AN EVALUATION OF THE UPSTREAM CRUDE OIL INDUSTRY SUPPLY CHAIN RISK : LEVERAGING ANALYTIC HIERARCHY PROCESS

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AGENDA

- Introduction
- Research Objectives
- Research Methodology
- Data Collection and Analysis
- Empirical Results and Discussion
- Conclusions and Managerial Implications

INTRODUCTION

- Global supply chains, are becoming complex as goods and services are delivered faster and cheaper
- Greater disruption risk from the source of raw materials to the consumer
- The potential for disruption comes in many packages, from large-scale natural disasters and terrorist attacks to plant manufacturing fires, widespread electrical blackouts, and operational contingencies and terrorist attacks
- The upstream crude oil supply-chain networks are vulnerable and susceptible to disruption risk in drilling, pipeline operation, transportation and distribution.
- Post 9/11, the biggest risk in the oil industry remains security threat that ranges from exploration and development security to pipeline security, maritime transport security, to protection of product distribution and retailing sector.

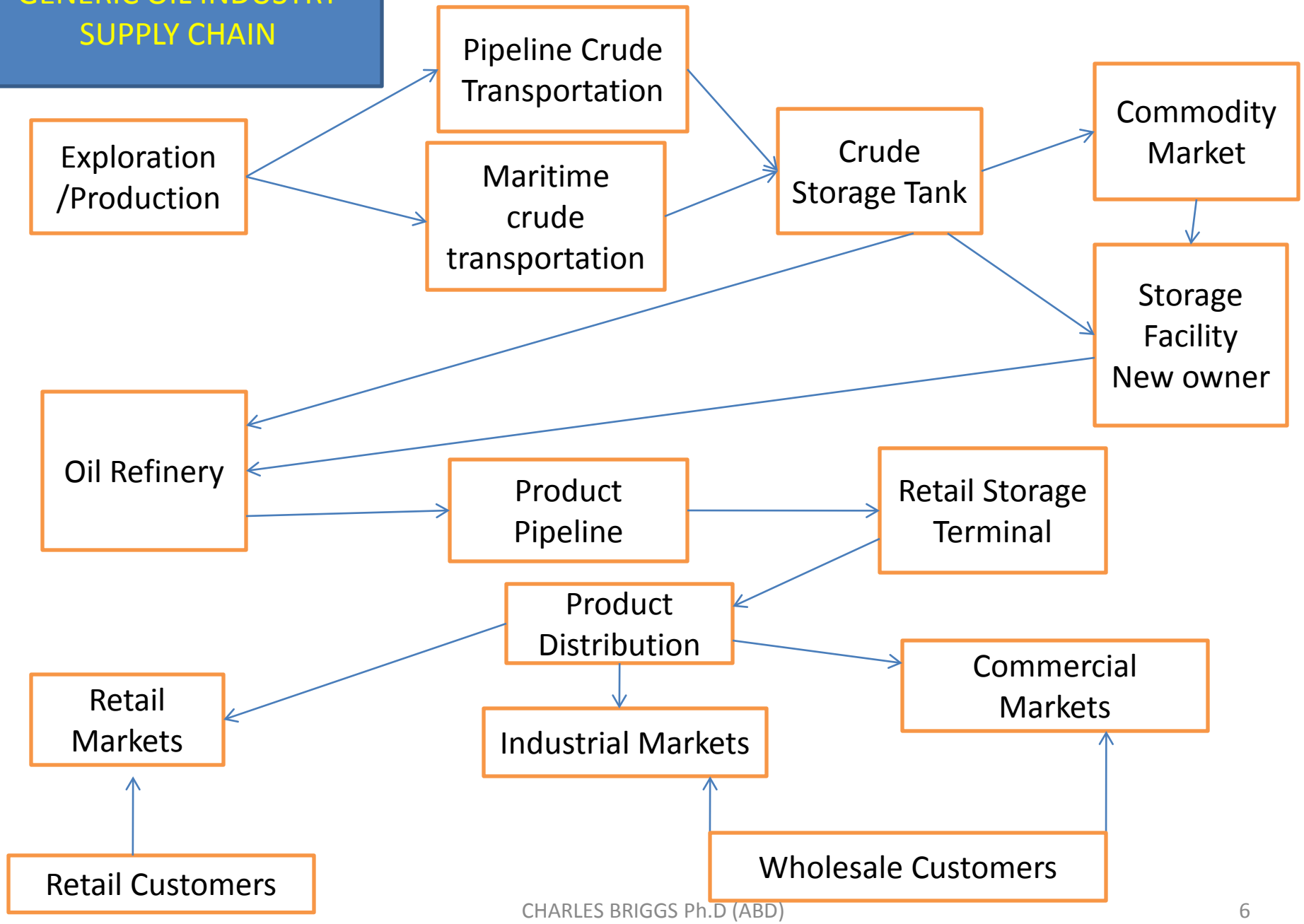
RESEARCH OBJECTIVES

- Identifies sources of the upstream crude oil supply chain risks and vulnerabilities
- Leverage the analytic hierarchy process (AHP) to model risk management in the crude oil industry supply chain.
- Analyze and evaluate the potential impact of risks in the UCOSC
- Propose risk treatments (mitigation) in the UCOSC

Topology of the Oil Industry Supply Chain

- The oil industry supply chain is a complex network of several entities consisting of:
  - **Upstream**: Exploration, Development, Production, and Transportation of the crude oil to the point of transformation into final products.
  - **Midstream:** Consists of the infrastructure used to transport crude oil and petroleum products, such as Very Large Crude Carriers (VLCCs) and liquefied Natural Gas (LNG) tankers or through pipeline networks to various refineries around the world
  - **Downstream**: Processing, Transportation, Marketing and Distribution. And serves two different customers:

GENERIC OIL INDUSTRY SUPPLY CHAIN



Maritime Crude Oil Transportation

Pipeline crude oil Transportation

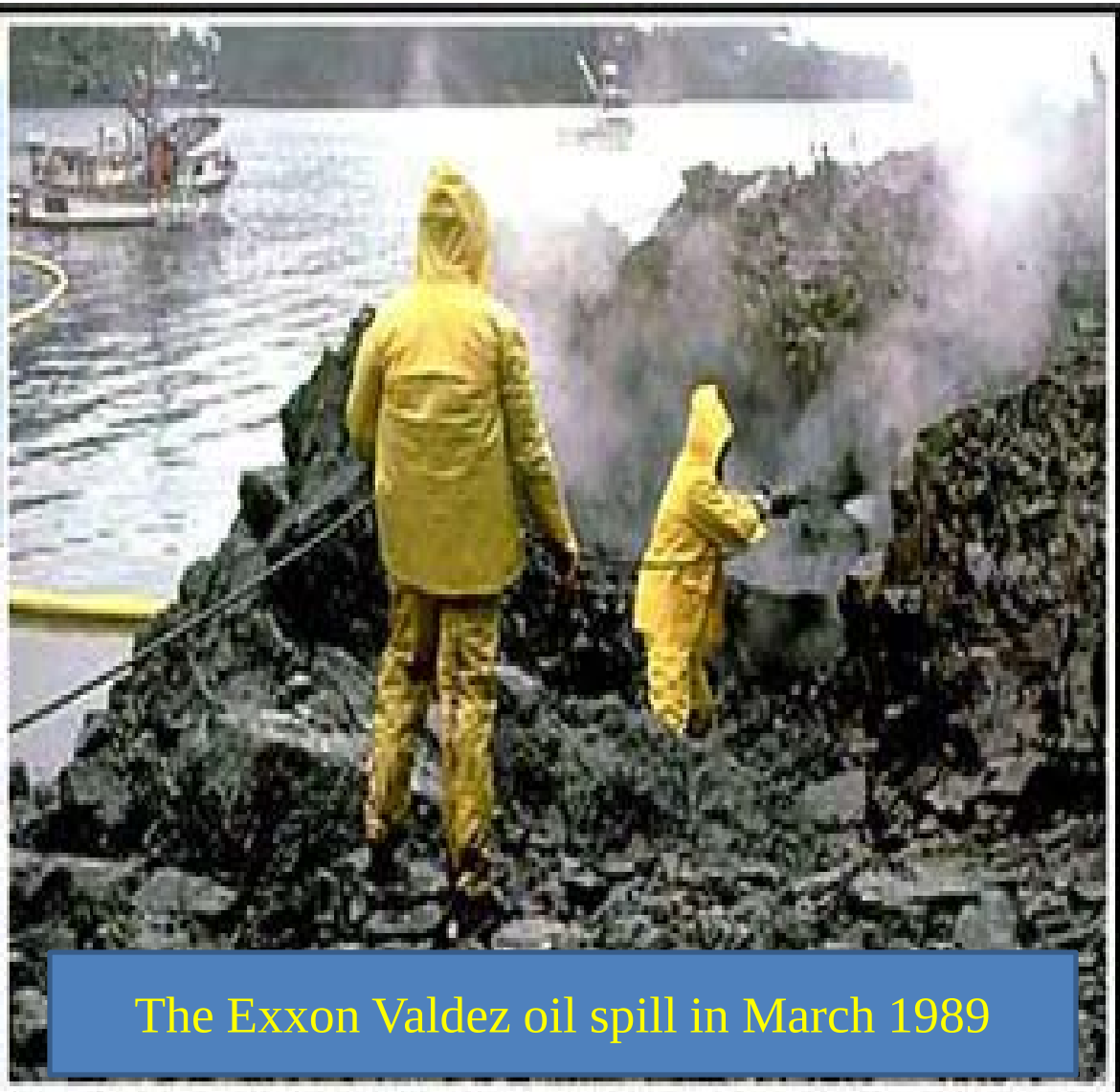
SOURCES OF CRUDE OILSUPPLY CHAIN RISKS AND VULNERABILITIES

- Exploration and Production Risks
- Environmental and Regulatory Compliance Risk
- Transportation Risk
- Availability of Oil Resource Risk
- Geopolitical Risk
- Reputational Risk

Oil Exploration and Production site

Source of Exploration and Production Risk

Environmental Risk of Oil Spill



The Exxon Valdez oil spill in March 1989

Image of Double Hull Crude Oil Tanker: The OPA-90 Requirement

The Prestige Oil Disaster

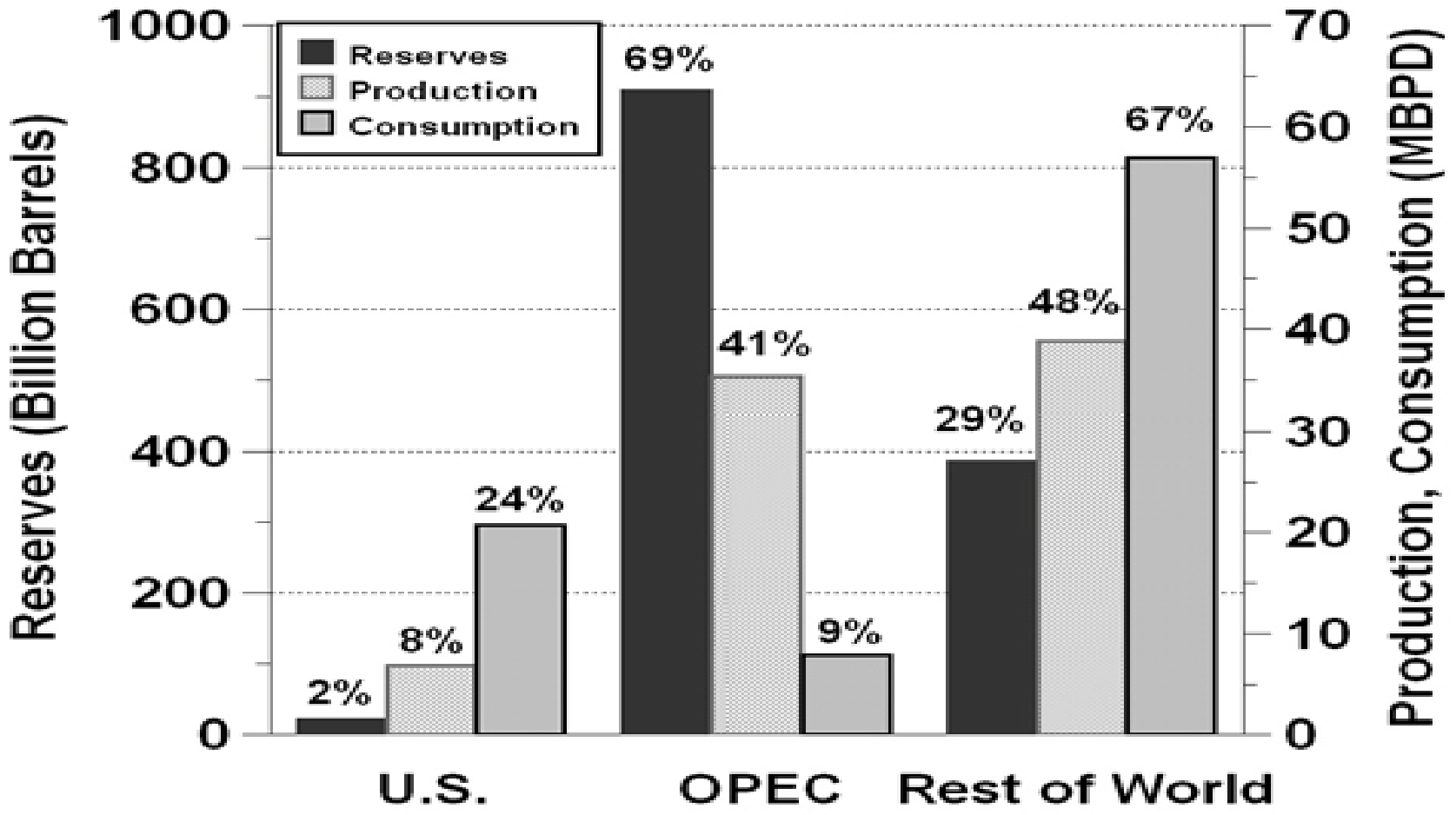
- Our coast is vulnerable to potential damage.
- 2/3 of all goods transported around global waters are from the petroleum industry.

Transportation Risk: Maritime oil tanker piracy

Threats to Pipeline Oil Transportation

Attack on crude oil pipeline

Availability of Oil Resource Risk



World Oil Reserves, Production, and Consumption, 2007.
U .S. Department of Energy Fact # 578: July 6th 2009.

The Alternative Options

- **Accept and control the risk**: Accept the risk and put in place appropriate controls to manage the risk.
- **Terminate or forgo activity:** Risks are avoided by stopping an activity however, mitigating risk involves the planning of future actions and activities to prevent or reduce the consequence of the risk occurring.
- **Transfer and / or share risk:** Some risks are transferred. Risk transfer does not mean total elimination of risk, it entails transferring the consequence of a risk to a third party eg. to insurance, using external agents with renowned knowledge.

RESEARCH METHODOLOGY

- Management decision making problems often involve multiple criteria/objectives/attributes.
- Multi-Criteria Analysis is a decision-making tool developed for complex multi-criteria problems those include qualitative and/or quantitative aspects of the problem in the decision-making process.
- Multiple-Criteria Analysis (MCA) is a collection of methodologies to compare, select, or rank multiple alternatives that involve incommensurate attributes

RESEARCH METHODOLOGY

- Evaluation and management of the upstream crude oil supply chain vulnerabilities and risks represent a typical MCDM problem that entails multiple criteria that can be both qualitative and quantitative
- An example of MCDM selected to model risk management in the upstream crude oil supply chain risk is AHP developed by Saaty (1980).

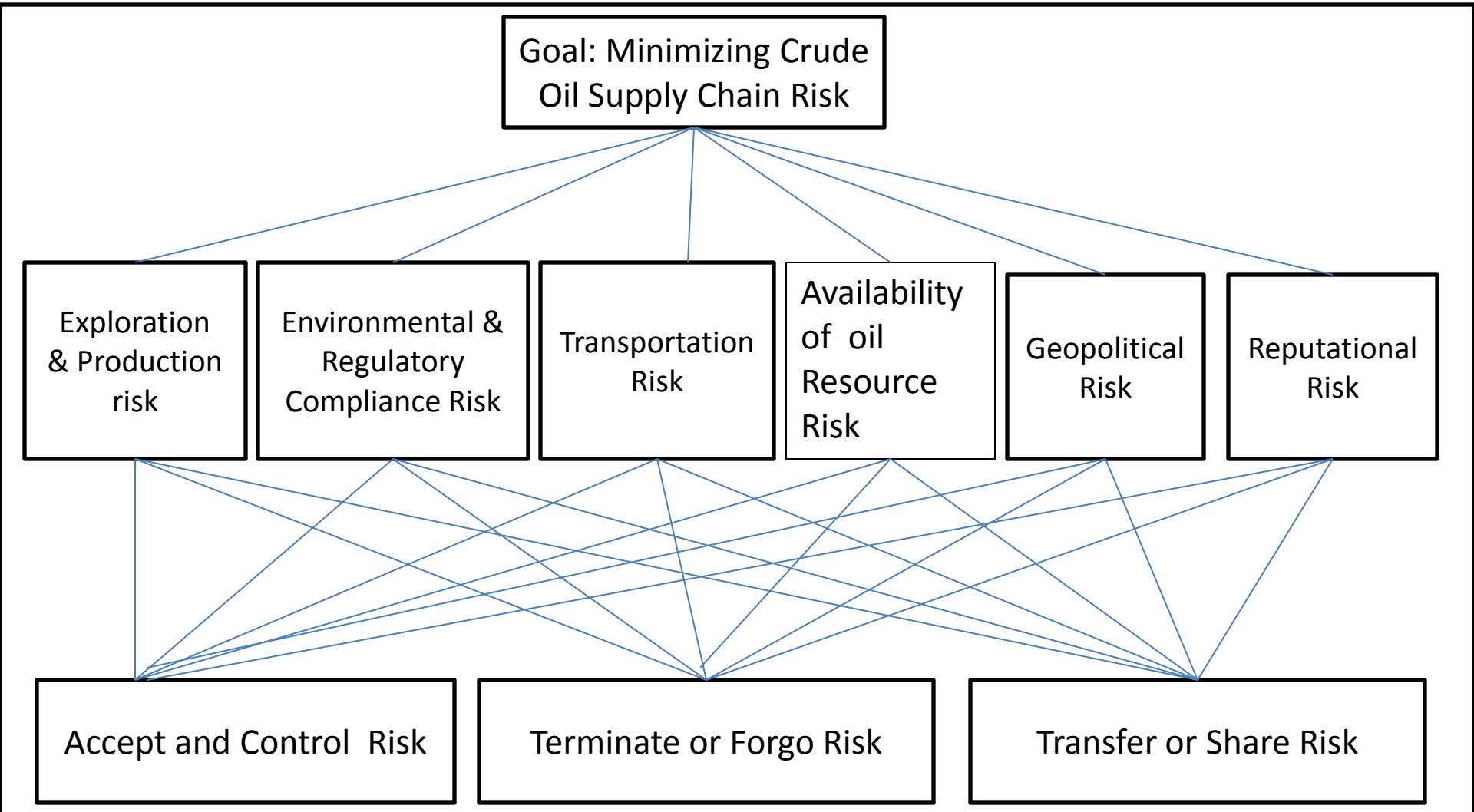
AHP was selected for this research

- Because it allows decision-makers to model a complex problem in a hierarchical structure portraying the relationships of the overall goal, criteria (objectives), and alternatives.

RESEARCH METHODOLOGY

- Gaudenzi and Borghesi, (2006), used AHP in evaluating supply chain risk management.
- Hemaida and Schmits, (2006), used AHP in vendor selection.
- Dey et al, (2001), used AHP for cross country petroleum pipeline selection.
- Dey (2004), used AHP in decision support system for inspection and maintenance: a case study of oil pipeline.
- Sam Nataraj, (2005), used AHP as a decision-support system in the petroleum pipeline industry.
- The AHP has also been a helpful methodology used in solving decision problems in studies such as, supplier selection, forecasting, risk opportunities modeling, plan and product design, etc. (Siddharth V. et al., 2007).

RESEARCH METHODOLOGY



DATA COLLECTION AND ANALYSIS

- A survey questionnaire approach was used for gathering relational data to assess the order of importance of the upstream crude oil industry supply chain risks.
- From the hierarchy tree, a questionnaire was developed to enable pairwise comparisons between all the factors at each level in the hierarchy.
- The pairwise comparison process elicits qualitative judgments or opinions that indicate the strength of the experts' preference in a specific comparison according to Saaty's 1-9 scale.
- The questionnaire was designed to collect opinion of subject matter expert (Risk Managers) in the oil industry requiring them to respond to several pairwise comparisons where two categories at a time are compared with respect to the major goal.
- The result of the survey questionnaire technique was then used as input for the AHP.
- The pairwise comparison matrix developed from the AHP survey questionnaire is depicted Table 2.
- The analysis was carried out using Expert Choice Software (11.5)

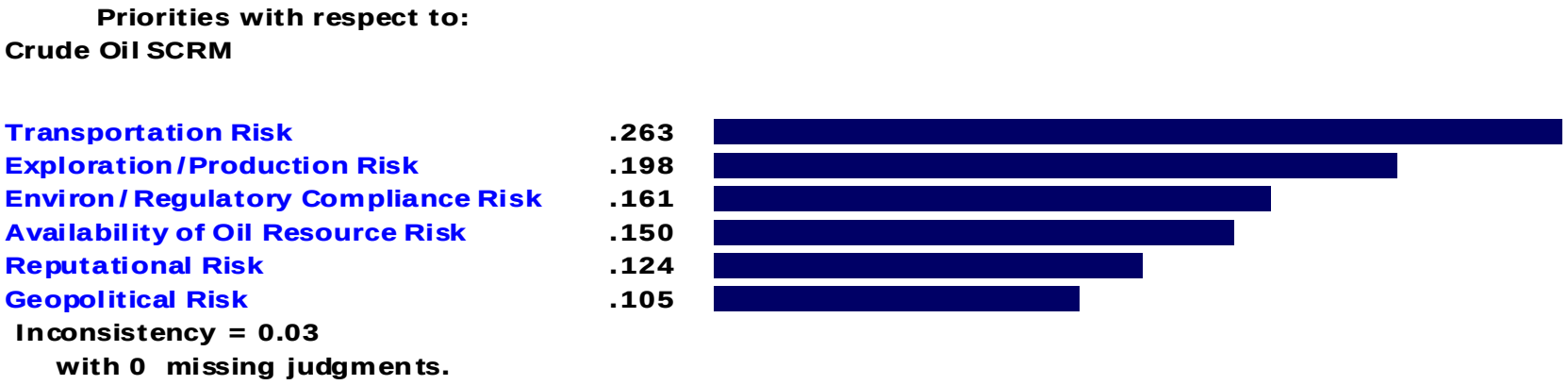
Table 2. Priority Matrix for the Major Objectives

Objective	Priority	Rank
Transportation Risk	.263	1
Exploration /Production Risk	.198	2
Environmental and Regulatory Compliance Risk	.161	3
Availability of Oil Resource Risk	.150	4
Reputational Risk	.124	5
Geopolitical Risk	.105	6
Inconsistency Ratio	**0.03**	

RESULT AND DISCUSSION

Comparing the Priority matrix for the Major Objectives

- The result shows that Transportation Risk, (.263), Exploration/Production Risk (.198) and Environmental/Regulatory Compliance Risk (.161) are the top three major risk areas in the upstream crude oil supply network, followed by availability of oil resource risk (.150), reputational risk (.124) and geopolitical risk (.105). While reputational risk is .124 (12.4%) and geopolitical risk is .105 (10.5%) indicating that the latter two are less important priorities to be considered. With inconsistency of 0.03 which is less than .10 indicating reliable expert opinions.

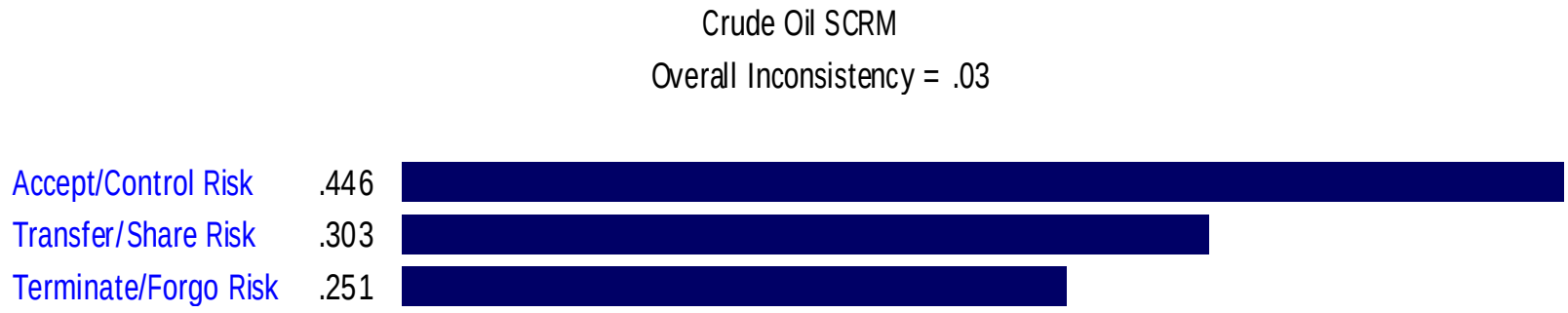


Priority of Objectives with Respect to Alternative Options.

		Alternative Priority	Alternative Priority	Alternative Priority
		Accept & Control Risk	Transfer or Share Risk	Terminate or Forgo Activity
Objective Priority				
Transportation Risk	.263	.413	.327	.260
Exploration and Production Risk	.198	.550	.240	.210
Environmental & Regulatory Compliance Risk	.161	.413	.327	.260
Availability of Oil Resource Risk	.150	.500	.250	.250
Reputational Risk	.124	.413	.327	.260
Geopolitical Risk	.105	.413	.327	.260
Composite Score		.446	.303	.251

Ideal Synthesis with Respect to the Goal.

- The global priorities for the alternative policies are ranked as follows: accept and control risk (.446), transfer or share risk (.303), and terminate and forgo risk (.251). When normalized, the priorities for the alternative policies add up to 1.00. This result indicate that accepting and controlling risk is the most important risk management policy option among the three policy options, with inconsistency of 0.03. < than .10 indicating reliable expert opinions.



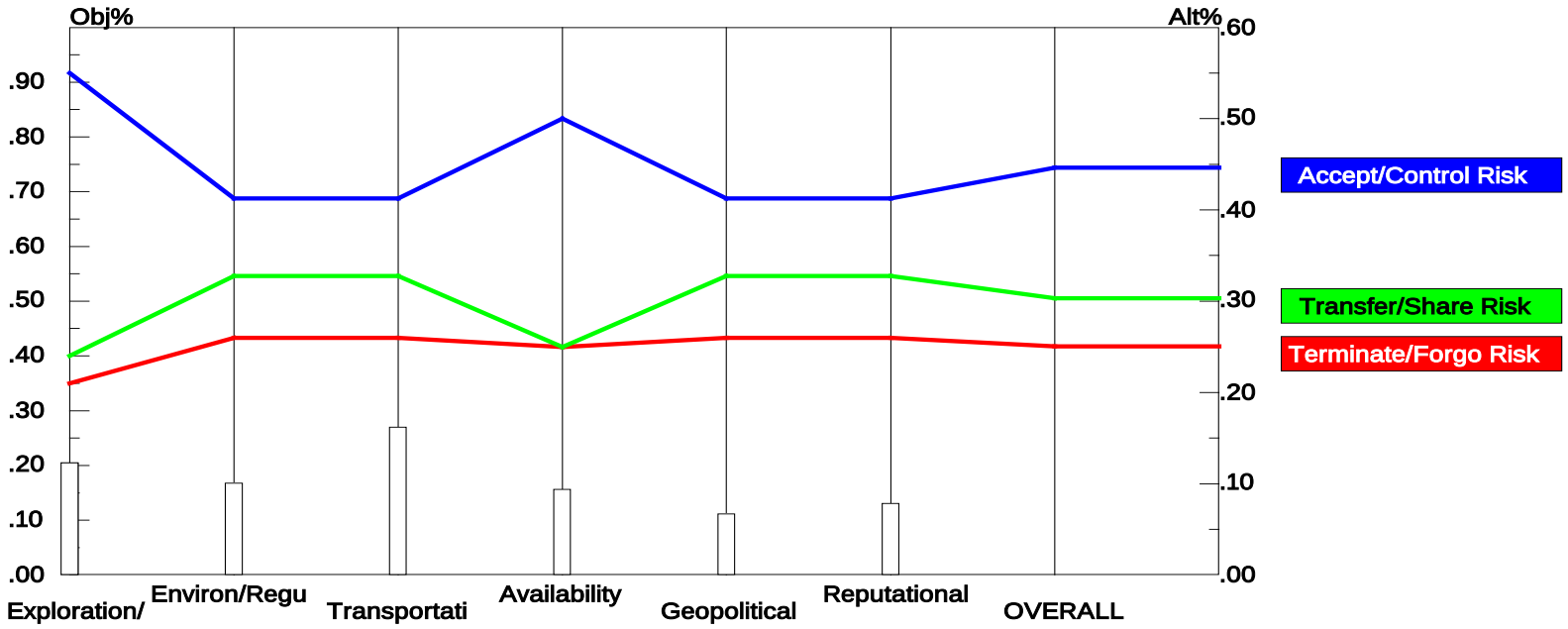
Sensitivity Analysis

- The sensitivity analysis option of the Expert Choice enables the decision maker to graphically explore the response of the overall alternative policy options and to changes in the relative importance (weight) of each attribute or criterion.
- A series of sensitivity analysis could be conducted using Expert Choice software which includes:
  - Performance
  - Gradient
  - Dynamic
  - Head to Head,
  - Two-Dimensional Plot.

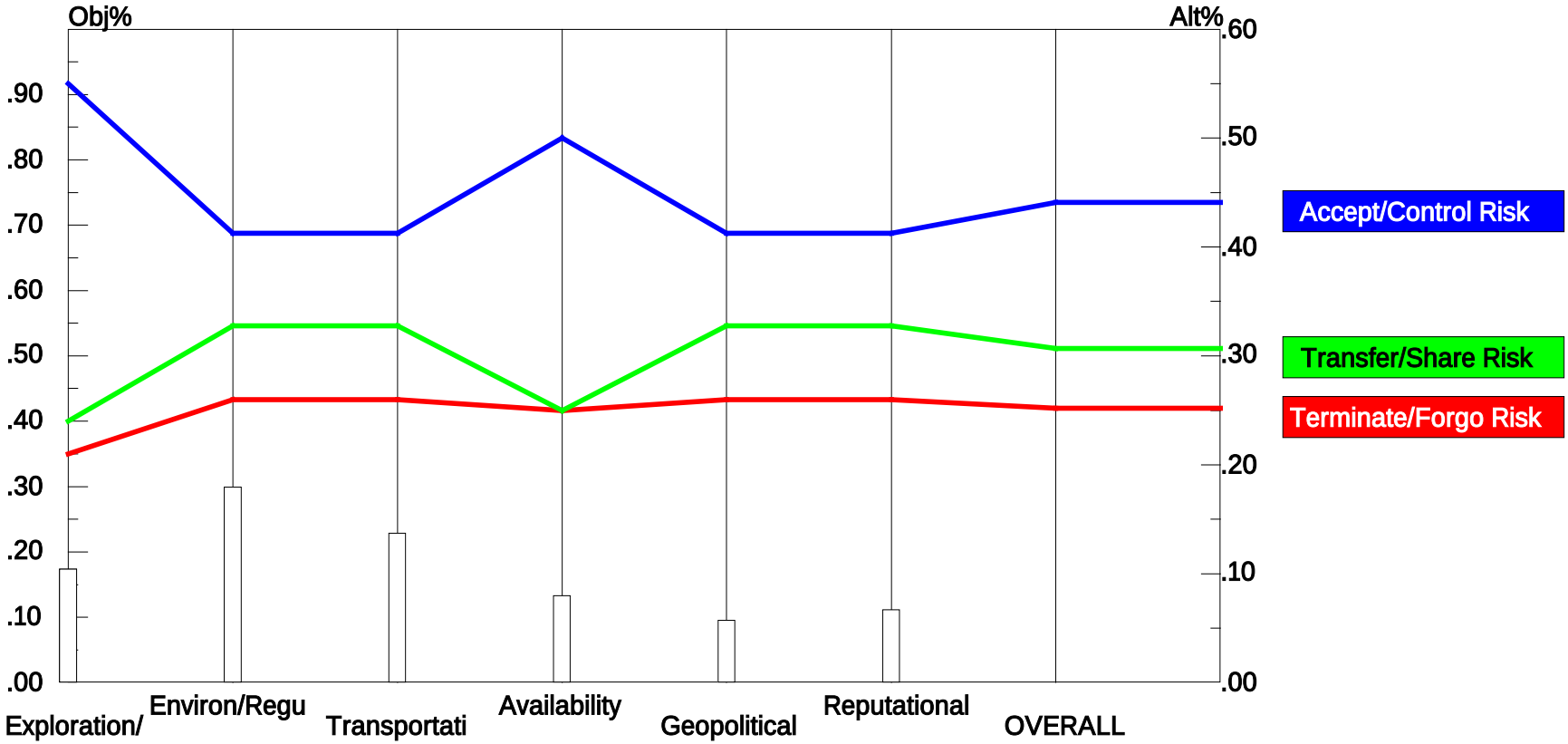
Each of these five graphical modes expresses different viewpoint to a sensitivity analysis enabling the user to easily manipulate the criterion priorities and instantly observe the impact of the change that is reflected in the ranking of alternative.

Performance Sensitivity Analysis for nodes below:

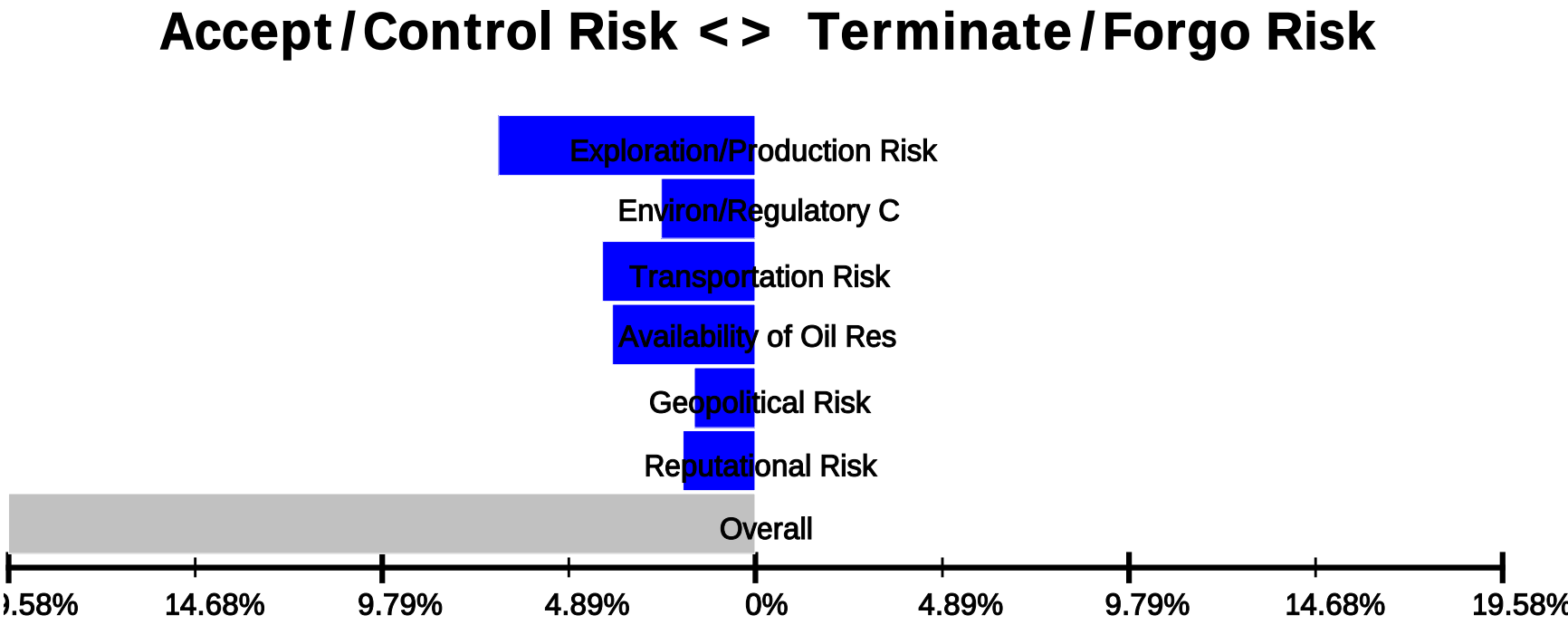
Shows that accept and control risk is about .45 (45%), transfer or share risk is about .31 (31%), and terminate or forgo activity is about .25 (25%). Based on the result of the relative priorities of each criterion (left Y axis): exploration and production risk is about .20 (20%), environmental and regulatory compliance risk is about .18 (18%), transportation risk is about .28 (28%), availability of oil resource risk is about .16 (16%), geopolitical risk is about .10(10%) while reputational risks is about .11(11%).



Scenario 1. With respect to environmental and regulatory compliance risk can be seen that changing the criterion value with respect to environmental and regulatory compliance risk from .18 to .30 did not change the ranking of the alternatives and that accept and control risk still remain the number one alternative.

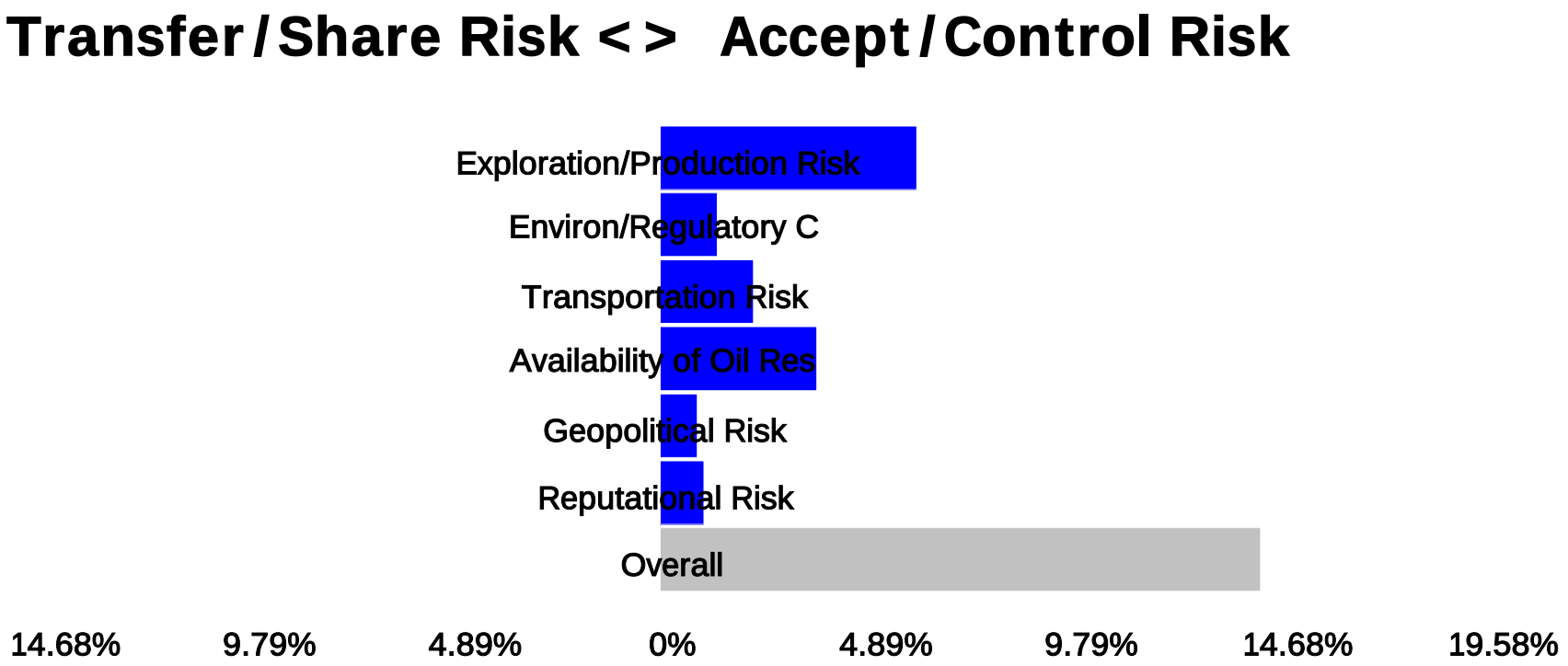


Head-to-Head Sensitivity Analysis graph shows the differences between the priorities of the alternatives taking two at a time for all of the criteria. Here comparing accept and control risk to terminate or forgo risk shows that accept and control risk is about 7.5 times more important with an overall of 19% than terminate and forgo.



Head-to-Head Sensitivity Analysis between Transfer/Share Risk/Accept and Control Risk.

Here the result indicate that accept and control risk is 5.2% more important to transfer and share risk, also with an overall result that accept and control risk is 14.68%.



Conclusion

- The objective of risk management is not, arbitrarily to reduce or eliminate risk.
- Risk management is therefore the responsibility of those who are accountable to deliver the associated objective; therefore the identification of the risk can only have value or meaning when explicitly linked to the objective.
- Different approaches can be taken to identify risks and the approach taken might depend on the complexity of the industry and the volatility of the risk environment.

Conclusion

- However, the identification of the risks may result in a long list, that may not all be monitored or managed by risk managers, some of the risks may simply be monitored or managed as part of daily management routine while some may be combined since they address the same underlying issues, or may be managed at different organizational level.
- For the oil Industry collaborative interest can also mean collective security and corporative protection of the flow of oil which benefits both producing and consuming nation.

THANK YOU EVERY BODY .

PLEASE WISH ME LUCK IN MY FINAL EXAM.