finance that influences the project supply chain.
▪ Micro – Scope definition, project size, duration, schedule and milestones, interfaces, organisation model.
▪ Planning/Execution – Take due considerations for shift in context between planning and execution.
✓ How does the contracting strategy support the project objectives?
▪ Reduce imbalances along the project supply chain.
▪ Align and commit the supply chain to deliver.
▪ Increase the likelihood of project success.</td></tr>
<tr><td>6. Success factors</td><td>✓ What are the ‘factors’ that determine the success of a contract strategy – as seen both from a client’s and contractors point of view?
▪ Client; achieve project objectives, strong project team/supply chain, contractor (or the project’s extended supply chain) performs according to expectations,
▪ Contractor; profit, ability to use and develop competence,
▪ General; working together in a non-adversarial manner, effective resolution of changes and disputes, ability to balance potential for conflicts when aligning ‘project goals – contract strategy – contracts format and structure – contractors goals’, openness,
✓ What are the success factors of the client’s attitude?
▪ Non-adversarial
▪ Commercially oriented and fair
▪ Supply chain management; ability to manage contractual interfaces, enable the supply chain to perform – give sufficient freedom to act
✓ What are the success factors of the contractor’s attitude?</td></tr>
</table>

	▪ Non-adversarial ▪ Pro-active ▪ Co-operative ▪ Integrity with respect to ability to deliver in accordance with promises.
7. Are there common objectives	✓ Are there common objectives among the actors in the project value chain? ▪ The project is the source of present and future business for all actors in the project's supply chain. ▪ Making the project a success. ▪ Risks and benefits are linked to the project supply/value chain, not each actor. ✓ Are there elements or aspects that may be improved in each actor's approach to contracting strategies? ▪ A supply chain management framework for the project. ▪ The contract strategy as the project supply chain management planning and operation tool. ▪ Elevating understanding of common business objectives. ▪ Visible incentives and remuneration linked to performance. ✓ How could these be leveraged? ▪ Enhanced front-end loading. ▪ Enhanced competence. ▪ Long term relationships ▪ Stronger focus on creating balanced project teams and project supply chains. ▪ Developed through upcoming projects.

8. Re-use and potential for improvement	✓ Is it possible to ‘copy’ a successful contract strategy from one project to the next? ▪ Yes, but with due consideration to the “specialities” of that particular project. ▪ Principles and guidelines for establishment of project and contract strategies. ▪ Elements, idea and part of the structures will be necessary and useful to develop/improve through several projects. ▪ Clients “value orientation”; Financing Demands; Market situation; Level of Scope Definition Available; Risk Bearing Ability of Contractor (financial strength and track record); Time to market requirements; Technical, execution and financial risks ▪ Whilst the above may determine the basic strategy there is an almost unlimited scope and variety that can be introduced into the secondary conditions of a contract such as a incentive schemes and other objective alignment mechanisms. ✓ Is the combination of contract strategy and project context so unique that more basic aspects have to be addressed? If so, do you have examples of relevant aspects? ▪ Market, technical solutions, level of definition, internal vs external core competence to develop the SOW ▪ Basic factors such as sophistication of client, location of project i.e. remote or easy access, capability of local suppliers and construction contractors, client standards and specifications, type of financing involved, client approach i.e. adversarial or otherwise, contract conditions. ▪ The contract object and the definition of it is seldom the same. ▪ We should be more willing to address the basic aspects every time to at least identify possible improvement areas. This is a key issue: Be specific every time ✓ Then, how should we proceed to bring more knowledge about this area, to make up ‘guidelines’ for contract strategies in the project context for the future? ▪ Increase understanding among the actors. ▪ A first step would be recognising that there is no “one size fits” all approach to contracting. ▪ List all those parameters that have a bearing on the contract strategy.

	▪ Assess the underlying variables and formulate recommendations for the appropriate strategy around these ▪ Analyse the reasons why things succeed and other fail ▪ Reviewing the work processes leading up to contract award, Supply Process. ▪ A key deliverable is the production of documentation defining these processes (Process Maps), checklists, key success factors and organisational learning through workshops and cross fertilisation from project teams. ▪ Improve knowledge and understanding of how the various mechanisms and strategies was established and how they have been proven in practice. ▪ Project objectives become more demanding there will be more innovative contract forms that seek to align supply chain “actors” and allocate or share risks more appropriately. ▪ A systematic examination of pros and cons when choosing project strategies needs to be recognised as a best practice. ▪ Tap into the experience of the people who will be executing and administering the contract during its life- the wealth of experience available will help make better decisions, weight the responses, and the guidelines could then be developed from this information. ▪ Front end loading – Clever, analysing project participants, who do their work up front
9. Incentives	✓ What kind of incentives and/or incentive mechanisms do you believe to support a win/win context for both clients and contractors? ▪ Target based incentives. ▪ Dynamic, reflecting the dynamics of the project’s development. ▪ Aligning; company’s goals => project => contract strategy => contract formats and structure => contractor’s goals. ▪ Must reflect an understanding of the context dependency. ▪ Linked to actor’s capability versus SOW. ▪ Designed around the project’s real business needs, as well as possible to commit to.

	▪ Simple ones that focus on the things that matter. ▪ Designed in areas where the project's supply chain actors are in a position to influence. ▪ "Make the important measurable, not the measurable important" ✓ Could incentive mechanisms be counter-effective? ▪ Targets and milestones should be realistic, otherwise such schemes would be counter-effective. ▪ Challenge is to find and set 'realistic', static time and cost targets. ▪ No hidden agendas; the project's (open) targets should be the same as the actor's tagets. ▪ If too complex, detail focused, and doesn't address things that matter. ▪ Sub-optimisation, versus global/project optimisation. ▪ Balanced versus skewed focus.

Participants & Contributors

Those that contributed up-front to the workshop with input to the questionnaire and/or participated in the workshop were:

Name	Company
Mr. Mike Abramczyk	ESSO Norge
Mr. Johan Almen	Aker Maritime
Mr. Thor Chr. Andvik	Statoil
Mr. Bjorn Egil Asbjornslett	Epci
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Mr. Imre Csoti	Raytheon Engineers & Constructors B.V.
Mr. Henk Dolman	Raytheon Engineers & Constructors B.V.
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Mr. Magne Holta	Statoil
Mr. Mark Iden	Preussag
Mr. Odd Instefjord	Epci / Statoil
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Mr. Hogne Pedersen	Statoil
Mr. Malcolm J. Sheperd	Foster Wheeler
Mr. Knut Skarestad	Phillips Petroleum Company
Ms. Mette Sundholm	Statoil
Mr. Oliver N. Utoy	Statoil
Mr. Raj Verma	Norsk Hydro
Mr. Rolf Vestre	Norsk Hydro

Appendix F – Agile Virtual Enterprise Reference Model.

Appendix F gives the full structure of the Agile Virtual Enterprise Reference Model (Goransson, 1999). The full structure of the reference model is not presented as a matrix in Goransson (1999).

The Agile Virtual Enterprise Reference Model (Based on structure as listed in; Goranson, H.T., 1999. *The Agile Virtual Enterprise. Cases, Metrics, Tools*. Quorum Books, Westport, CT.)			**Infrastructure Breakdown**[67]																																
			Social/ Cultural			Legal/Explicit															Physical														
						Business Processes					Contracts/Regulations					Workflow					Logistics/Warehousing					Equipment					Laws of Physics				
			B.a Social and Psychological Laws	B.b Community Cultures	B.c Business Culture	C.a.a Strategy Development	C.a.b Supervise Risk/Reward Process	C.a.c Supervise Engineering Quality	C.a.d Work Scheduling	C.a.e Depth of Customer Relations	C.b.a Quality Assurance Agreements	C.b.b Risk/Reward Contracts	C.b.c How the Virtual Enterprise is Represented	C.b.d Assignment of New Technology	C.b.e Labour Agreements	C.c.a Planning Work Breakdown Assignment	C.c.b Work Breakdown Responsibilities	C.c.c Monitoring/Adjusting the WBS	C.c.d Arbitration/Adjudication	C.c.e Routine Exception Handling	D.a.a VE Human Collaboration	D.a.b VE Product Collaboration	D.a.c Customer's Pipeline, Product	D.a.d Customer's Pipeline, People	D.a.e Raw Commodities	D.b.a How Modular	D.b.b How Reconfigurable	D.b.c How Scalable	D.b.d How Relocatable	D.b.e How Storable	D.c.a Geographically Limited Processes	D.c.b Scale Limited Processes	D.c.c Attention Limited Processes	D.c.d Time Limited Processes	D.c.e Accident Limited Processes
Decision Point Breakdown	Opportunity Identification	1.1 Opportunity strategy																																	
		1.2 Opportunity Exposure																																	
		1.3 Targeted Marketing																																	
		1.4 Search																																	
	Partner Identification	2.1 Opportunity Strategy																																	
		2.2 Partner Performance History																																	
		2.3 Partner Search																																	
	VE Formation	3.1 Vision/Strategy Development																																	
		3.2 Partner Criteria and Selection																																	
		3.3 Enterprise Metrics																																	
		3.4 Capitalisation																																	
		3.5 Product Liabilities																																	
		3.6 Risk/Reward Strategy																																	
		3.7 Operating Strategy																																	
		3.8 Dissolution Plan																																	
	VE Operation	4.1 Performance Metrics																																	
		4.2 Customer Relations																																	
		4.3 Operating Practice																																	
	Reconfigure/ Dissolution	5.1 Identification of Need																																	
		5.2 Residual Liabilities																																	
		5.3 Dissolution Plan																																	

[67] Information infrastructure is not presented in the matrix. This is also one infrastructure breakdown, though it is not broken further down in Goranson (1999).