Generating Risk Contingencies with (Statistical) Confidence

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Outline

Preface: Lecture Ground Rules

We Should Not Permit . . .

The rudeness of not interrupting.

When you do not understand fully.

Or have a question.

What is Risk?

- “Risk. An uncertain even or condition that, if it occurs, has a positive or negative effect on a project’s objectives.”
  - PMBOK glossary (4th edition, 2008)

Exercise #1

(Did you think you were not going to work?)

1. Your supervisor needs a departmental dinner prepared.
2. The meal consists of: soup from a frozen container; salad containing tomato; lettuce; carrots and cucumbers; a grilled steak (medium); corn on the cob; deep dish apple pie (bought frozen from a store); and ice cream (bought from a store). Preparations up to putting food into serving dishes are included. (Don't worry about serving.)
3. You have agreed to prepare this meal at a fixed price and to deliver it to the supervisor's kitchen, ready to serve, by 6 p.m.
4. Identify and classify two risks with respect to probability and impact. For each risk, decide whether to accept, avoid, transfer, or mitigate the risk.

Answers?

(But the most important question is left for last.)

5 If the total cost of the project is about $10,000, how much do we need in contingency funds?

Why Do We Come Here to Discuss Risk?

- How good is our project management?
  - Thirty percent of projects are late.
  - More than half are 220 percent late.
  - More than half are 190 percent over budget.
  - (And how many meet specifications?)

  - via Meredith and Mantel, 7th edition

Projects Are All About Risk!

Because they are about change.

- Clint Eastwood understands: “But playing it safe is what’s risky, because nothing new comes of it.”
  - “We All Have the Same Fears,” by Clint Eastwood, *Parade* magazine (*The Washington Post*), 15 October 2006, page 5.

When in Rome ...

But when measuring ...

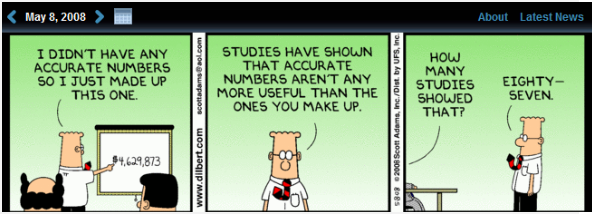
- “measures must be either subjective or objective, quantitative or qualitative, but they must be numeric, reliable, and valid” (p. 71 [7])
  - “subjective vs. objective”
  - “quantitative vs. qualitative”
  - “reliable”
  - “valid”

Measurement of Risk, Performance . . .

> “I often say when you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge of it is of a meagre and unsatisfactory kind.”
>
> — Lord Kelvin (1883)

Do Numbers Give More Information?

Are numbers better?



- Not unless they are good!
- But what do we mean by "good"?

Communication Difficulties with Measurements ...

Are numbers better?

Risk Versus Uncertainty

A Distinction without a Difference?

- Risk: “the probability of each and every state of nature and thus each and every outcome” is known. An expected value of each alternative action can be determined.
- Uncertainty: information is not complete and the expected value of each alternative cannot be determined.
- Certainty: assume “there is one and only one possible outcome”
- M&M, page 59 [7]

Risk Contingency, Exercise #2

- You have the following 10 risks, with their probabilities and associated impacts. How much money do you set aside for contingency?

	Probability	Impact
1	0.15	743
2	0.09	768
3	0.93	74
4	0.01	841
5	0.33	342
6	0.60	493
7	0.74	211
8	0.91	331
9	0.85	882
10	0.83	686

	Probability	Impact
1	0.01	495
2	0.17	920
3	0.087	274
4	0.21	145
5	0.24	538
6	0.19	98
7	0.096	852
8	0.0074	221
9	0.11	389
10	0.061	456

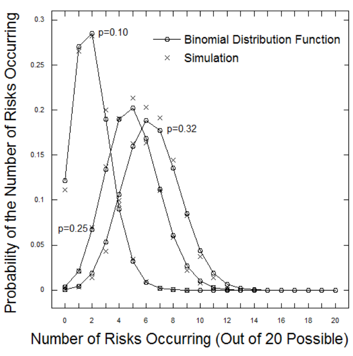
Research with Homayoun Khamooshi, Ph.D.

(Go here for detailed explanations.)

- “A Practical Method of Determining Project Risk Contingency Budgets,” Cioffi, D. F., and Khamooshi, H. H., *Journal of the Operational Research Society*, 2009 (April), Volume 60, pages 565–571; published online 19 March 2008, doi: 10.1057/palgrave.jors.2602586.
- “Program Risk Contingency Budget Planning,” Khamooshi, H. H., and Cioffi, D. F., *IEEE Transactions on Engineering Management*, Volume 56, No. 1, February 2009, page 171; doi: 10.1109/TEM.2008.927818.
  - doi: “Digital Object Identifier”

Numerical Simulation Versus Analytic Calculation

(If they did not agree, there would be no talk.)



The Binomial Distribution

(Do you think it's right?)

$$b(s, n, p) = \frac{n!}{s!\,(n-s)!}\, p^s (1-p)^{n-s}$$

What Allows Analytic Contingency Setting?

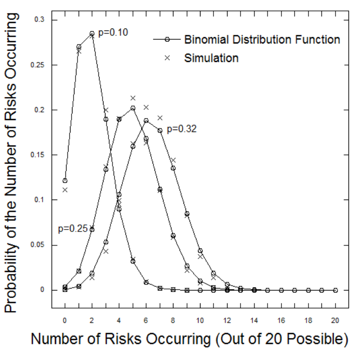
(A bit of an exaggeration.)

$$\sum_{s=0}^{a} \frac{n!}{s!\,(n-s)!}\, p^s (1-p)^{n-s} = 1 - \sum_{s=a+1}^{n} \frac{n!}{s!\,(n-s)!}\, p^s (1-p)^{n-s}$$
$$= 1 - I_p(a+1, n-a);$$

- I_p is a named, standard function, i.e., tabulated, if you will
  - (for those who want to know, it is the incomplete Beta function)

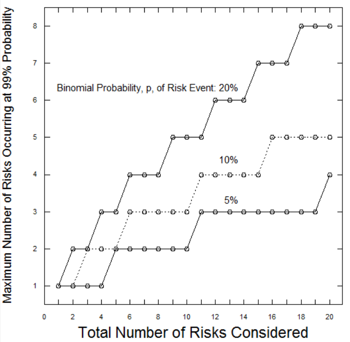
Let’s Sum By Eye, First

(Same figure as before.)



How Many Risks Should We Should Worry About?

If we believe our probabilities!



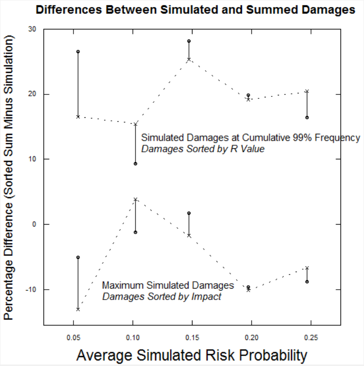
A Detailed Comparison at a Single Probability

Total no. of risks is 20; ave risk prob 0.1025.
After 10,000 trials, simulated damages at 99% frequency are 12,553, and maximum damages are 16213.

		Damages Sorted By:			
	Cumulative	1) $P \times I$		2) Impact	
a	Binomial Prob	Σ	Δ	Σ	Δ
1	0.3777	3508	-72%	3508	-72%
2	0.6627	6619	-47%	6723	-46%
3	0.8579	9703	-23%	9834	-22%
4	0.9527	12045	-4%	12942	3%
5	0.9874	13729	9%	16026	28%
5.27	0.99	14491	15%	16833	34%
6	0.9972	16582	32%	19048	52%
7	0.9995	18155	45%	21902	74%
8	0.9999	19689	57%	24755	97%
9	1.0000	21688	73%	27603	120%

How Good at Different Average Probabilities?

Certainly better than luck!



The Mandatory Responsibility Warning

Models do not make decisions.

PEOPLE DO

1, 2, 3: Summary, Conclusions, and Advice

1. Measurements should be valid and reliable, and they need to be expressed in numbers.
2. If you measure risks with probabilities and impacts, one (at least) method exists for estimating contingencies with statistical confidence.
3. Try to develop the habit of using numbers when you make measurements.
   - (which is not saying that measurements need to be made with numbers)