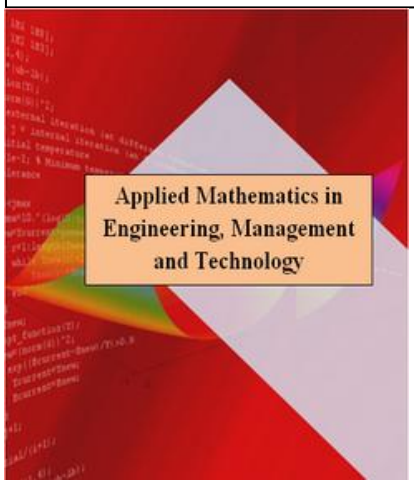
Applied mathematics in Engineering, Management and Technology 3(4) 2015:446-466
www.amiemt-journal.com

How to reduce costs and manage risk in the upstream oil and gas industry with enterprise project portfolio management solutions Case study :Iranian oil company

Seyed Saeed Madani
National Iranian oil company



Abstract:

Cost reduction and risk management are two key concepts in managing and controlling the process of upstream oil and gas industry and have significant effect on improving the efficiency and effectiveness of final products. Generally, oil and gas companies face with so many hazard matters and materials and in this case using a framework for controlling the procedures and activities is so vital. In this paper, a common framework based on enterprise project portfolio management is presented in order to review useful solutions. The results of the current research could be useful for oil and gas contractors and companies.

Introduction

Cost reduction and risk management are two key concepts in managing and controlling the process of upstream oil and gas industry and have significant effect on improving the efficiency and effectiveness of final products. The target of this study is to review some useful solutions in order to managing and controlling the risk of oil and gas procedures based on project portfolio management.

Cost reduction strategies:

Cost reduction is the process used by companies to reduce their costs and increase their profits. Depending on a company's services or product, the strategies can vary. Every decision in the product development process affects cost.
Companies typically launch a new product without focusing too much on cost. Cost becomes more important when competition increases and price becomes a differentiator in the market.

The most important Cost reduction strategies are as follows:

- Supplier consolidation
- Component consolidation
- Low-cost country sourcing
- Request for quotations (RFQ)
- Supplier cost breakdown analysis
- Function cost analysis / Value analysis / Value engineering
- Design for manufacture / Design for assembly
- Reverse costing
- Cost driver analysis
- Product benchmarking
- Design to cost
- Design workshops with suppliers
- Competitor benchmarking

As a small business owner you can follow their lead to boost your profits as well. There is no one-size-fits-all approach. But one of the key themes in this research is to not wait until the ship is sinking before plugging your profit leaks.

1. Cost-cutting Strategy: Expense Category

This is the most common method small business owners use to cut their excess costs. It's simple, the information is generally readily available, and the cost-cutting options are easily found. Common areas for expense category cuts are: space, telecom, vehicles, utilities, and printing; they might be different in your business. The analysis begins with your current expenses and a view toward a more suitable level for those expenses. Take a look at your tax return or a recent profit and loss statement. Expenses cut across products, services, customers, and locations. There are lots of quick wins available with this powerful cost-cutting strategy.

In which business expense categories have your costs grown beyond expectations? Perhaps a look at your year-over-year or seasonal trends might signal that an expense category analysis could be worthwhile in your business now.

2. Cost-cutting Strategy: Product

The second strategy focuses your cost-cutting attention on a specific product or division. In this approach, all related expenses are on the table for consideration. The European company BASF recently underwent a major analysis to reduce fixed costs at its specialty chemicals business even as sales and profits increased in other areas. A small business owner could explore: purchasing, materials, design, production, and delivery, among other areas tied to a product.

Any and every cost related to this product is under review. In this strategy, there's a strong possibility that inter-related expenses can be found. For example, a change in materials could lead to a change in design options and production methods. Be advised that these changes can move in both directions; one way increases quality while another could measurably reduce quality.

Are all of your products delivering their fair share to your bottom line? If it has been a while since you have done a product profitability analysis, now is a good time to see if more of your attention is warranted.

3. Cost-cutting Strategy: Geographic

The third strategy focuses on a specific geographic area or physical location such as a branch. Generally, an income statement for the city (multiple stores) where the business is operating or a specific store location can be easily compiled. In this case all the numbers are used to evaluate whether the location is pulling its weight in terms of contributing to the required minimum profit margin and overheads. Electrolux decided to close its factory for refrigerators and freezers in Australia to concentrate its production in Thailand.

Regional bank Hancock Holding Company is closing or selling 36 branches in Louisiana and Texas affecting around 300 staff and costing $21m in the process. Yet it's often not an overall industry phenomenon; in fast food Quiznos is closing stores while Subway is opening them. KFC is shrinking while Chick-fil-A is expanding. And it's not just who you see across the street; retailers including Best Buy and Barnes & Noble are facing stiff on-line competition.

If you have multiple locations it's time to run a geographic income statement to consolidate all the profits and expenses associated with that location. This analysis needs to be a bit more strategic because physical distribution expenses to some profitable locations will be greatly affected if some nearby locations are closed. So take a holistic look at this cost-cutting strategy before taking any action. But it is definitely worth a look.

- <strong<="" strong=""></strong

- As much as we small business owners don't like to admit it, some customers are simply not worth it. If you've encountered some bad customer behavior in your past you know exactly what I mean. These are the customers that make excessive demands, whose expectations simply cannot be met while you deliver your offerings at a reasonable profit. I'm not referring to a one-off incident. Time and time again these customers squeeze out extra services, extra benefits, rework, special treatment, late nights, expedited delivery and a whole host of other cost building activities without a commensurate increase in price.
- When we are starting our businesses we welcome all customers with great anticipation that the exchange will indeed be profitable. That's the deal. You deliver quality and they pay a fair price. I know of a woman who was banned from the Home Shopping Network because she returned almost everything; there is a pattern here over several years. The lifetime value of the customer was simply not high enough to retain her as a customer.

You don't need to take drastic action, but knowing what has happened in the past and your options going forward is very powerful. If you're not sure whether you're making money on each and every customer, perform a customer profitability analysis on a few of them. You'll know where to start. Look at the revenues and go beyond the numbers to include the associated services, time, and money required to service them and see if you are really generating your target profit margins on each customer in question. Look at your fixed costs to check on contribution. And you'll find it's time to treat your high-profit customers just a little better too.

Risk Management

Risk management is the identification, assessment, and prioritization of risks (defined in ISO 31000 as the effect of uncertainty on objectives) followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events[1] or to maximize the realization of opportunities. Risk management's objective is to assure uncertainty does not deflect the endeavor from the business goals.[2]

Risks can come from various sources: e.g., uncertainty in financial markets, threats from project failures (at any phase in design, development, production, or sustainment life-cycles), legal liabilities, credit risk, accidents, natural causes and disasters as well as deliberate attack from an adversary, or events of uncertain or unpredictable root-cause. There are two types of events i.e. negative events can be classified as risks while positive events are classified as opportunities. Several risk management standards have been developed including the Project Management Institute, the National Institute of Standards and Technology, actuarial societies, and ISO standards.[3][4] Methods, definitions and goals vary widely according to whether the risk management method is in the context of project management, security, engineering, industrial processes, financial portfolios, actuarial assessments, or public health and safety.

Risk sources are more often identified and located not only in infrastructural or technological assets and tangible variables, but also in human factor variables, mental states and decision making. The interaction between human factors and tangible aspects of risk highlights the need to focus closely on human factors as one of the main drivers for risk management, a "change driver" that comes first of all from the need to know how humans perform in challenging environments and in face of risks (Daniele Trevisani, 2007). As the author describes, «it is an extremely hard task to be able to apply an objective and systematic self-observation, and to make a clear and decisive step from the level of the mere "sensation" that something is going wrong, to the clear understanding of how, when and where to act. The truth of a problem or risk is often obfuscated by wrong or incomplete analyses, fake targets, perceptual illusions, unclear focusing, altered mental states, and lack of good communication and confrontation of risk management solutions with reliable partners. This makes the Human Factor aspect of Risk Management sometimes heavier than its tangible and technological counterpart»[5]

Strategies to manage threats (uncertainties with negative consequences) typically include transferring the threat to another party, avoiding the threat, reducing the negative effect or probability of the threat, or even accepting some or all of the potential or actual consequences of a particular threat, and the opposites for opportunities (uncertain future states with benefits).

Certain aspects of many of the risk management standards have come under criticism for having no measurable improvement on risk, whereas the confidence in estimates and decisions seem to increase.[1] For example, it has been shown that one in six IT projects experience cost overruns of 200% on average, and schedule overruns of 70%.[6]

Widely used vocabulary for risk management is defined by ISO Guide 73, "Risk management. Vocabulary."[3]

In ideal risk management, a prioritization process is followed whereby the risks with the greatest loss (or impact) and the greatest probability of occurring are handled first, and risks with lower probability of occurrence and lower loss are handled in descending order. In practice the process of assessing overall risk can be difficult, and balancing resources used to mitigate between risks with a high probability of occurrence but lower loss versus a risk with high loss but lower probability of occurrence can often be mishandled.
Intangible risk management identifies a new type of a risk that has a 100% probability of occurring but is ignored by the organization due to a lack of identification ability. For example, when deficient knowledge is applied to a situation, a knowledge risk materializes. Relationship risk appears when ineffective collaboration occurs. Process-engagement risk may be an issue when ineffective operational procedures are applied. These risks directly reduce the productivity of knowledge workers, decrease cost-effectiveness, profitability, service, quality, reputation, brand value, and earnings quality. Intangible risk management allows risk management to create immediate value from the identification and reduction of risks that reduce productivity.
Risk management also faces difficulties in allocating resources. This is the idea of opportunity cost. Resources spent on risk management could have been spent on more profitable activities. Again, ideal risk management minimizes spending (or manpower or other resources) and also minimizes the negative effects of risks.

Method

For the most part, these methods consist of the following elements, performed, more or less, in the following order.
1. identify, characterize threats
2. assess the vulnerability of critical assets to specific threats
3. determine the risk (i.e. the expected likelihood and consequences of specific types of attacks on specific assets)
4. identify ways to reduce those risks
5. prioritize risk reduction measures based on a strategy

Principles of risk management

The International Organization for Standardization (ISO) identifies the following principles of risk management:[7]
Risk management should:
- create value – resources expended to mitigate risk should be less than the consequence of inaction, or (as in value engineering), the gain should exceed the pain
- be an integral part of organizational processes
- be part of decision making process
- explicitly address uncertainty and assumptions
- be a systematic and structured process
- be based on the best available information
- be tailorable
- take human factors into account
- be transparent and inclusive
- be dynamic, iterative and responsive to change
- be capable of continual improvement and enhancement
- be continually or periodically re-assessed

RISK AND UNCERTAINTY

The first section of the literature review emphasises the centrality of risk and uncertainty to investment decision-making by focusing on the following three questions:

How does the academic investment decision-making literature conceptualise risk and uncertainty?

How do investment decision-makers conceptualise risk and uncertainty?
How do these decision-makers cope with risk and uncertainty in investment decision-making?

Investigating the methods of coping with risk and uncertainty adopted by investment decision-makers highlights the role of quantitative techniques. This leads into identification of the need for a study that ascertains which of the tools and techniques that are presented in the decision theory literature are most appropriate for investment appraisal. This is the first research question that this thesis aims to answer.

Consider the first question proposed above. Risk and uncertainty are inherent in all decision-making (Bailey et al., in press, Hammond et al., 1999; Harrison, 1995; Goodwin and Wright, 1991; Morgan and Henrion, 1990) and hence receive considerable attention in the academic investment decision-making literature (for example, Atrill, 2000; Buckley, 2000; Murtha, 1997; Borsch and Mossin; 1968). This prominence is well deserved. Ubiquitous in realistic settings, risk and uncertainty constitute a major obstacle to effective capital investment decision-making (Simpson et al., 2000 and 1999; Lamb et al., 1999; Ball and Savage, 1999; Watson; 1998; Rose, 1987; Murtha, 1997; Newendorp, 1996; Oransanu and Connolly, 1993; McCaskey, 1986; Brunsson, 1985; Corbin, 1980; Thompson, 1967).

AUTHORS	TERM	CONCEPTUALISATION
1. Anderson et al. (1981)	Uncertainty	A situation in which one has no knowledge about which of several states of nature has occurred or will occur
2. Anderson et al. (1981)	Uncertainty	A situation in which one knows only the probability of which several possible states of nature has occurred or will occur
3. Anderson et al. (1981)	Risk	Same as (1)
4. Anderson et al. (1981)	Risk	Same as (2)
5. Humphreys and Berkley (1985)	Uncertainty	The inability to assert with certainty one or more of the following: (a) act-event sequences; (b) event-event sequences; (c) value of consequences; (d) appropriate decision process; (e) future preferences and actions; (f) one's ability to affect future events
	Risk	
6. Lathrop and Watson (1982)	Uncertainty	Potential for deleterious consequences
7. Lathrop and Watson (1982)	Uncertainty	Lack of information available concerning what the impact of an event might be
8. MacCrimmon and Wehrung (1986)	Risk	Exposure to the chance of loss in a choice situation
9. Harrison (1995)	Uncertainty	A common state or condition in decision-making characterised by the possession of incomplete information regarding a probabilistic outcome.
10.Harrison (1995)	Risk	An uncommon state of nature characterised by the absence of any information related to a desired outcome.
11.Spradlin (1997)	Risk	The possibility of an undesirable result
12.Holmes (1998)	Uncertainty	A situation which refers to a state where the decision-maker has sufficient information to determine the probability of each outcome occurring.
13.Holmes (1998)		A situation where the decision-maker can identify each possible outcome, but does not have the information necessary to determine the probabilities of each of the possibilities.

However, despite this prominence, there is much confusion in the academic investment decision-making literature over the definitions of risk and uncertainty. Table 2.1 presents a sample of the definitions of risk and uncertainty given by some of the contributors to the capital investment decision-making literature. The table clearly illustrates conceptual proliferation in the academic investment decision-making literature. This has led Argote (1982 p420) to assert:

"…there are almost as many definitions of risk and uncertainty as there are treatments of the subject."

A comment echoed by Yates and Stone (1982 p1):

"…if we were to read 10 different articles or books on risk, we should not be surprised to see it described in 10 different ways."

CURRENT PRACTICE IN INVESTMENT APPRAISAL DECISION-MAKING

The fundamental concepts used in decision analysis were formulated over two hundred years ago. Yet the application of these concepts in the general business sector did not become apparent until the late 1950s and early 1960s (for example, Grayson, 1960), and it has only been within the last five to ten years that it has seriously been applied to investment decision-making in practice (for example, see Section 6.3 of Chapter 6 and studies by Schuyler (1997) and Fletcher and Dromgoole (1996)). Furthermore, it is widely acknowledged that current practice in the techniques used for investment appraisal decision-making in practice in all industries trails some way behind current decision theory (for example, Atrill, 2000; Arnold and Hatzopouous, 1999; Schuyler, 1997). This has been established via empirical research which has tended to focus on whether, when and which decision analysis techniques are used by organisations (for example see studies by Arnold and Hatzopoulous, 1999; Carr and Tomkins, 1998; Schuyler, 1997; Buckley et al., 1996 Fletcher and Dromgoole, 1996; Shao and Shao, 1993; Kim et al., 1984; Stanley and Block, 1983; Wicks Kelly and Philippatos, 1982; Bavishi, 1981; Oblak and Helm, 1980; Stonehill and Nathanson, 1968). These studies have typically used survey techniques to produce statistical results indicating the percentage of organisations using decision analysis techniques (for example, Schuyler, 1997). As will be discussed in more detail in Chapter 4, utilising survey techniques for data collection has precluded the researchers from conducting an investigation of why companies endorse the use of some techniques and yet fail to implement others and, more importantly, it prevents the identification of the decision analysis techniques which perform best (that is, where the predicted outcome from the technique is close to the actual outcome) (Clemen, 1999). As will be seen in section 3.4, the failure of these earlier studies to investigate such issues has contributed to the divide between the behavioural decision theorists and decision analysts, and to the gulf between current practice and current capability in decision analysis highlighted above (Clemen, 1999). Evidently then, since the empirical research conducted to date has limitations, there is a need for a study to establish common practice in investment appraisal. This is the second research question that this thesis aims to address.

In the early 1950s, there were many proposals suggesting how a decision-maker should objectively choose a best strategy from the admissible class. No sooner did someone suggest a guiding principle of choice, however, than someone else offered a simple concrete example showing that this principle was counterintuitive in some circumstances and therefore the proposed principle could not serve as the long sought key (Raiffa, 1968). In 1954, Savage laid the foundations of modern Bayesian decision theory. In particular he showed that utilities and subjective probabilities could model the preferences and beliefs of an idealised rational decision-maker facing a choice between uncertain prospects. At least, they should do, if you accept Savage's axiomatic definition of rationality (French, 1984). Building on Savage's work, decision analysis was developed in the 1960s by Howard Raiffa (Raiffa, 1968; Raiffa and Schlaifer, 1961) and Ronald Howard (1968), and represents an evolution of decision theory from an abstract mathematical discipline to a potentially useful technology (foreword by Phillips in Goodwin and Wright, 1991).

Simplistically, decision analysis seeks to introduce intuitive judgements and feelings directly into the formal analysis of a decision problem (Raiffa, 1968). Its purpose is to help the decision-maker understand where the balance of their beliefs and preferences lies and so guide them towards a better informed decision (French, 1989 p18). The decision analysis approach is distinctive because, for each decision, it requires inputs such as executive judgement, experience and attitudes, along with the "hard data". The decision problem is then decomposed into a set of smaller problems. After each smaller problem has been dealt with separately, decision analysis provides a formal mechanism for integrating the results so that a course of action can be provisionally selected (Goodwin and Wright, 1991 p3). This has been referred to as the "divide and conquer" orientation of decision analysis (Raiffa, 1968).

Decompositional approaches to decision-making have been shown to be superior to holistic methods in most of the available research (for example, Kleinmuntz et al., 1996; Hora et al., 1993; MacGregor and Lichenstein, 1991; MacGregor et al., 1988; Armstrong et al., 1975). Fischer (1977) argues that decompositional approaches assist in the definition of the decision problem, allow the decision-maker to consider a larger number of attributes than is possible holistically and encourage the use of sensitivity analysis. Holistic evaluations, he believes, are made on a limited number of attributes, contain considerable random error and, moreover, are extremely difficult when there are fifty or more possible outcomes. Kleinmuntz (1990) shares this perspective. He suggests that the consistency of holistic judgements will deteriorate as the number of possible outcomes increases because of the limits on human information processing capabilities. Whereas he argues, systematic decomposition relaxes the information processing demands on the decision-maker reducing the amount of potential error in human judgement. Furthermore, since decompositional methods provide an "audit trail" it is possible to use them to produce a defensible rationale for choosing a particular option. Clearly this can be important when decisions have to be justified to senior staff, colleagues, outside agencies, partners, the general public, or even to oneself (Goodwin and Wright, 1991).

Since its conception the role of decision analysis has changed. No longer is it seen as a method for producing optimal solutions to decision problems. As Keeney (1982) points out:

"Decision analysis will not solve problems, nor is it intended to do so. Its purpose is to produce insight and promote creativity to help decision-makers make better decisions." (Goodwin and Wright, 1991 p4)

This changing perception of decision analysis is also emphasised by Phillips (1989):

"…decision theory has now evolved from somewhat abstract mathematical discipline which when applied was used to help individual decision-makers arrive at optimal decisions, to a framework for thinking that enables different perspectives on a problem to be brought together with the result that new intuitions and higher level perspectives are generated." (Goodwin and Wright, 1991 p4)

However, whilst decision analysis does not produce an optimal solution to a problem, the results from the analysis can be regarded as "conditionally" prescriptive which means that the analysis will show the decision-maker what they should do, given the judgements that have been elicited from them during the course of the analysis. The fundamental assumption underlying this approach is that the decision-maker is rational (Goodwin and Wright, 1991). When a decision-maker acts rationally it means that they calculate deliberately, choose consistently, and maximise, for example, their expected preference/utility. Consistent choice rules out vacillating and erratic behaviour. If it is assumed that managerial decision-makers want to maximise, for example, their personal preferences, and that they perceive that this will happen through maximising the organisation's objectives, then it may also be assumed that such managers will pursue the maximisation of the organisation's performance in meeting its objectives (Harrison, 1995 p81). More simply, if managers are rewarded based on the organisation's performance and they behave rationally, they will try to maximise the outcome of their decisions for the organisation, to achieve the highest amount of personal utility.

DECISION ANALYSIS AND ORGANISATIONAL PERFORMANCE

As Dean and Sharfman (1996) observe, the following two assumptions must hold to prove a link between investment decision process and decision effectiveness. Firstly, it must be assumed that investment decision processes are related to choices; or, more specifically, that the investment decision process followed influences the choices made. Although this assumption appears intuitively obvious, many academics have argued that the operating environment shapes organisational and individual choices (for example, Aldrich, 1979; Pfeffer and Salancik, 1978). Others, however, claim that despite the existence of these external factors, managers retain a substantial degree of control over choices (for example, Miles, 1982; Child, 1972). One argument made in favour of this position by Dean and Sharfman (1996) is that some managers make very poor choices with devastating consequences for their firms, while others in very similar circumstances make much better choices (for example, Bourgeois, 1984). Such variation, the authors assert, could not exist if constraints alone were driving decisions. Hence, Dean and Sharfman (1996) conclude that it appears likely that viable outcomes are a product of the decision process used. Leading on from this, the second assumption is that choices relate to outcomes, and that all outcomes are not equally good. Once again there can be very little doubt that external forces also influence decision effectiveness (Hitt and Tyler, 1991; Pfeffer and Salancik, 1978). Changes in competitor strategies or customer tastes can turn strategic coups into disasters or vice versa. However, Dean and Sharfman (1996) note that it is unlikely that the influence of such forces eliminates the impact of choice on decision effectiveness as it is hard to imagine a decision in which all potential choices will be equally successful or unsuccessful.

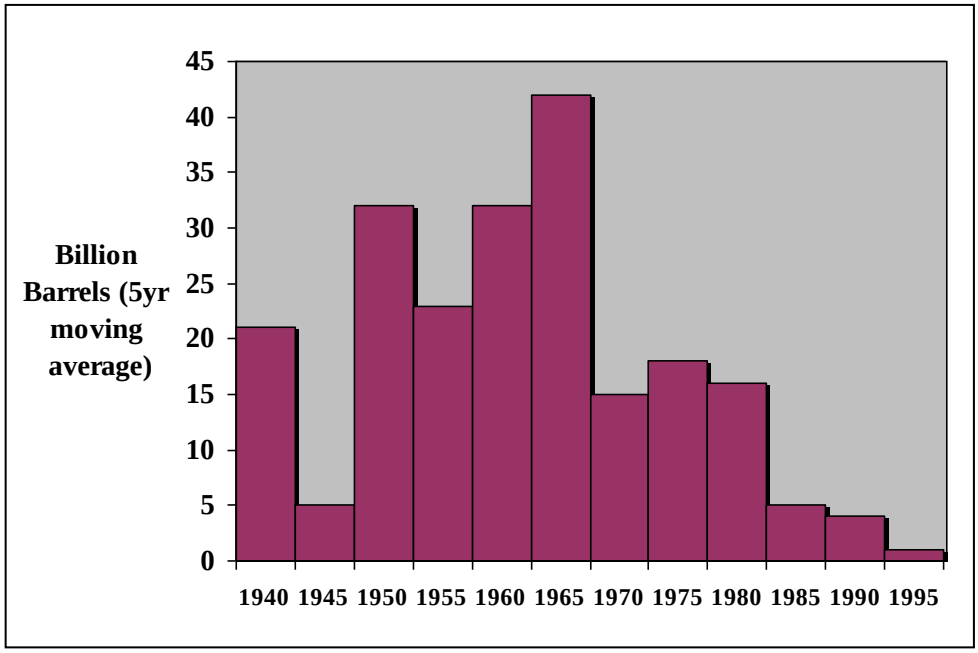
The two assumptions then appear plausible (Dean and Sharfman, 1996) which suggests that it is reasonable to expect the investment appraisal decision-making process to influence decision effectiveness. However, as Aldrich rightly observed (1979), the importance of managerial decisions in determining organisational outcomes is ultimately an empirical question (Dean and Sharfman, 1996). Many empirical studies have investigated the existence of a relationship between the investment decision-making process and effectiveness. None have concentrated on the use of decision analysis in the investment decision-making processes of organisations. However, several have explored the effects of comprehensiveness, rationality, formality and consensus in the decision-making process on organisational performance. In much of the decision theory literature, it is argued that decision analysis provides:

"…convincing rationale for choice, improves communication and permits direct and separate comparisons of different people's conceptions of the structure of the problem, and of the assessment of decomposed elements within their structures, thereby raising consciousness about the root of any conflict." (Humphreys, 1980 in Goodwin and Wright, 1991 p177)

- Field size

Globally many of the oil majors still generate much of their output – and profits – from giant fields discovered decades ago. For example, in 1996 it was estimated that 80% of BP's (British Petroleum) oil and gas production was from North America and Britain, mainly from a handful of large fields in Alaska and the North Sea (The Economist, 1996). Production from nearly all these giant fields is either near its peak or is already declining. New fields are rarely as large or as profitable as these earlier large reservoirs. Worldwide since the mid-1980s, few giant oilfields have been discovered (figure 3.1) and, although, many smaller fields have been found, they have not delivered the same economies of scale (The Economist, 1996).

Figure 1: Worldwide giant fields (initial reserves by discovery year) (source: Campbell, 1997 p52)



- Finite resource

Whilst virtually everyone is agreed that oil is a finite resource there is much disagreement in the industry about exactly when demand will irreversibly exceed supply. Some analysts, such as Campbell (1997) argue that production of conventional oil, which he defines to be that oil with a depletion pattern which starts at zero, rises rapidly to a peak, and then declines rapidly, will peak in 2010 (figure 3.2). Others believe it will last much longer:

"…the world is running into oil not out of it ... The issue [of limited oil resources will be] unimportant to the oil market for 50 years" (Odell, 1995)

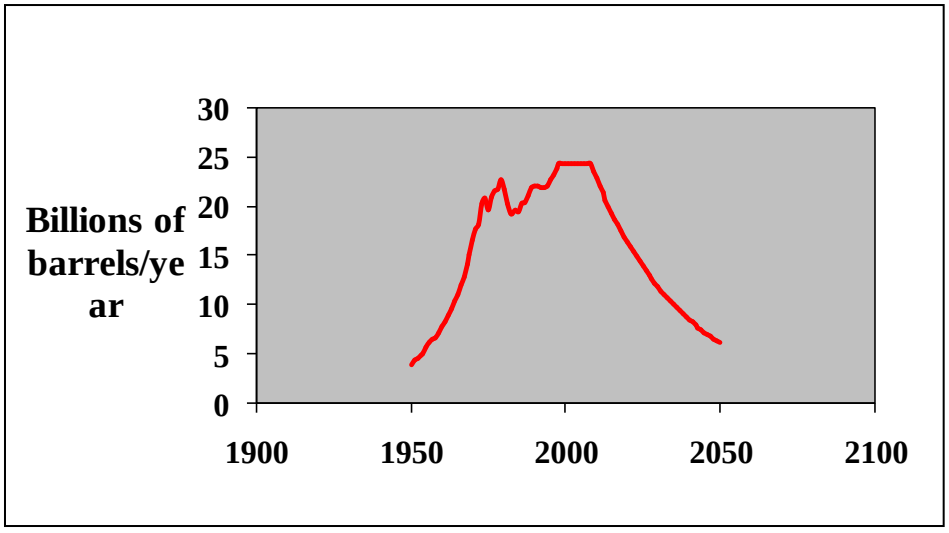
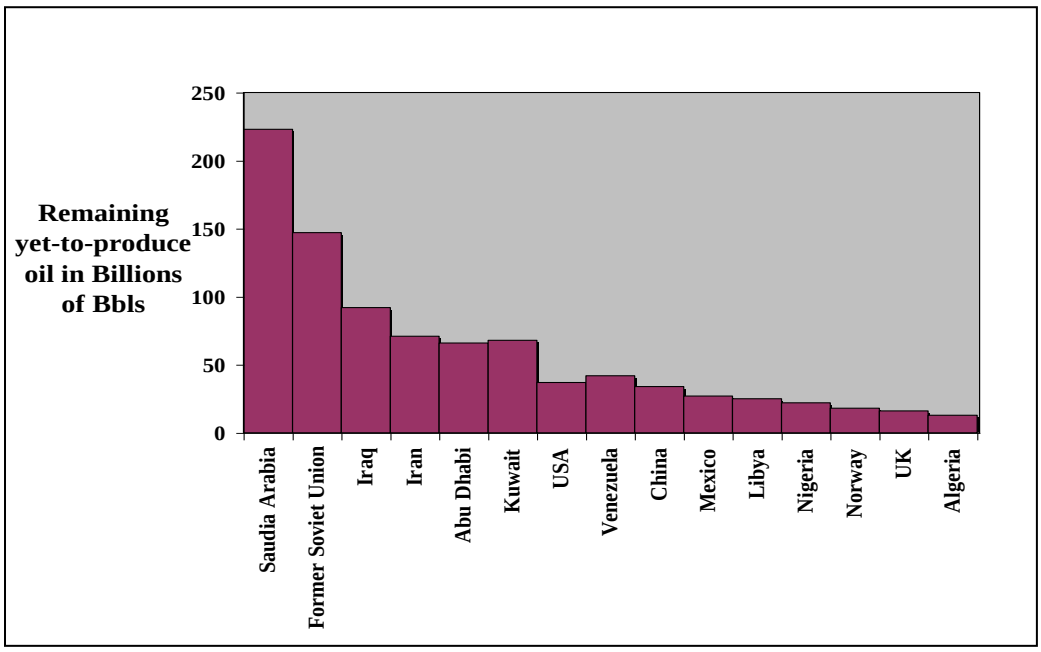


Figure 2: Campbell's prediction of world oil production after 1996 (actual production to 1996 and then predicted thereafter) (source: Campbell, 1997 p100)

Yet, much of this is conjecture. What is known is that worldwide proven reserves have increased by approximately two thirds since 1970 but the countries that contain ample quantities of low cost oil, and which account for most of that increase, are currently inaccessible to western firms (figure 3.3). Middle Eastern

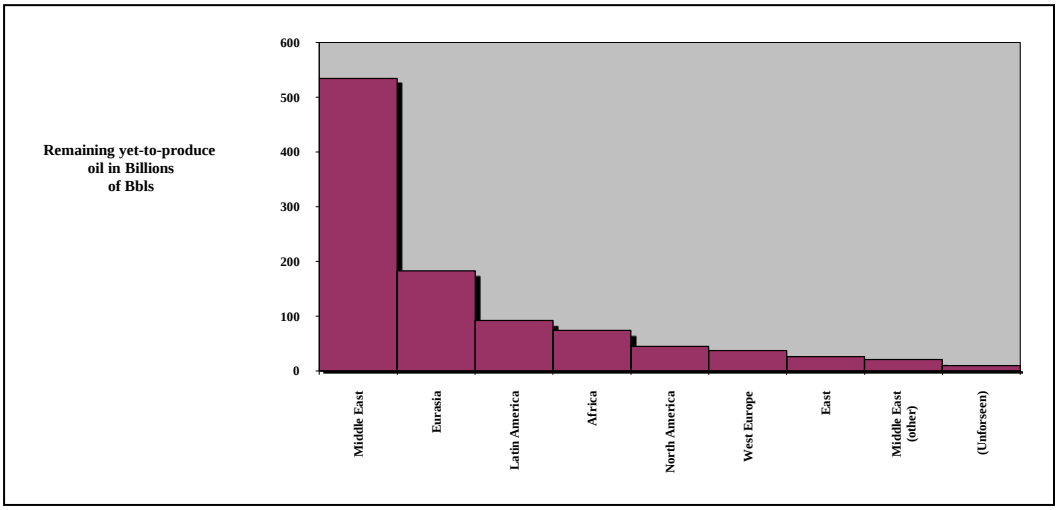
countries that are members of the Organisation of Petroleum Exporting Countries (OPEC), for example, account for almost sixty percent of the worlds' proven reserves (figure 3.4).

Figure 3.: Distribution of remaining (Yet-to-Produce) oil (in Billions of Bbls) by country (calculated by subtracting total production of conventional oil to date from Campbell's estimate of cumulative production of



conventional oil and dividing by country) (source: Campbell, 1997 p 95)

Figure4: Distribution of remaining (Yet-to-Produce) Oil (in Billions of Bbls) by region (calculated by subtracting total production of conventional oil to date from Campbell's estimate of cumulative production of



conventional oil and dividing by region) (source: Campbell, 1997 p95)

However, nationalism runs high in Saudi Arabia and Kuwait and relationships within Iraq are tenuous – a situation which is unlikely to change in the near future (The Economist, 1996). Moreover, whilst the statistics might indicate that technically the oil firms are reporting increased reserves in reality this conceals two trends. Firstly, by using new technology either to extend field life or to exploit fields that were previously inaccessible, oil companies have been able to increase their reported reserves. Secondly, petroleum companies are becoming increasingly reliant on gas which is harder to transport and less profitable to produce (The Economist, 1996).

Some, such as Laherrère (1999), are more cynical and believe that the bulk of the recent "reserves growth" can be attributed to faulty reporting practices.

- Demand

World demand for oil, gas and coal in the 21st century will depend on two contrary forces. Firstly, there is the possible reduction in demand by the countries in the Organisation for Economic Co-operation and Development (OECD) caused by structural changes, saturated markets, ageing populations and increasing efficiency. Such efficiency gains are driven by competition, concerns for energy security and environmental measures. Action to meet Kyoto targets, set in a summit on global warming in Kyoto, Japan in December 1997, will put a cost on carbon emissions – either by taxation or by trading. Coal and oil will face fierce competition in power generation. As indicated above, oil majors are relying increasingly on gas (The Economist, 1996). Skeikh Ahmed Zaki Yamani believes that new hybrid engines could cut petrol consumption by almost 30%, while fuel-cell cars, which he predicts will be widely used by 2010, will cut demand for petrol by 100%. In a recent article in Energy Day he said:

"Thirty years from now there will be a huge amount of oil – and no buyers. Oil will be left in the ground. The Stone Age came to an end not because we had a lack of stones and the oil age will come to an end not because we have a lack of oil." (Energy Day, 3rd July 2000 p7)

His claims are substantiated by a study from U.S. based Allied Business Intelligence (ABI), which forecasts millions of fuel-cell vehicles by 2010. ABI business analyst Atakan Ozbek is also quoted in the same Energy Day article:

"By the second decade of this century mass production of automotive fuel cells will result in first a glut in the world oil supply and then in a total reduction of oil as a vehicle fuel." (Energy Day, 3rd July 2000 p7)

Secondly, there is the potential demand in developing countries. How it is fulfilled depends on future economic growth. The oil companies, however, are optimistic with Shell suggesting that energy consumption will be between sixty and eighty percent higher by 2020, with developing countries consuming over half of the available energy (Moody-Stuart, 1999).

- Restructuring

International oil prices are notoriously volatile (figure 3.5). However, when, in the winter of 1998-1999, oil prices dropped to their lowest levels in real terms for twenty-five years, the profit margins of even the largest companies were squeezed and all companies were forced to reduce costs. This proved difficult and with the need to improve their return on capital employed, which has historically been lower than the cost of that capital, the boards of some of the largest companies perceived the only way to make further savings was through big mergers, followed by ruthless restructuring (The Economist, 1998).

In 1998 BP agreed to buy Amoco for $48 billion, Exxon and Mobil, America's biggest oil firms, announced a $77 billion merger that has made Exxon Mobil the world's biggest oil firm – and, on some measures, the largest firm in the world. The merger is already starting to transform the world's oil industry. Firms that were once considered big, such as Chevron and Texaco, are rushing to find partners. This is true even in Europe, where national champions have traditionally resisted pressures to merge. France's Total announced in 1998 that it was buying Belgium's Petrofina for some $13 billion (The Economist, 1998) and, more recently, Total Fina have also bought France's Elf.

Whilst some argue that this is just typical oil industry over-reaction to the bottom of the price cycle (for example, Euan Baird of Schlumberger in The Economist, 1998), others believe that the structure of the oil industry has altered irreversibly:

"…the changes unleashed by the mergers look unstoppable" (The Economist, 1998 p74)

Indeed, whilst there may well always be a role for the "scrappy entrepreneur" (The Economist, 1998), size is becoming increasingly important in the oil industry. It takes a great deal of capital and a "matching appetite for risk" (The Economist, 1998), to succeed in the Caspian or West Africa. Tackling a $6 billion project in China will be a huge effort for Texaco, with its revenues of some $50 billion. For Exxon Mobil though, which is four times that size, such projects will be, according to The Economist (1998), "small potatoes".

This section has highlighted the current global challenges facing the oil industry. Since the current study will focus on those petroleum companies operating in the U.K., the next section examines the effect of the worldwide challenges on the U.K. industry. The impact on investment decision-making will then be investigated.

ADOPTING AN APPROPRIATE METHODOLOGICAL FRAMEWORK

Orton's (1997) summary of Daft's (1985) distinction between deductive research (theory, method, data, findings) and inductive research (method, data, findings, theory) suggests that the management research process can be viewed as a coherent series of logically directed steps. Gill and Johnson (1991) believe that such statements and the neat, tidy accounts of the conduct of the research process produced by seasoned researchers (Burgess, 1984a), are misleading. In particular, the authors argue that they simplify concepts which are frighteningly out of step with those researchers who have given a "warts and all" account of their methodologies (O'Mahoney, 1998; Barley, 1995; Bryman and Burgess, 1994; Ferner, 1989). Discussions by such researchers have revealed that social research is not a set of neat procedures. Rather, it is a social process whereby interaction between researchers and researched will directly influence the course of action which a research project takes (O'Mahoney, 1998; Okley, 1994; Burgess, 1984b; Shaffir et al., 1980; Shipman, 1976; Bell and Newby, 1977; Bell and Encell, 1978; Hammond, 1964). The research process, and hence the methodology employed, is not a clear cut sequence of procedures following a neat pattern, but a messy interaction between the conceptual and empirical world, with deduction and induction occurring at the same time (Bechofer, 1974 p73). Laing (1997) argues that the methodological framework cannot be seen as a rigid, purely objective construct. Rather, it should be perceived as a framework, the final version of which is determined by environmental pressures. It is within such a context that the methodological framework employed in this research has evolved. There is widespread recognition that there can be a significant gap between the methodological approach and intentions articulated at the commencement of the research project and that ultimately implemented (for example, O'Mahoney, 1998; Laing, 1997). Consequently, in seeking to demonstrate the validity and reliability of the data gathered and the results presented, it is necessary to examine and evaluate critically the actual research process undertaken (Laing, 1997) and this is the aim of this chapter.

In describing the core elements of management research, Gill and Johnson (1991 p154) stress the centrality of a comprehensive review of the existing literature to the research process. They describe the literature review phase of research as constituting:

"…a critical review which demonstrates some awareness of the current state of knowledge on the subject, its limitations and how the proposed research aims to add to what is known."

A comprehensive review and critical appraisal of the relevant literature is thus crucial to formulating the underlying research questions to be examined by the study and in the subsequent development of the specific research instruments to be utilised in the data gathering process. Following the approach used by Laing (1997), at the outset of this research, the literature review involved the systematic searching of a number of major databases against a list of key words and phrases. This allowed the researcher to identify as fully as possible all published material that broadly related to aspects of the research subject. From this comprehensive search, relevant articles and texts were obtained, analysed, annotated and classified. Subsequently, the references and bibliographies of key articles and texts identified from these databases were searched in order to follow up additional potentially relevant material. This literature review was continually updated throughout the duration of the research process as additional relevant material was published. The new publications, though not

impacting on the development of the underlying research questions or the specific research instruments, enhanced the subsequent analysis of the primary data gathered during the field research.

In seeking to explore the investment decision-making process of the upstream oil and gas industry, the literature review for the study, presented in Chapters 2 and 3, examined research from two different areas. Firstly, it investigated the academic literature on investment decision-making and, in particular, that relating to decision theory and secondly, it explored the literature relating to the industry and its investment decision-making process. Reviewing these literatures highlighted gaps in existing knowledge and the identification of the research questions for the current study. These three questions are:

1. Which techniques are the most appropriate for companies to utilise in their investment decision-making?
2. Which techniques do companies use to make investment decisions and how are they used in the investment decision-making process?
3. Is there a relationship between using decision analysis techniques in investment appraisal decision-making and good organisational performance?

This section will examine the specific research instruments used to explore these questions in turn. The following section will evaluate the effectiveness of the methodological approach.

To answer the first research question and identify the decision analysis tools that are most appropriate for investment appraisal decision-making in the upstream oil and gas literature, the current study drew primarily on the decision theory and oil industry literatures. This involved firstly, identifying the whole range of techniques that are available and, secondly deciding which of these tools are the most appropriate for upstream investment decision-making. It demanded careful consideration of factors such as the business environment of the upstream industry and the level and type of information used for investment decision-making in the industry. Through this process, the research identified the decision analysis techniques that are particularly useful for upstream investment decision-making. Then, drawing again on the investment appraisal and industry literatures, and also on insights gained at conferences and seminars, an approach to investment decision-making in the oil industry was developed that utilised the full spectrum of tools identified. Some decision analysts advocate using one decision analysis technique for investment appraisal (for example, Hammond, 1966). However, in reality, each tool has limitations (Lefley and Morgan, 1999) some that are inherent, others which are caused by a lack of information or specification in the literature (see Chapter 5). As such, the knowledge that the decision-maker can gain from the output of one tool is limited (see Chapter 5 and Newendorp, 1996). Therefore, a combination of decision analysis techniques and concepts should be used to allow the decision-maker to gain maximum insight, encouraging more informed investment decision-making (this is justified in Chapter 5). Some oil industry analysts have recognised this and presented the collection of decision analysis tools that they believe constitute those that decision-makers ought to use for investment decision-making in the oil and gas industry (for example, Newendorp, 1996). However new techniques have only recently been applied to the industry (for example, Galli et al., 1999; Dixit and Pindyck, 1998 and 1994; Ross, 1997; Smith and McCardle, 1997) and as such, these previously presented approaches now require modification. Consequently, although informed through secondary data sources, the identification of the decision analysis techniques that are most appropriate for investment appraisal decision-making and the approach to investment appraisal that is presented in this thesis, are believed to be two of the main findings of the research.

In exploring the second research question, the current study aimed to establish current practice in investment appraisal decision-making in the operating companies in the U.K. oil and gas industry. Two factors directly affected the choice of research method chosen to investigate this question; firstly, there is widespread recognition in social science research that the primary strength of qualitative research is that it facilitates the in-depth exploration of the perceptions and values of key organisational stakeholders. Bryman (1989 p12) identified the principal advantage of qualitative research as being that:

"…it expresses commitment to viewing events, actions, norms and values from the perspective of the people being studied."

This reflects the primarily interpretive approach inherent in qualitative research involving the exploration of meanings and perceptions within a naturalistic rather than positivist framework (Hammersley and Atkinson, 1983). Such essentially intangible issues, Laing (1997) argues, cannot be explored adequately by traditional quantitative survey-based research methods. A second factor that impinged on the choice of research method was that previous empirical research had typically used quantitative survey-based research which had produced statistical results that indicated the percentage of organisations using decision analysis techniques (defined in Chapter 5) (for example see studies by Arnold and Hatzopoulous, 1999; Carr and Tomkins, 1998; Schuyler, 1997; Buckley et al., 1996; Shao and Shao, 1993; Kim, Farragher and Crick, 1984; Stanley and Block, 1983; Wicks Kelly and Philippatos, 1982; Bavishi, 1981; Oblak and Helm, 1980 and Stonehill and Nathanson, 1968). Researchers such as Clemen (1999) perceived that through using survey-based research methods these studies had overlooked many interesting issues. For example, they had not indicated why decision analysis was used in some organisations but not others nor had they provided an explanation of why companies endorsed the use of certain techniques and failed to implement others (Clemen, 1999). It can be argued that the failure of such studies to examine these issues had contributed to the division between behavioural decision theorists and decision analysts outlined in Section 2.4 of Chapter 2. Therefore, qualitative methods were chosen to build a picture of decision analysis use in upstream organisations. In using such an approach the researcher aimed to investigate the relationship between normative decision analysis models and behavioural decision theory descriptions.

The next step involved deciding which companies would comprise the population for the current study. Limited resources had already dictated that the research had to be constrained to oil companies who had offices in the U.K.. A list of all the operators active in the U.K. was obtained via UKOOA (United Kingdom Offshore Operators Association). These thirty-one companies then constituted the population for the research study.

Following this, the next decision was which qualitative instrument, or combination of instruments, to use. Methods such as case study research and participant observation were clearly impractical with such a large number of companies within a relatively short and finite time-period. Acknowledging that the companies in the sample were all competitors, and that the issues that would be under discussion are commercially sensitive multi-company focus group discussions were also omitted from consideration. Intra-company focus groups were considered and rejected since it was felt that this would prohibit a frank expression of attitudes and experiences and become an exercise in reporting the formal organisational perspective. This process of elimination identified a semi-structured style of interviewing with several respondents in each company to be a useful instrument to employ in this research. Using this technique, a set of themes and topics is defined to form questions in the course of conversation. This strategy, it is argued in the qualitative methods literature, gives informants an opportunity to develop their answers and allows the researcher the freedom to follow up ideas, probe responses and investigate motives and feelings (for example, Okley, 1994; Bryman, 1989). It also allows the researcher to be sensitive to the participants' understanding of the language and concepts under investigation. In exploring the investment appraisal decision process, the interviews focussed on four core areas. These were firstly, decision analysis techniques that were used and why; secondly, how the tools were used; thirdly, the integration of the results from the techniques into the whole investment decision-making process; and fourthly, respondents' perceptions of the effectiveness of the process. Based on such core themes, a common interview schedule (Appendix 1) was developed. The initial questions focused on relatively broad conceptual issues, progressing to specific practical issues during the course of the interview, with the aim of producing rich and detailed accounts of the participants' perceptions of the investment decision-making process.

BP volunteered to pilot the interview schedule and the researcher visited them several times in April 1998 to conduct interviews. The researcher was unfamiliar with interviewing. Taping the interviews permitted reflection later on the researcher's ability and role as an interviewer. The interviews were transcribed and these transcripts played a valuable role indicating those terms and processes the researcher was using which were academically understood but which required clarification at practitioner level. The interview schedule was amended accordingly with some questions being rephrased, others discarded and several new questions being added. These interviews were used to improve the researcher's technique as an interviewer rather than for data collection. After the modification of the interview schedule, the transcripts from these interviews were discarded.

The researcher then had to decide whom to approach in each of the companies and how best to approach them. Ideally, the researcher wanted to speak to individuals who were actively involved in the whole investment appraisal process. With this rationale, it was decided to approach each operator's Exploration Manager, or equivalent, using the membership list of the Petroleum Exploration Society of Great Britain. Initially the project was outlined in a letter that indicated what would be required of each participant company, detailing what would be done with the collected data and giving assurances of confidentiality and anonymity. This was then followed up with either an e-mail or telephone call.

The letters were sent in March 1998 and the researcher began receiving responses in early April. The number of positive responses was overwhelming. Twenty-seven of the thirty-one companies approached agreed to participate – a response rate of 87%. This high response rate is clearly a function of timing and subject. As indicated in Chapter 3, the increasingly dynamic and complex operating environment of upstream had increased the pressure on petroleum companies to manage their investment decision-making processes better and decision analysis techniques were beginning to receive increasing attention in the industry literature (for example, Ball and Savage, 1999; Galli et al., 1999; Watson, 1998; Schuyler, 1997; Murtha, 1997; Nangea and Hunt, 1997; Otis and Schneiderman, 1997; Newendorp, 1996). During the interviews, many of the respondents reported that their organisations were currently in the process of reviewing their investment decision-making processes and that this was their motivation for participating in the research.

Data collection began in May 1998. The interviews varied in length with the majority lasting approximately two hours. All the interviews were tape recorded in full. In addition, notes were taken during the interviews to highlight key issues and facilitate the subsequent analysis of transcripts. After assurances of confidentiality and anonymity, none of the respondents had any reservations about such recording. This emphasis on confidentiality inevitably influences the way in which the data is subsequently utilised and presented. All the companies interviewed have been assigned a code letter. The letter that was assigned to each company depended on the number of decision analysis techniques used in their investment appraisal approach. Company A used the least number of decision analysis techniques. Company B used the next least number of decision analysis tools and so on. These labels have been used throughout the thesis. Although 27 companies were originally interviewed, subsequent merger activity reduced this number to 20. So only letters A to T have been assigned to represent the interviewed companies, with letter T representing the company that used the highest number of decision analysis techniques. Where more than one respondent was interviewed in an organisation, each interviewee was assigned a number so that, for example, the second respondent that was interviewed from company B would be referred to as B2 and the third as B3. It is important to note that where companies merged, the respondents in these organisations were contacted after the merger and asked to report any changes to their corporate investment appraisal process. These insights were then analysed along with the relevant interview transcripts in the next stage of the research.

While divisions exist amongst researchers over the issue of whether interviews should be transcribed selectively or in full (Bryman, 1989), given the emphasis within this research on securing an in-depth understanding of attitudes and experiences, it was decided to transcribe all interviews in full. Such an approach, though time-consuming, facilitated the identification of themes, utilisation of quotations and the avoidance of biased judgements arising from initial impressions of the interview data. In addition, when coding the interview data from the transcripts, the original tapes were utilised, alongside the contemporaneous notes, in order to ensure that the interviewees' expression and emphasis was taken into account (Laing, 1997). Where necessary, respondents were contacted by telephone or e-mail for clarification.

The challenges of analysis and interpretation of qualitative data are widely recognised and well documented (Rossman and Rallis, 1998; Bryman and Burgess, 1994; Hammersley, 1992; Denzin, 1978). The difficulty of handling such data is well illustrated by Miles' (1979) description of qualitative data as "an attractive nuisance". In analysing the data from this research, rigorous use was made of appropriate structural approaches such as inductive analysis. In inductive approaches to data analysis, hypotheses are not generated before the data are collected and therefore the relevant variables for data collection are not predetermined. The data are not grouped according to predetermined categories. Rather, what becomes important to analyse emerges from the data itself, out of a process of inductive reasoning (Maykut and Morehouse, 1994 pp126-127). In this

research project, the analysis of the interview data involved the coding of this data against both the core themes contained in the interview schedule which were derived from the analysis of the relevant literature and the emergent themes identified through the contemporary notes. After this initial coding, the data was further coded under more specific themes as well as additional emergent themes. Such multi-stage coding is vital in order to avoid as far as possible constraining any potential empirically based conceptual development to flow from this research (Denzin, 1978). It must be noted that while the data collection and data analysis elements of the research are described separately here, they cannot be seen as discrete stages (Laing, 1997). In common with many other qualitative studies, the collection and inductive analysis of the data ran concurrently although the balance between the two elements shifted over the duration of the research. Okley (1994 pp20-21) writes that

"...to the professional positivist this seems like chaos. … The fieldworker cannot separate the act of gathering the material from that of its continuing interpretation. Ideas and hunches emerge during the encounter and are explored or eventually discarded as fieldwork progresses."

suggest possible improvements.

EVALUATING THE EFFECTIVENESS OF THE RESEARCH METHODOLOGY

Through the utilisation of qualitative methods and statistical analysis the research presented in this thesis has generated a robust body of data. This claim can be justified on three counts.

First, using the academic investment decision-making and oil industry literatures, an approach to investment decision-making has been developed that utilises the full complement of decision analysis techniques presented in the decision theory literature. Second, using semi-structured interviews a description of the use of decision analysis in investment decision-making in the upstream was produced that is representative of current practice in the industry. The data from this second stage are consistent with previous research that indicated a gap between current practice and current capability in investment appraisal (for example see studies by Arnold and Hatzopoulous, 1999; Carr and Tomkins, 1998; Schuyler, 1997; Buckley et al., 1996; Shao and Shao, 1993; Kim, Farragher and Crick, 1984; Stanley and Block, 1983; Wicks Kelly and Philippatos, 1982; Bavishi, 1981; Oblak and Helm, 1980 and Stonehill and Nathanson, 1968). The findings as such are demonstrably valid and reliable. Thirdly, using the data gathered from the research interviews and publicly available financial data, the relationship between use of decision analysis techniques in investment appraisal decision-making and good organisational performance was investigated statistically. As such the research has contributed to the current discussion (for example, Clemen and Kwit, 2000; Clemen, 1999) in the decision theory literature of the relationship between normative and descriptive models of investment decision-making. Furthermore, since the sample used in this research contains 87% of the U.K. petroleum operators, it is clear that the findings are representative of all U.K. petroleum operators. Moreover, since most of the oil companies that operate in the U.K. are amongst the major players in the oil industry, the findings can be said to be indicative of investment decision-making practices in the major companies in the worlds' upstream oil and gas industry.

As with any research, the results have to be interpreted bearing in mind some limitations. The context within which the research is undertaken inevitably impinges on the actual articulation of the research methods employed. In this regard the time, and by implication the resource limitations, influenced the final methodology adopted in three ways.

Firstly, time and resource constraints precluded the use of observational research techniques that would have facilitated an enhanced understanding of the dynamics of the investment decision-making process and the links between the different stages of the process, the "soft" effects on organisation performance from using decision analysis and the relationships between the individuals involved.

Secondly, the research was limited to a single time period that coincided with a period of very low oil prices, proliferation of mergers and corresponding job losses. Interviewing respondents who knew that they were to be made redundant affected the data gathered from them since respondents often perceived their organisations' approach to decision-making as extremely poor and portrayed their management in a less than favourable light.

In all cases this data was disregarded and other respondents were used in these companies. Furthermore, there was tremendous uncertainty in the industry at this time and many companies were changing their approach to investment decision-making and, as indicated above, were becoming more interested in decision analysis. Often the respondents from these companies were actively involved in this change and, on many occasions, they perceived the current study as a vehicle for initiating or encouraging it. As indicated in section 4.2, this significantly affected the response rate and also resulted in these respondents being particularly forthcoming with information on company practice. If it had been possible to return to these companies, it would have been interesting to look further on the effect of the mergers on companies' investment appraisal decision-making practices.

Thirdly, resource and time constraints affected the number of people consulted in each company. Despite the initial intention to consult multiple respondents in each company this was often not possible. Typically, only one person in each company was interviewed usually this individual was the Exploration, Commercial or License Manager. Bowman and Ambrosini (1997) have described the dangers of using single-respondents to ascertain company practice. They argue that where single-respondents are used, the researchers must be convinced that the research results are not dependent on the person that happened to be surveyed or interviewed. In this study, where the researcher felt there was the possibility of bias from a particular company representative, this data was disregarded and another respondent in that organisation sought. Hence, the researcher is confident that the data gathered is representative of company practice. Furthermore, in this study, as indicated above, it was the Exploration Managers that were usually interviewed. In most companies Exploration Managers are usually involved in generating investment proposals and presenting these proposals to the boards of their companies. So, in most cases, this individual is often the only person in the company who has been involved in both generating the analysis and witnessing the investment decision-making process.
A general understanding of the oil industry can be gained from the process model shown in figure 5.1. In particular it highlights the extent to which investment appraisal decision-making in the upstream is characterised by risk and uncertainty as indicated in Chapter 3. The figure indicates the points at which investment decisions are taken to proceed with or to abort the project. If the decision is to continue, a further investment decision must be taken on whether to invest in the gathering and analysis of additional data in order to assess better the risk and uncertainty (at abandonment, the decision is not whether to abandon but when and how to do so). At any of these decision points, the consequences of that investment decision on all the subsequent processes, right through to the abandonment phase, need to be estimated and considered in the investment decision-making. For example, when a company is considering drilling a further appraisal well in a field, an estimate of the total recoverable reserves from the field needs to be produced and used as input to the economic analysis (Lohrenz and Dickens, 1993). The economic analysis will then model the cash flow throughout the project's life including a prediction of when the field will be abandoned and the estimated cost (Simpson et al., 2000).

The upstream oil and gas industry shares with some other businesses, such as the pharmaceutical industry and aerospace engineering, typically long payback periods. Payback is defined as the length of time between the initial investment in a project by the company and the generation of accumulated net revenues equal to the initial investment (figure 5.2). In the oil industry, this period is typically between ten to fifteen years.

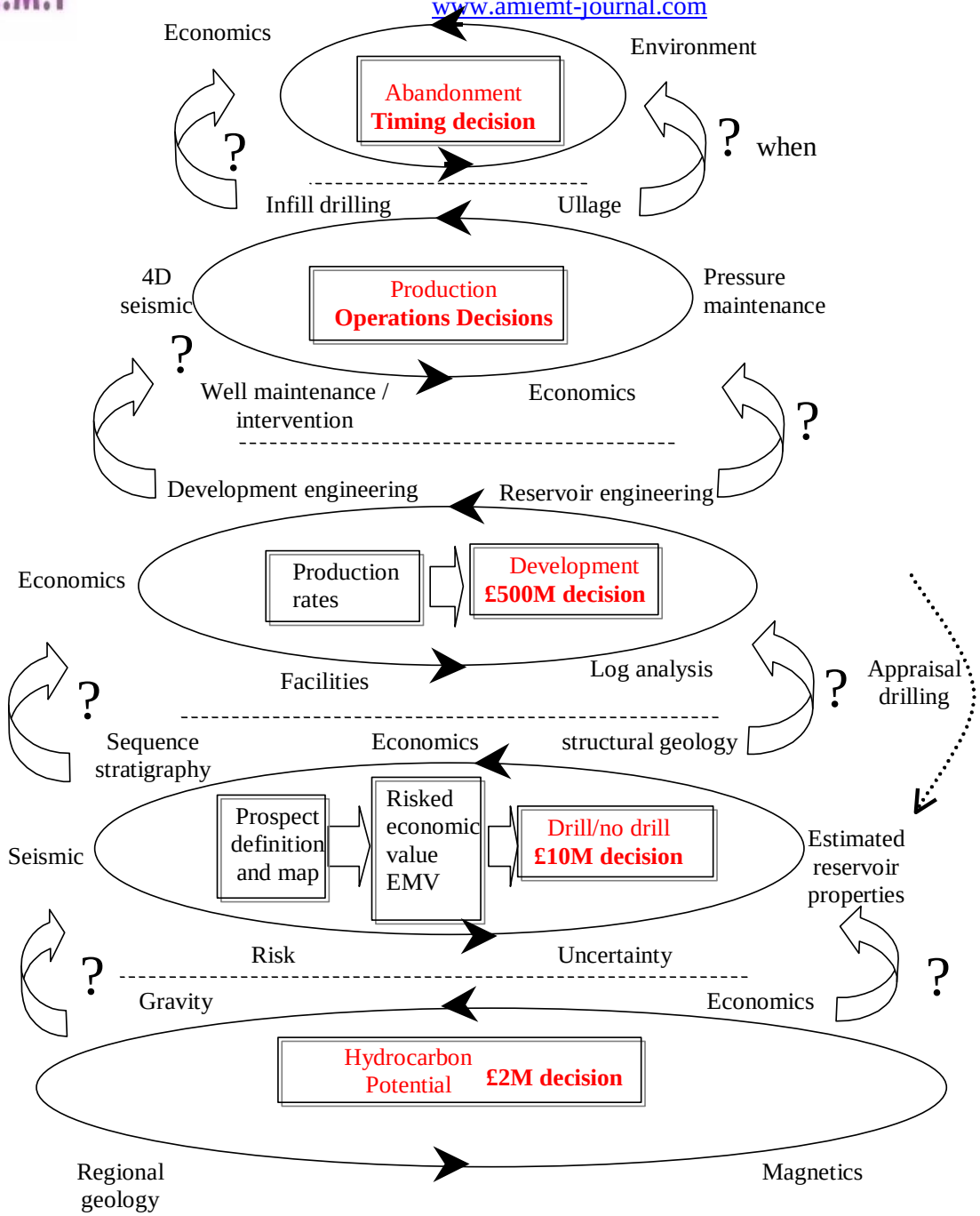


Figure 5: The upstream oil and gas industry: a multi-stage decision process

For example, in the North Sea there is an average gap of seven years between initial exploration expenditure and the commitment to develop a prospect. It takes another three or four years to get to the point when oil is actually produced and then fields normally produce for around twenty years before they are abandoned. (It should be noted that currently average lead times are being reduced through the wider availability of infrastructure and technology). Most of the main costs or cash outflows are incurred in the earlier, exploration and development, years while the cash inflows or revenues are spread over the active productive lifetime of the field. This makes economic modelling particularly difficult since at each investment decision point indicated in the process map in figure 5.1, estimates must be generated of the values in a decade's time of variables, some of which are notoriously volatile, such as, oil price and inflation. It also means that it is critical that discounted cash flow (DCF) techniques are adopted in investment appraisal (Simpson et al., 1999). The most well known DCF tool is the net present value (NPV) method and it will be reviewed here. The intention is to give only a brief overview of NPV. More detailed explanations can be found in finance and economics texts (for example, Atrill, 2000; Brealey and Myers, 1996; Drury, 1985; Weston and Brighman, 1978).

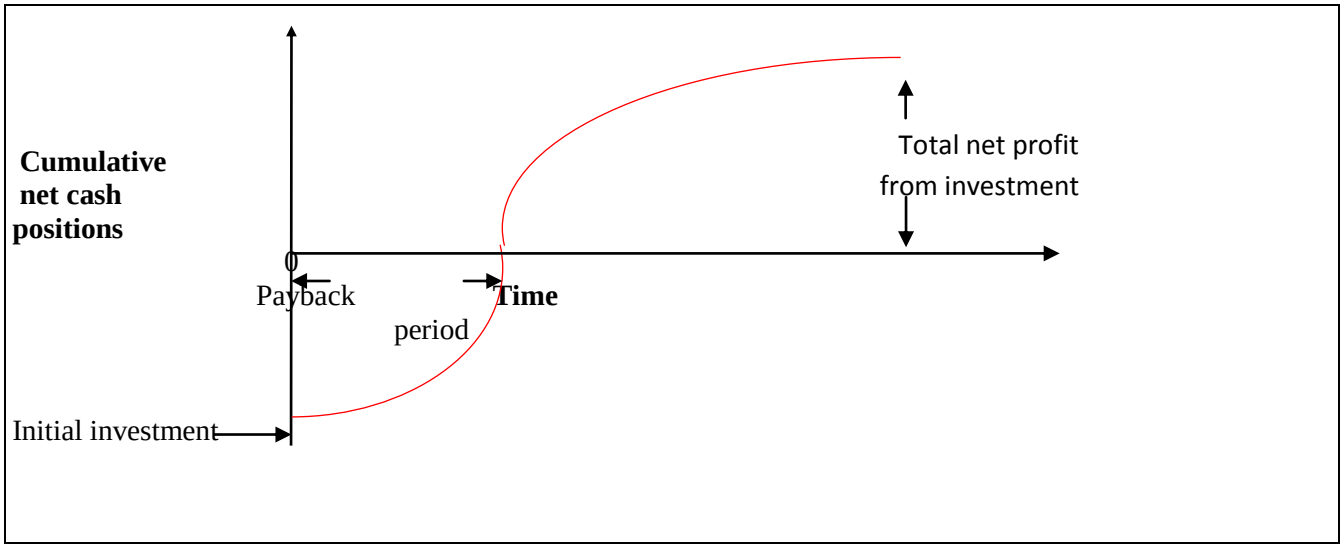


Figure 6: Cumulative cash position curve (source: adapted from Newendorp, 1996 p14)

As indicated above, when money is invested in a project a commitment of funds is generally required immediately. However, the flow of funds earned by the investment will occur at various points of time in the future. Clearly, receiving £1000 in, for example, a year's time is less attractive than receiving £1000 now. The £1000 now could be invested so that in a year's time it will have earned interest. This implies that money that will be earned in the future should be discounted so that its value can be compared with sums of money being held now. This process is referred to as discounting to present value (Goodwin and Wright, 1991 p147).

The severity with which future sums of money are discounted to their present value is a function of the discount rate applied. Determining the appropriate discount rate for a company's potential investment project is, ultimately, a matter of judgement and preference. However, many attempts have been made to make the choice of a discount rate as "objective" as possible, making this a complex area which is beyond the scope of this thesis. Edinburgh based oil industry analysts Wood Mackenzie's base case nominal discount rate is made up of four different elements:

- The risk-free real rate of return available through an index-linked, long-term gilt yield. This comprises the real rate of interest known at the time of purchase and whatever inflation rate occurs over the period of redemption.
- An assumption of the long-term inflation rate.
- The equity risk premium. This is the return expected by equity investors over and above the return on risk free assets. A premium is required because equity returns – like upstream investments – can only be estimated and are not guaranteed.
- The exploration risk premium. Oil companies are generally perceived as being "riskier" than the equity market (Wood Mackenzie, 1998).

Conclusion:

This paper tackled the subject of managing and controlling the risk in oil and gas procedures based on management portfolio solutions. The results of the current paper could be useful and applicable for oil and gas contractors and companies.

References

Aldag, R.J., and Power, D.J., 1986, An empirical assessment of computer aided decision analysis, Decision Sciences, 17, pp572-588
Aldrich, H.E., 1979, Organisations and environments, Englewood Cliffs, Prentice Hall, New Jersey
Allaire, Y., and Firsitrotu, M.E., 1989, Coping with strategic uncertainty, Sloan Management Review, 3, pp7-16
Allais, M., 1953, Le comportement de l'homme rationnel devant le risque: Critique des postulates et aximoes de l'ecole americaine, Econometrica, 21, pp503-546
Allias, M., and Hagen, J., editors, 1979, Expected utility hypotheses and the Allais paradox, Dordrecht, The Netherlands, Reidel
Anderson, B.F., Deane, D.H., Hammond, K.R., and McClelland, G.H., 1981, Concepts and Judgement in Decision Research, Praeger, New York
Argote, L., 1982, Input uncertainty and organisational co-ordination in hospital emergency units, Administrative Science Quarterly, 27, pp420-434
Argote, L., Seabrigh, M.A., and Dyer, L., 1986, Individual versus group use of base rate and individuating information, Organisation Behaviour and Human Decision Processes, 38, pp65-75
Armstrong, J.S., Denniston, W.B., and Gordon, M.M., 1975, The use of decomposition principle in making judgements, Organisation Behaviour and Human Decision Processes, 14, pp257-263
Arnold, G.C., Hatzopoulous, P.D., 2000, The theory-practice gap in capital budgeting: Evidence from the United Kingdom, Journal of Business Finance and Accounting, June, volume 27, numbers 5 and 6, pp603-626
Atrill, P., 2000, Financial Management for Non-specialists, Second Edition, Prentice Hall, England
Bailey, B., Couet, B., Lamb. F., Rose, P., and Simpson, G., in press, Taking a Calculated Risk, Oilfield Review
Ball, B.C. and Savage, S.L., 1999, Holistic vs. Hole-istic E&P Strategies, SPE 57701, Journal of Petroleum Technology, September, pp74-84
Barley, S., 1995, Images of imaging: notes on doing longitudinal fieldwork, in Huber, G. and Huber, G. and Van de Ven, A. (editors), Longitudinal Field Research Methods: Studying processes of organisational change, Sage, London
Baumard, P., 1999, Tacit Knowledge in Organisations, Sage Publications, London
Bavishi, V.B., 1981, Capital budgeting practices at multinationals, Management Accounting, August, pp32-35
Baxter, M. and Rennie, A., 1996, A financial calculus: An introduction to derivative pricing, Cambridge University Press, Cambridge
Bechofer, F., 1974, Current Approaches to empirical research: some central ideas, in Rex, J., (editor), Approaches to Sociology: an introduction to major trends in British Sociology, Routledge, Kegan Paul, London
Bell, C. and Encel, S., 1978, (editors), Inside the Whale, Peragamon Press, Oxford
Bell, C. and Newby, H., 1977, (editors), Doing Sociological Research, Allen&Unwin, London
Bernoulli, D., 1738, Specimen theoriae novae de mensura sortis, translated by Louise Sommer published in Econometrica, volume 22, 1954, pp23-36
Bernoulli, J., 1713, Ars conjectandi tractatus de seribus infinitis, Basel
Bernstein, P.L., and Silbert, T.H., 1984, Keeping Informed, Harvard Business Review, 62(5), pp32-40
Black, F. and Scholes, M., 1973, The pricing of options and corporate liabilities, Journal of Political Economy, 81, pp637-554
Blair, J.D., Slaton, C.R., and Savage, G.T., 1990, Hospital Physician Joint Ventures: a Strategic Approach for Both Dimensions of Success, Hospital and Health Services Administration, 35(1), pp3-26
Borsch, K. and Mossin, J., (editors), 1968, Risk and Uncertainty, proceedings of a conference held by the International Economic Association, Macmillan, New York
Bourgeois, L.J., III, 1985, Strategic goals, perceived uncertainty, and economic performance in volatile environments, Academy of Management Journal, 28, pp548-573
Bourgeois, L.J., III, 1984, Strategic management and determinism, Academy of Management Review, 9, pp586-596
Bourgeois, L.J., III, 1981, On the Measurement of Organisational Slack, Academy of Management Review, 6, pp29-39
Bourgeois, L.J., III, and Eisenhardt, K.M., 1988, Strategic Decision Processes in High Velocity Environments: Four cases in the Microcomputer Industry, Management Science, 34(7), pp816-835
Bowman, C. and Ambrosini, V., 1997, Using Single Respondents in Strategy Research, British Journal of Management, volume 8, pp119-131
Weston, J.F., and Brighman, E.F., 1978, Management Finance, 6th edition, Holt, Rinehart and Winston, New York
Whiteside, M., 1997, Portfolio Optimisation, Indeva Energy Consultants, Oxon
Whitney, J. and Smith, R., 1983, Effects of Cohesiveness on Attitude Polarisation and the Acquisition of Knowledge in a Strategy Planning Context, Journal of Marketing Research, 20, pp167-176
Whyte, W.F., 1955, Street Corner Society, 2nd Edition, University of Chicago Press, Chicago
Wicks Kelly, M.E. and Philippatos, G.C., 1982, Comparative analysis of foreign investment practices by US based manufacturing multinational companies, Journal of International Business Studies, 13(3), pp19-42
Wildavski, A., 1988, Searching for safety, Transactions Publishers, New Brunswick (USA)
Wilmot, P., Dewynne, J., and Howison, S., 1994, Option Pricing, Financial Press, Oxford
Winter, F.W., 1985, An Application of Computerised Decision Tree Models in Management Union Bargaining, Interfaces, 15(2), pp74-80

Wiseman, J., 1974, The research web, Urban Life and Culture, volume 3, number 3, pp317-328
Wohstetter, R., 1962, Pearl Harbour: Warning and Decision, Stanford University Press, Stanford, CA
Wood Mackenzie, 2000, Newsletter, issue 37, February
Wood Mackenzie, 1999, North West Europe Upstream Service, May
Wood Mackenzie, 1998, North Sea Report 272, November
Wooldridge, B., and Floyd, S.W., 1990, The Strategy Process, Middle Management Involvement, and Organisational Performance, Strategic Management Journal, 11, pp231-241
World Vest Base, http://www.wvb.com
Wright Investors Service, http://www.wisi.com/index.htm
Yates, J.F. and Stone, E.R., 1992, The risk construct, in Yates, J.F., (editor), Risk taking behaviour, pp1-26, Wiley, New York
Yergin D., 1991, The Prize: The epic quest for oil, money and power, Simon and Schuster, Sydney
Zimmer, A.C., 1983, Verbal vs Numerical processing of subjective probabilities, in Scholz, R.W., (editor), Decision-making under uncertainty, Amsterdam