



A Pilot Risk Analysis Study for an IBM Services Delivery Location

DAAG, April 21st, 2010

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IBM T.J. Watson: The Yorktown Heights building Westchester County, New York



About the Risk Analytics team at IBM T.J. Watson Research

- We are an interdisciplinary group; 10 researchers and developers with different but related backgrounds: Stochastic optimization, risk analysis, decision analysis, artificial intelligence, statistics
- We collaborate with other divisions of IBM and other teams in Research to provide analytics to pursue projects for internal and external clients of IBM
- Many of us pursue research on probabilistic models/ decision making under uncertainty
- The Risk Analytics group was formed around 2 years ago and it is growing!

Executive Summary of the Pilot Risk Analysis Study

▪ Objective of Pilot

- Quantitatively assess risks and their potential impacts on IBM Services Delivery **S** resources located in Location **L** (in India) to drive improved long term resource planning

▪ Motivation

- More than 60% of **S** resources in India
- Need to understand business exposure if a location's capability is compromised, in order to support decision making regarding optimal location of resources
- Results also can provide support for conversations with client regarding location of resources, with respect to cost versus risk trade-offs

▪ Results

- Working with Services Delivery **S** team in India to identify key risk categories, their dependencies, and their probabilities and severities for five primary buildings in **L**. Research developed a probabilistic model to characterize risk about costs over a three year time frame.
- *Legal and regulatory environment* was found to have greatest potential for increased costs
- *Natural hazards and socio-political unrest* were found to represent less risk than that due to more 'mundane' *infrastructure outages* (public and business-related)

Outline

- **Research Approach**

- Risk analysis methodology
- Definitions
- The model
- Model assumptions

- The Inputs

- Analysis Results

- Discussion

Members involved:

- Services Delivery **S** Team
- India Qualitative Risk Assessment Team
- Research Team

Research Approach

- **Phase I: Provide a systematic, quantitative approach to risk assessment (Complete)**
 - Systematically identify risks and their types

Use India qualitative risk assessment as starting point and develop list of 10 key risk areas, covering both risk events and risks due to overall business environment
 - Estimate the probability of a risk event or environment over 3 year planning horizon

Collect expert opinion on number of expected risk events of each type and their durations and probabilities
 - Link each risk to its business impact and quantify that impact

Quantify impacts in terms of productivity and costs, based on assumed resource headcounts
 - Analyze risk information to determine locations and/or risk types contributing most to risk profile

Compute cost distributions using Monte Carlo simulation (Excel and Matlab-based computations) and compare cost uncertainties across locations and risk types

- **Phase II: Provide an approach to prioritize business actions based on understanding of risk/reward trade-offs (TBD)**
 - Identify risk mitigation plans and related costs, evaluate risk/return associated with sets of mitigation plans and prioritize actions to achieve desired risk profile with minimal investment

Risk Event Definitions

Risk Events	Definition
<i>Natural Hazard Incidents</i>	An event caused by natural sources (e.g. hurricane, flooding, earthquake) that impacts business or public infrastructure such that work cannot be conducted
<i>Incidents of socio-political unrest</i>	An event that causes civil unrest (e.g. terrorism, strike, rioting) or high-profile public event that impacts business or public infrastructure such that work cannot be conducted
<i>Business and/or public infrastructure outages (excepting those caused by natural hazards and/or social-political unrest)</i>	An event that impacts business and/or public infrastructure (IBM or broader) such that work cannot be conducted, excluding those that are caused by natural hazards and/or socio-political unrest. Examples include power outage, cooling outage, telecommunications outage, transportation outage, road construction, etc.
<i>Health events resulting in facility shutdown</i>	A public health incident that impacts ability of work to be conducted at an S facility. Examples include a pandemic, a gas leak, food safety incident, etc.
<i>Legal/Regulatory-related incidents</i>	A legal or regulatory incident resulting in an unplanned work stoppage at an S facility.
<i>Other incidents</i>	Other incidents not included above that may impact work at an S facility
Risk Events Impacting Productivity only	Definition
<i>Other health-related issues</i>	Health events impacting productivity of S workforce, possibly resulting from safety issues associated with other risk events, such as natural hazard or socio-political unrest, but not causing a complete work stoppage

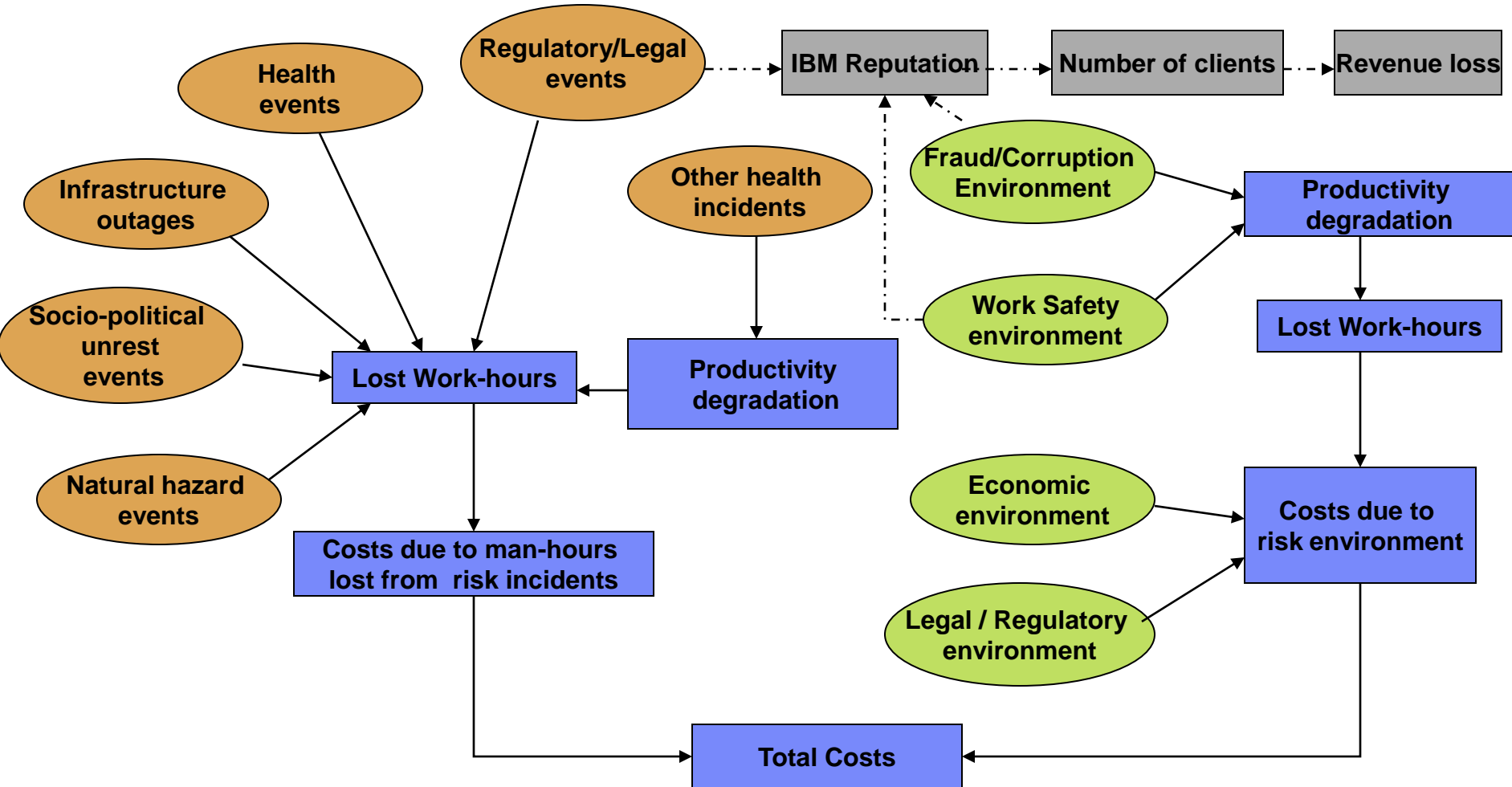
Risk Environment Definitions

Risk Environment	Definition
<i>Economic conditions</i>	The general state of economic conditions, considering factors impacting cost of doing business in India (foreign exchange rates, wage inflation, real estate costs and/or availability, etc.)
<i>Regulatory/Legal Requirements</i>	The status of regulation and/or legal requirements impacting cost of delivering GBS engagements using Indian resources (for example, the tax regime, security regulations, labor-related regulations)
<i>Fraud/Corruption/Quality conditions (Labor-related)</i>	The quality and reliability of vendors, fraud and corruption, or other factors with potential to impact productivity of S resources
<i>Work environment conditions (safety)</i>	Overall workplace conditions (e.g. health and safety conditions) with potential to impact productivity of S resources. Examples include such things as safe transportation options for employees working late, etc.

Risk Quantification Model

Risk events

Risk environment



Model Assumptions

■ Risks

- Risks in one category occur independently of risks in another category
- Probabilities are assumed to be same across all 5 L buildings
- Risk Incidents
 - Incidents occur following a Poisson distribution
 - For minor and moderately severe incidents, duration of incidents follows a uniform distribution over the given range (in days)
 - Duration of severe events follows a Beta(1,3) distribution shifted and scaled to match the specified duration range (natural hazard events assumed to cause outage for no longer than 10 working days)
 - Other health incidents assumed to reduce productivity of an individual by 50%; All other incidents assumed to reduce productivity of an individual to 0%
- Risk environments
 - Impact of environment on costs is assumed to be spread evenly over 3 year time frame
 - For environmental states other than the 'Worst Case' state, Total Cost associated with a particular environment is assumed to follow a uniform distribution with range equal to the impact values used to define the environmental state
 - Total Cost associated with a 'Worst Case' environmental state is assumed to follow a Beta(1.1.,3) distribution shifted and scaled to match the cost impact range used to define the state

■ Costs

- Resource band distribution assumed to be same across all 5 L buildings (Resource band distribution provided by Finance team)
- Data obtained: Blended hourly cost rate, Rupee/\$ Exchange Rate, Working hours per day; Working days per year

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The Inputs* (All the numbers are representative)

Risk Events	Minor			Moderately Severe			Severe		
	Minor	Duration	% Affected	Moderately Severe	Duration	% Affected	Severe	Duration	% Affected
<i>Natural Hazard Incidents</i>	4 to 6 incidents	1 to 2 days	20% to 25%	2 to 4 incidents	2 to 3 days	25% to 30%	1 to 2 incidents	3 to 4 days or more	>50 %
<i>Incidents of socio-political unrest</i>	6 to 8 incidents	0.5 to 1 day	10% to 15%	4 to 6 incidents	1 to 2 days	20% to 30%	1 to 2 incidents	3 to 4 days or more	>50 %
<i>Business and/or public infrastructure outages (excepting those caused by natural hazards and/or social-political unrest)</i>	160 to 180 incidents	0.04 days to 0.25 days	1% to 5%	50 to 60 incidents	0.25 days to 1 days	5% to 15%	5 to 10 incidents	1 days to 2 days or more	>15%
<i>Health events resulting in facility shutdown</i>	50 to 60 incidents	0.5 days to 1 day	1% to 3%	10 to 15 incidents	1 day to 2 days	3% to 5%	5 to 10 incidents	2 days to 3 days or more	> 5%
<i>Legal/Regulatory-related incidents</i>	3 to 5 incidents	0.5 days to 1 day	1% to 5%	2 to 3 incidents	0.5 days to 1 day	5% to 10%	1 to 2 incidents	1 day to 2 days	>10%
<i>Other health-related issues</i>	100 to 200 incidents	0.5 days to 1 day	1% to 5%	50 to 60 incidents	1 day to 2 days	5% to 20%	5 to 10 incidents	2 days to 3 days or more	> 20%
<i>Other incidents</i>									

*Inputs provided by **India Qualitative Assessment Team**

The Inputs* (All the numbers are representative)

Risk Environment	Probability of 1%-20% Improvement	Probability of No change from current conditions	Probability of 1%-10% Degradation	Probability of 11%-20% Degradation	Probability of 21%-30% Degradation	Probability of >30% Degradation
<i>Economic conditions</i>	0.2	0.4	0.2	0.1	0.07	0.03
<i>Regulatory/Legal Requirements</i>	0.1	0.25	0.35	0.15	0.1	0.05
<i>Fraud/Corruption/Quality conditions (Labor-related)</i>	0.2	0.5	0.1	0.1	0.05	0.05
<i>Work environment conditions (safety)</i>	0.15	0.45	0.15	0.1	0.1	0.05

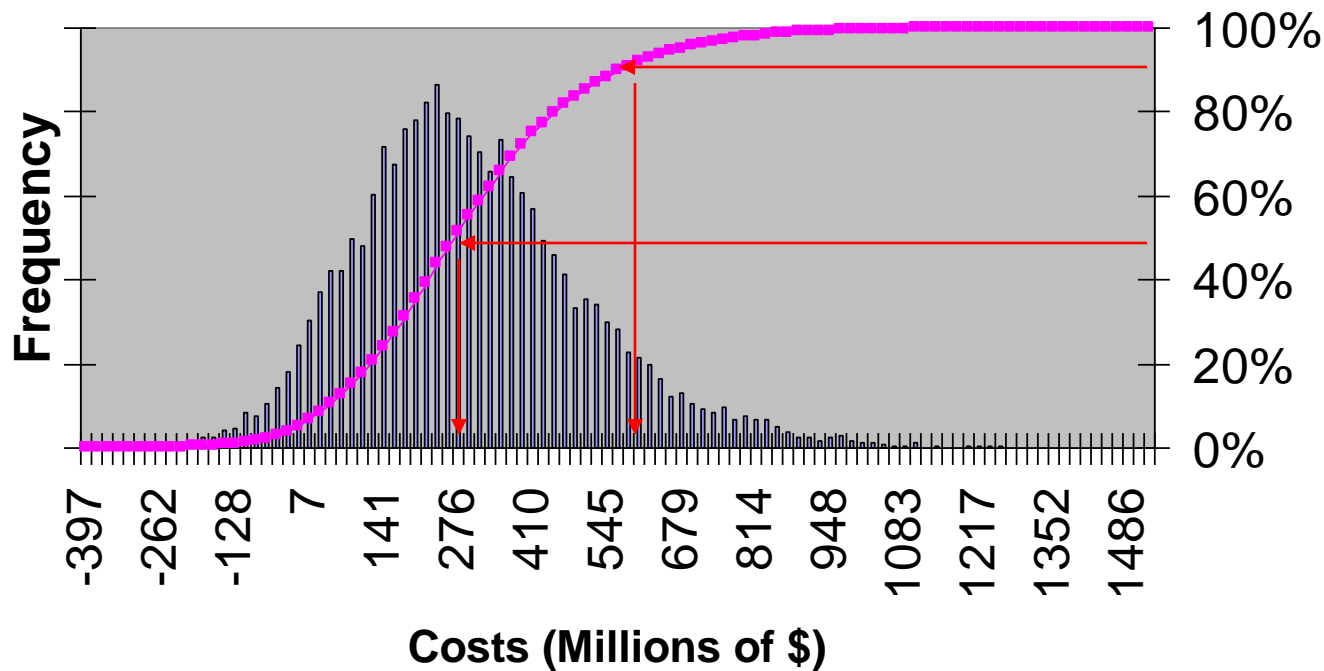
*Inputs provided by **India Services Delivery S team**

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Distribution of Total Risk-related Costs for Location L (All the analysis results are representative)

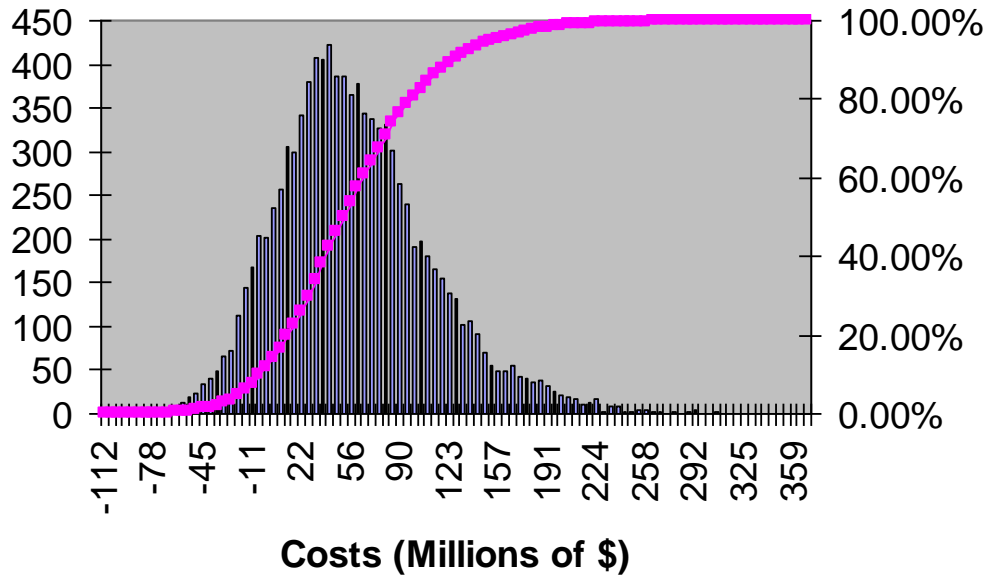
Distribution of Total Costs



- There is a **50% chance** that S costs could increase by more than **\$276M** over the next 3 years due to occurrence of risk events and/or presence of risk conditions
- There is a **10% chance** that risk-related additional costs will be more than **\$600M**.
- There is **less than 5% chance** that risks result in **no increased costs** over the next 3 years

Cost Breakdown by Buildings in Location L

Location L1



Number of resources	15186
L1	N1
L2	N2
L3	N3
L4	N4
L5	N5

	Average	Standard Deviation
L1	57.15	53.46
L2	67.83	63.46
L3	83.12	77.76
L4	14.13	13.22
L5	59.83	55.97
Total	282.06	127.43

- L3 location drives greater cost variation in L due to larger number of resources housed at that location

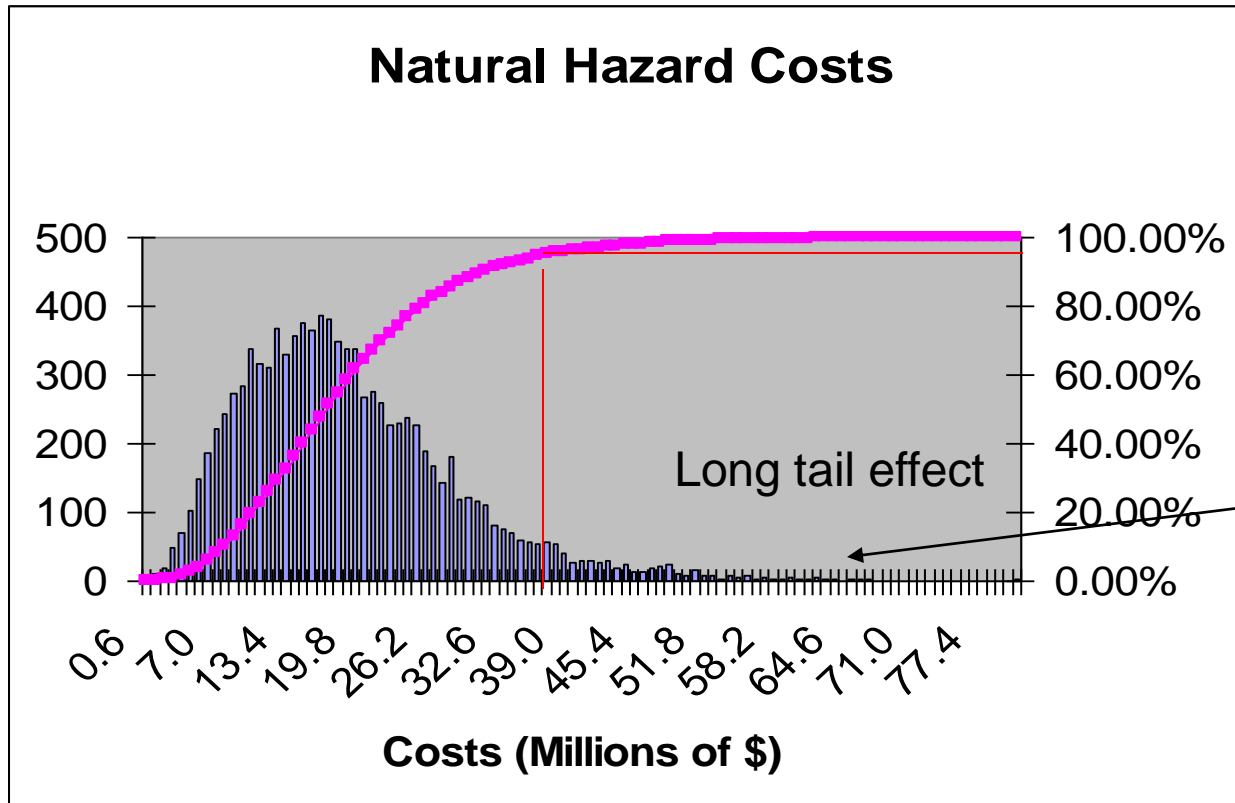
Cost Breakdown by Risk Type

Risk	Avg	Std dev
Natural Hazards	18.74	10.05
Socio-Political	15.79	9.54
Infrastructure Outages	30.71	18.94
Health and Safety	23.97	18.66
Legal/Regulatory	1.92	1.56
Other Health Related*	42.56	16.10
Economic Conditions	24.47	89.87
Regulatory/Legal Environment	58.67	86.96
Fraud/Corruptions	28.41	117.30
Work Environment*	46.34	120.94

There is **less than 5% chance** that risks result in **no increased costs** over the next 3 years

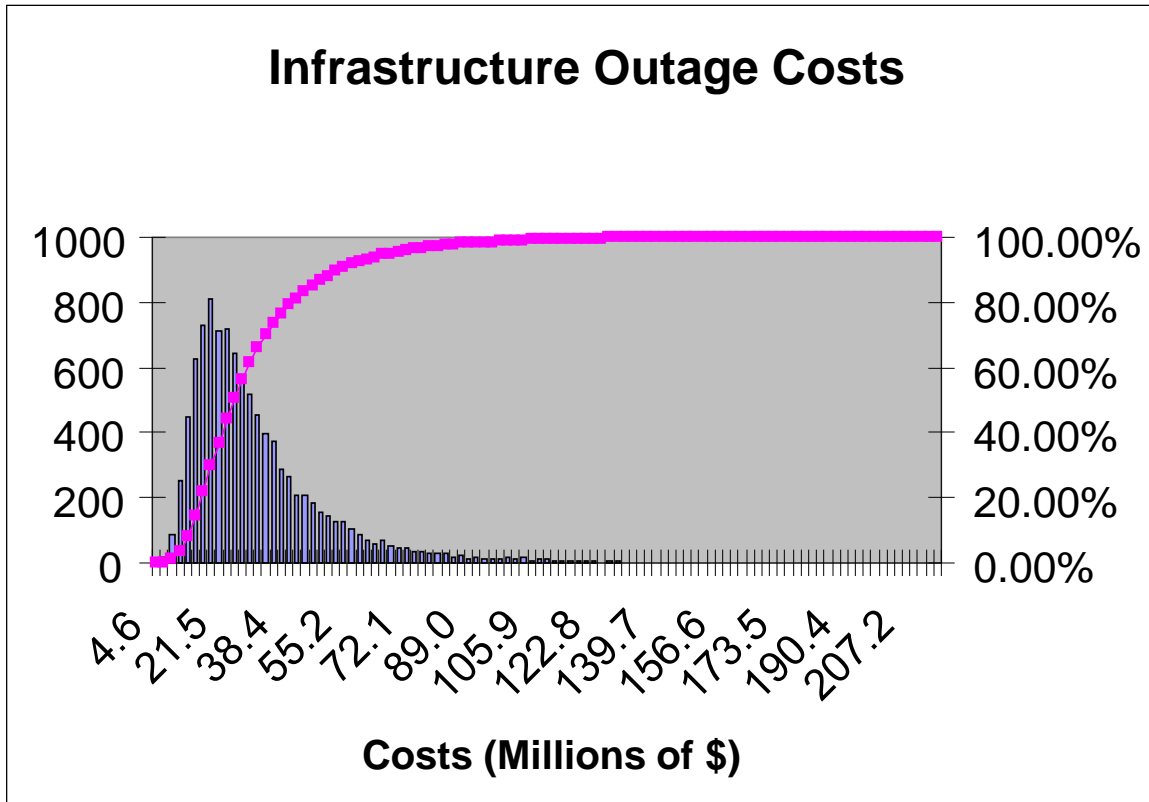
*Need to look into further. .

Cost Associated with Natural Hazard Events



- There is **only 5% chance** that a natural hazard event will result in **more than \$39M** in cost due to lost work-hours, but there is a **small chance that costs could go as high as \$70M**

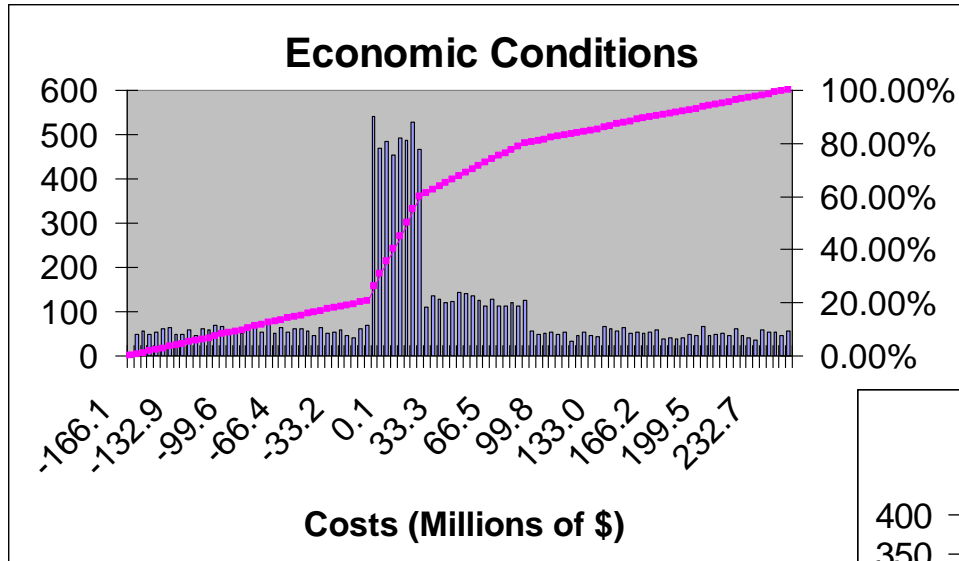
Cost Associated with Infrastructure Outages



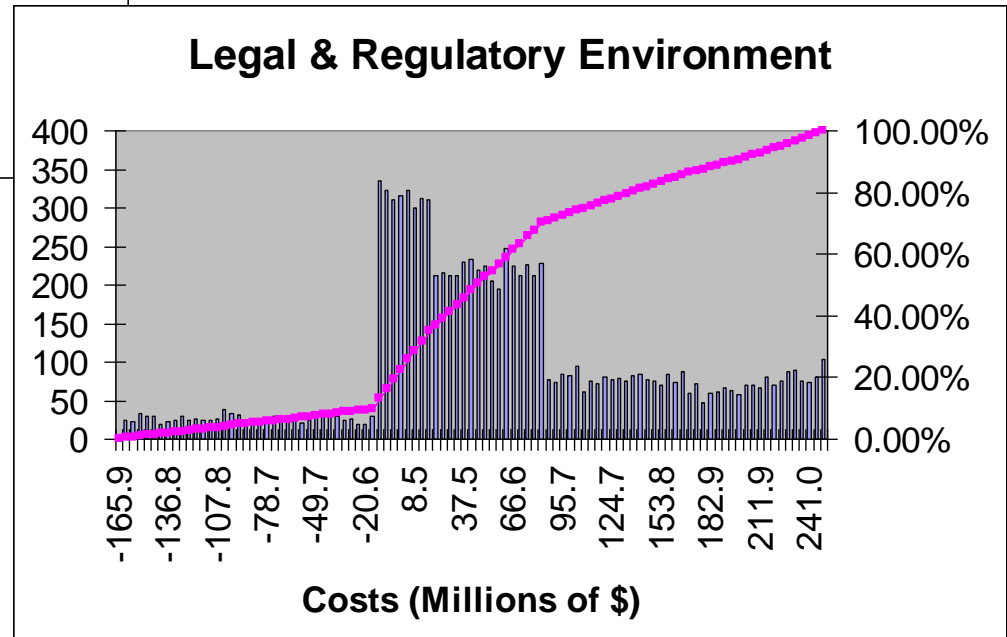
- Uncertainties associated with infrastructure outages present a larger risk than those associated with natural hazard events or socio-political unrest

- There is **~20% chance** that costs due to lost man hours will run to **more than \$50M**

Cost Associated with Business Environment

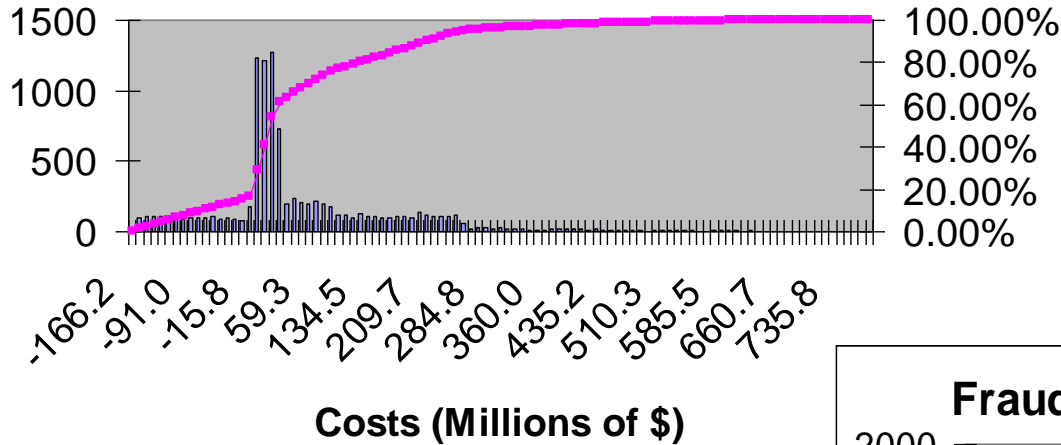


- Overall, changes in the legal and regulatory environment are found to present larger risks than changes in economic conditions



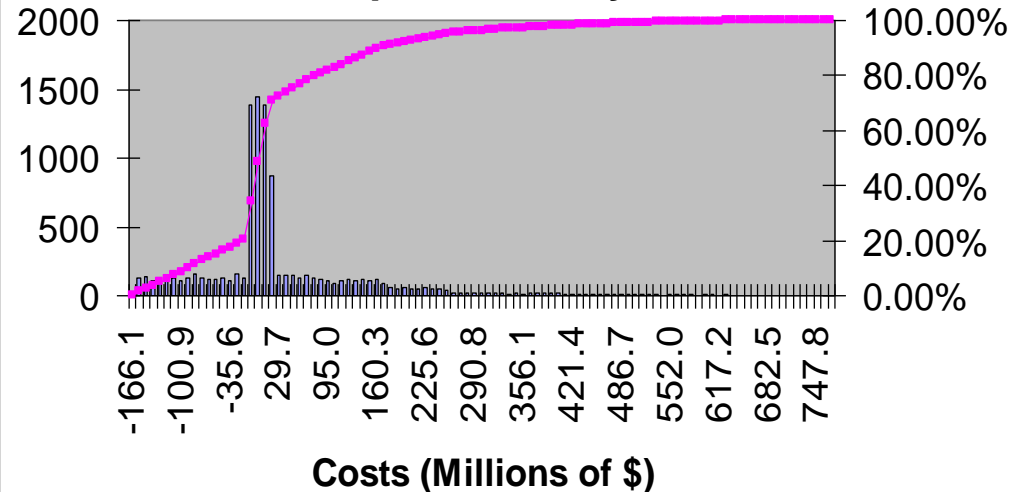
Cost Associated with Business Environment

Work Safety Conditions



- Work Conditions and/or Fraud & Corruption in the business environment, which can impact resource productivity, present moderate risk

Fraud/Corruption/Quality Environment



Risk Mitigation Actions

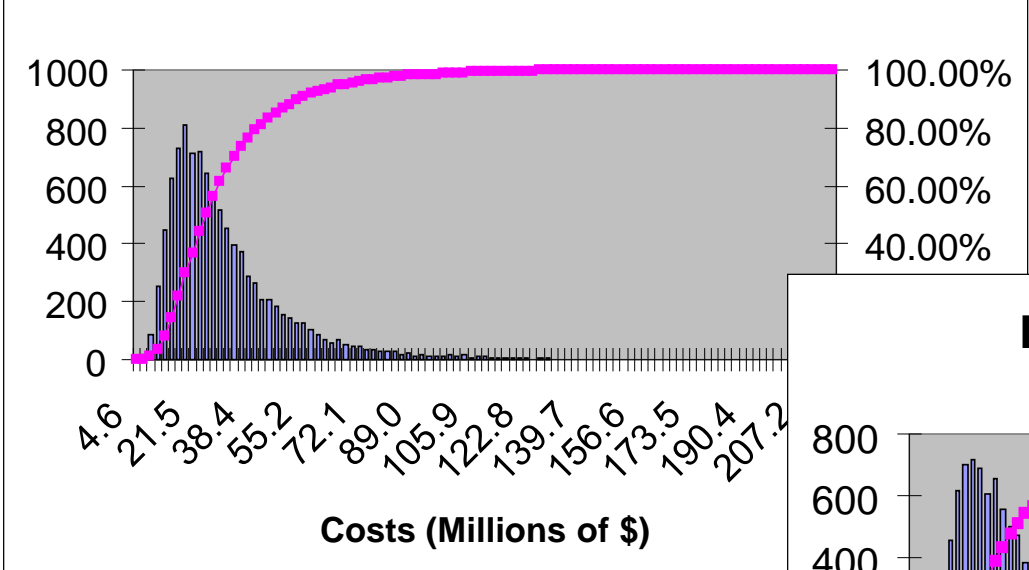
■ Which risks are controllable?

- Not controllable (except through change in location of resources)
 - Occurrence of Natural Hazard events, Socio-political events, Public infrastructure outages
 - Economic environment, Legal and Regulatory environment, Fraud & Corruption
- Controllable or Partially Controllable
 - Duration of incidents
 - Occurrence of certain types of infrastructure outages
 - Occurrence of legal and regulatory incidents
 - Occurrence of some health incidents that impact productivity
 - Work environment conditions

■ Which actions will have most impact in reducing costs and cost uncertainty?

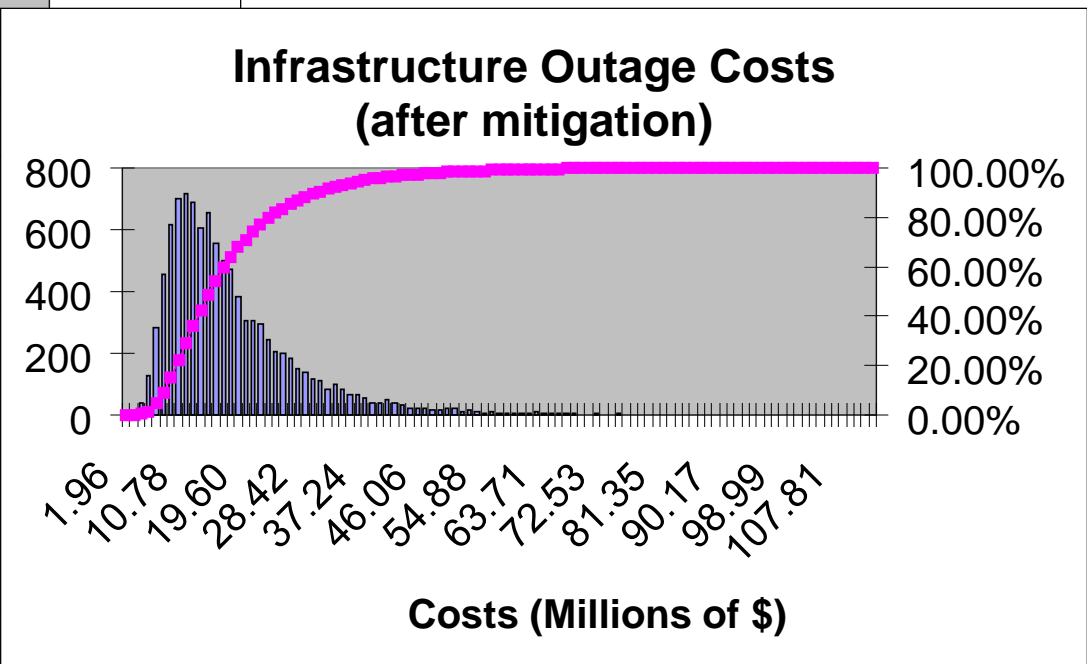
Example: Impact of reducing duration of infrastructure outages by 20%

Infrastructure Outage Costs (before mitigation)



- Expected cost reductions of ~\$25M over 3 years

Infrastructure Outage Costs (after mitigation)



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Discussion

■ Response from other team members (besides Research)

- Services Delivery S Team had worked with India Qualitative Risk Assessment Team before, they felt that the risk analysis methodology was useful. They appreciated the introduction of uncertainty, but they thought that certain risk input numbers were too high!
- India Qualitative Risk Assessment Team were interested in the approach, having done previous work on risk management.
- It was difficult to keep all the participants actively engaged in the pilot analysis.

■ Response from top management

- Felt more comfortable with the results, did not perceive risks to be unexpected
- Our methodology and results were passed on to other teams involved in risk in India

■ Critique of the methodology

- Figuring out the appropriate probabilistic model took time and it was a first cut
- Assessments were hurried due to time pressure of the pilot project
- Several assumptions made for simplicity
- Very little validation of the inputs (either by repeated communication with experts, or through examination of data wherever available)