

Module 5 MGMT 6062

Quantitative Risk & Opportunity Analysis

This helps further refine the priority to resolve risks & review opportunities

Objectives of Quantitative Analysis

Further assessment

- Numerical assessment of the extent to which risks might happen and opportunities could appear, as created by
 - Internal project activities
 - External situations
 - Political, economic, social, technological,, legal, environmental

Focus

- Lower Project Risks
 - Cost, Time, Lost Benefits
- Enhance Project Opportunities
 - Cost, Time, added Net Benefits
- Approval for resultant Decisions and Actions

Decisions

- Further inform Project decisions on whether and how we
 - Might resolve risks, and pursue opportunities
 - Should update the Business Case: Scope, cost, time, benefits
 - Must add activities to the WBS, schedule & milestones
- Generally, the more complex the project (per previous analysis) the more investment we must make in Quantitative analysis

Qualitative methods of assessing risks & opportunities

Mathematical modeling

- Different events & outcomes are simulated based on different assumptions and large amounts of data
 - Simulations are outside the scope of this course, however, please review & understand the concepts in the readings

Sensitivity analysis

- Different events and outcomes are estimated, based on changing some underlying assumptions; large amounts of data not needed
 - Adjustments applied, e.g. discount rates, sensitivity analysis
 - Sometimes coupled with probabilistic 'expected monetary value

Expected monetary value

- Financial outcomes of different circumstances are quantified
- Selected results from the sensitivity analysis are applied
 - Expected monetary cost: additional costs, including benefits loss
 - Expected monetary benefit: net additional benefit

Cash Flows

- Financial and Economic cash flow modeling
 - Cash flows are forecasted, from present-day to a future year
 - Effects of Risks and Opportunities included

Analysis Tools: mathematical modeling

Simulations

MGMT 6062 course content does not currently include Simulations; however, please be familiar with the concepts

- Various scenarios are modelled mathematically
 - ‘Monte Carlo’: many simulations with different assumptions
 - ‘Bayes’ conditional probability analysis: ‘If event A has already happened, then is event B more likely?’
- Simulations are only as good as the initial assumptions & input data
 - Helpful when large amounts of data exist, such as financial analysis, population health, insurance/pension payouts
 - Helpful to separate fact from opinion, and refine assumptions

Artificial Intelligence

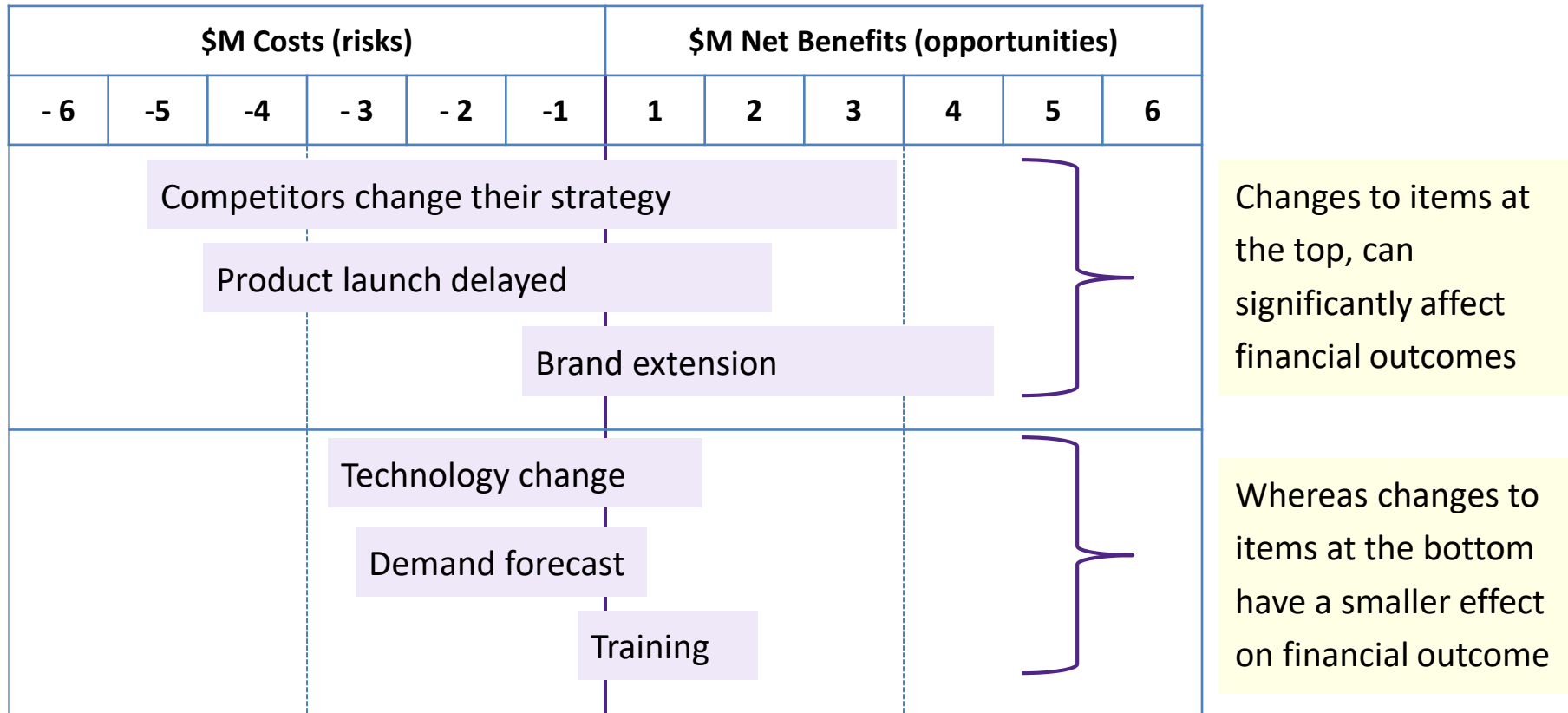
- This is another form of ‘simulation’
 - Helpful to consolidate different ideas into a summary
 - Helpful to arrive faster at alternative solutions
- However, it can over-simplify, which is misleading
 - Like any other model, it’s only as good as the initial assumptions
 - It applies mathematical algorithms; NOT expertise & thinking

Analysis Tools: Sensitivity analysis

Sensitivity analysis

- Probability/Frequency:
 - What is the probability distribution of various events happening?
 - If one hazard exists, is another more likely to exist?
 - If one event happens, is another more likely to happen?
- Visibility:
 - When might hazards, activities or events be more or less visible?
 - To what extent can we detect outcomes, good or bad?
- Outcomes:
 - What is the magnitude? How likely is it?
 - Severity: what are the different possible **negative** outcomes?
 - Benefits: what are the different possible **positive** outcomes?

Sensitivity Analysis example



- This diagram is sometimes termed a “Tornado Diagram” because of its shape
- Sensitivity analysis entails changing assumptions; therefore, expected cash flows will change
- The items most ‘sensitive’ to changes appear at the top of the diagram; therefore, we:
 1. Validate our assumptions and predictions for these items first
 2. Reduce uncertainties by considering an opportunity management or risk management plan
 3. Update project scope, time, cost, benefits as appropriate
 4. Re-run the analysis with cash flows based on the revised assumptions & plans

Expected Monetary Cost of Risks

Some literature refers to 'expected monetary value'. The term 'value' implies something positive.

Risk is negative. Therefore, when discussing risks, we prefer the term 'expected monetary cost'.

Risk Assessment: Quantitative Analysis Time

Schedule scenarios

- Probability that time will be affected
 - This entails review of critical WBS items and external factors
 - May be shown as a range of probabilities

Estimated Time Delay

- Schedule delays to absorb risks
 - Revised 'most likely' schedule, considering affected WBS items
 - Focus first on activities on Critical Path or with low Slack time
 - Consider whether the Critical Path will also change
 - Time Estimate for affected WBS items may be DIFFERENT to the TE from Beta Distribution ...

Cost of time delays

- Expected Monetary Cost of schedule delays
 - Probability X Delay X Cost of Delay
 - Costs/delayed day are likely HIGHER than normal cost/day

Context: at this point, assume we have NOT changed the Project Scope

Risk Assessment: Quantitative Analysis Cost

Cost scenarios

- Probability that cost will change from original plans
 - This entails review of critical WBS items and external factors
 - May be shown as a range of probabilities

Estimated cost increase

- Cost increases to absorb risks
 - Revised 'most likely' costs, considering ALL affected WBS items
 - Must consider ALL items, regardless whether on Critical Path

Net cost increase

- Expected Monetary Cost of project cost increases
 - Probability X Estimated Cost Increase
 - Resource cost/unit is likely HIGHER than planned cost/unit

Context: again, at this point, we have NOT changed the Project Scope

Risk Assessment: Quantitative Analysis Benefit Loss

Benefit loss scenarios

- Probability that benefits will be lost, as a result of risks
 - This first entails review of critical WBS items
 - This MUST also entail review of external factors: external risks such as market changes, could materially affect project benefits
 - May be shown as a range of probabilities

Estimated benefits loss

- Reduction in size of originally forecasted benefits
 - Review the Project Business Case; assess the potential changes

Net Benefit Loss

- Expected Monetary Cost of benefit loss
 - Probability X Estimated Benefit Loss
 - If schedule is delayed or WBS items cannot be sufficiently completed, **benefit loss could be significant**
 - Can the company **tolerate** the loss in benefits?

Total Expected Monetary Cost: schedule delays + cost increases + benefits loss

Risk Assessment: Other Quantitative Considerations

Failure

- The entire project can be 'stressed': all parts fail at once
 - Failure just one part causes other parts to fail
 - Project failure causes failure outside the project
- Recall the '6M' from Module 3:
 - Methods, machines (equipment), manpower (people), materials, measurement, 'mother nature' (environment)

Probability Distributions

- We tend to think in terms of 'averages' and 'bell curves':
 - Not quite true for Risk Management
 - Failure likely occurs at the 'tails' of the distributions
 - The 'probability distribution' likely follows a 'power-law'
 - Failure is sudden, and problems escalate

Document the Expected Monetary Costs

FOL Content > Getting Started and Resources > Risk Management Tools > Risk Register to support EMV analysis

Risk	
Alternative Negative Outcome	Probability
PESTLE Alternative # 1	
PESTLE Alternative # 2	
All risks	

Project Expected Monetary Cost			
Total Project Costs \$		Expected Monetary Project Costs \$	
Schedule delay	Resource needs	Schedule delay	Resource needs
		Total of above	Total of above

Expected Benefits Loss	
Total Benefits Loss	
Probability	Cost
	Total of above

- We are quantifying the Costs to the Project in comparison to original Business Case
- Project Expected Monetary Cost =
Probability X Total Cost for a) Schedule Delays and b) Additional Resources
- We are also quantifying Expected Benefits Loss; here we may consider applying a different Probability
 - For example, if we wish to quantify the cost of a catastrophic outcome (if it happens), consider using a Probability $p = 1.0$ and reviewing the cost ...

Expected Monetary Benefit of Opportunities

Some literature refers to 'expected monetary value'. The term 'value' implies something positive, but it has also been used when discussing risks and negative outcomes.

Opportunities are positive. To reinforce this point, when discussing opportunities, we prefer the term 'expected monetary benefit'

Opportunity Assessment: Quantitative Analysis Time

Schedule scenarios

- Probability that time will be affected
 - This entails review of critical WBS items and external factors
 - The opportunity could delay the schedule or accelerate it
 - May be shown as a range of probabilities

Estimated time changes

- Schedule changes to absorb opportunities
 - Revised 'most likely' schedule, considering affected WBS items
 - Focus first on activities on Critical Path or with low Slack time
 - Again, consider whether the Critical Path will also change

Net Benefit of time changes

- Expected Monetary Benefit of schedule changes
 - Probability X schedule change X cost & benefit of change
 - Determine the NET benefit: some opportunities may incur WBS delays (cost), others may shorten WBS times (benefit)

Context: at this point, assume we have NOT changed the Project Scope

Opportunity Assessment: Quantitative Analysis Cost

Cost scenarios

- Probability that cost will change from original plans
 - This entails review of critical WBS items and external factors
 - The opportunity could reduce costs OR increase costs
 - May be shown as a range of probabilities

Estimated cost changes

- Cost changes to absorb opportunities
 - Revised 'most likely' costs, considering ALL affected WBS items
 - Must consider ALL items, regardless whether on Critical Path

Net benefit of cost changes

- Expected Monetary Benefit of project cost changes
 - Probability X Estimated Cost change
 - Opportunities could increase costs OR reduce costs in the WBS items

Context: again, at this point, we have NOT changed the Project Scope

Opportunity Assessment: Quantitative Analysis Net Benefit Gain

Benefit gain scenarios

- Probability that benefits will increase, as a result of opportunities
 - This first entails review of critical WBS items
 - This MUST also entail review of external factors: external opportunities could materially affect project benefits
 - May be shown as a range of probabilities
- Must consider the NET BENEFIT of opportunity
 - It could result in additional costs, or it could reduce benefits expected from other opportunities

Estimated net benefit gain

- Net change to originally forecasted benefits
 - Review the Project Business Case; assess the potential changes

Net Benefit Gain

- Expected Monetary Benefit of benefit changes
 - Probability X Estimated Benefit Change

Total Expected Monetary Benefit: time change + cost change + benefits gain

Opportunity Assessment: Other Quantitative Considerations

Adjust for cognitive bias

- Success in business is seen as an 'obligation'
 - We wish to be seen as optimistic, confident and competent
 - We do not wish to be seen as critical or 'not a team player'
- Confirm the NET BENEFIT of opportunity .. in a positive way

Ask some Questions

- What are the alternative benefit outcomes?
- If the opportunity is pursued, what risks might this introduce, and to what extent have those risks been analysed?
- What are the dependencies (other things which must happen) in order to realize the opportunity?
- Would project resources be redirected from other activities, therefore causing delays, costs and lost benefits elsewhere?

Next Steps

- Quantifying Risks and Opportunities: show the effects on Project and Company Financials
 - Quantify Social and Environmental considerations as well

Document the Expected Monetary Benefits

FOL Content > Getting Started and Resources > Risk Management Tools > Opportunity Register to support EMV analysis

Opportunity	
Alternative Positive benefit	Probability
PESTLE Alternative # 1	
PESTLE Alternative # 2	
All risks	

Project Expected Monetary Benefit			
Total Project Costs \$		Expected Monetary Project Costs \$	
Schedule Change	Resource needs	Schedule Change	Resource needs
		Total of above	Total of above

Expected Benefits Gain	
Benefits Gain	
Probability	Benefit
	Total of above

- Again, we are quantifying the Costs & Benefits to the Project in comparison to original Business Case
- Project Expected Monetary Cost of pursuing the opportunity =
Probability X Total Cost for a) Schedule Changes and b) Additional Resource needs
- We are also quantifying Expected Benefits Gain: We may wish to show two analyses
 - Total Expected Monetary Benefit (as shown above)
 - Net Expected Monetary Benefit (not shown above) Benefits minus Costs minus new Risk Costs

Financial and Economic analysis

Financial cash flows

“Cash In”

- Operating revenues
 - Product sales
 - Service sales
 - User fees
- Asset sales
 - Net proceeds of reconditioning & selling existing assets
 - Generally considered an Investing cash flow
- Financing proceeds
 - Shareholder equity contribution
 - Debt contribution
 - Any other Project Financing
 - Government Grants

“Cash Out”

- Property, plant & equipment
 - Capital expenditures in physical & intangible assets
 - Considered an Investing cash flow
- Operating expenses
 - Operating labour
 - Maintenance labour & parts
 - Marketing, sales, administration
 - Professional services
 - Leases and rentals
- Increase in working capital
 - Inventory, work-in-progress, supplies
- Taxes
- Financing costs
 - Shareholder dividends
 - Debt interest & principal repayments
 - Any related financing service fees

Financial and Economic Cash Flows combined

“Cash In”

- Operating Revenues
- Asset Sales
- Financing proceeds **
 - Shareholder equity contribution
 - Debt contribution
 - Any other Project Financing
 - Government Grants may be considered as ‘credit’ (reduction) to capital expenditures
- Real savings: remove from budgets *
 - Capital
 - Expense
- Potential savings *
 - Potential capital & expense avoidance
 - Risk reduction, climate change mitigation
- Potential profit protection *
- Re-use of existing assets *

“Cash Out”

- Property, plant & equipment
- Operating expenses
- Increase in working capital
- Taxes
- Financing costs **
 - Shareholder dividends
 - Debt interest
 - Debt principal repayments
 - Any related financing service fees
- Overhead cost allocations *
 - Indirect costs of resources funded elsewhere
- Opportunity costs *
 - Benefits lost by inability to invest elsewhere
 - Reduction in benefits to other projects and operating activities

* Economic cash equivalent

** In traditional economic analysis, Financing CF are usually excluded, as they are assumed to be part of the Weighted Average Cost of Capital. Cash flow analysis, must INCLUDE these costs.

Economic cash flows: elaboration of 'indirect' cash flows

"Cash In"

- **Real savings: remove from budgets**
 - Elimination of previously-planned capital & expense costs which are no longer needed
- **Potential savings**
 - Avoidance of future costs which could be incurred if the project was not done
 - As a result of additional project cash expenditures (e.g. over-building to mitigate against climate change risks), avoidance of future possible re-construction costs
- **Net profit protection**
 - Retention of profits in other products & services, which would be lost if the project was not done
- **Re-use of existing assets**
 - Value of other assets which can be re-used; usually the lesser of book or market value

"Cash Out"

- **Overhead cost allocations**
 - Costs of resources assigned to the project but funded from elsewhere, e.g. from budgets in other departments
 - Any 'overhead cost' allocations
- **Opportunity costs**
 - Benefits lost by inability to invest elsewhere, because the project consumed resources which could have been used elsewhere
 - Re-use of existing assets which could have been re-used elsewhere
 - Profits lost as a result of less demand for other products & services, because customers buy the new products & services instead
 - Profits lost because the project has discontinued other products & services

Risk and Opportunity Assessment: Economic Cash Flows

Economic Analysis Item	Cash Out	Cash In	Explanation
Capital invested	X		• Initial & future outlays in property, plant, equipment
Capital saved		X	• Project investment costs reduction; remove from budgets
Capital avoided		X	• Future investments avoided if risk is mitigated or avoided
Expense invested	X		• Initial and continuing outlay in operating costs
Expense saved		X	• Operating costs reduction; remove from planned budgets
Expense avoided		X	• Future expenses avoided if risk is mitigated or avoided
Revenue inflow		X	• Expected inflow from sales, taxes, fees etc.
Revenue protect		X	• Revenue that would be lost if the project was not done:
Revenue lost	X		• Expected cannibalisation of revenues in other products
Terminal value		X	• Market value of project's assets if sold.
Risk cost	X		• Costs incurred if an undesirable event happens
Opportunity cost	X		• Benefits lost when resources must be applied elsewhere
Opportunity benefit	X		• Net benefits gained if a different opportunity is pursued

Next Steps

Move to Responses

- At this point we have completed various analyses
 - Some of the less-significant risks and opportunities may have been removed
 - For the remaining risks & opportunities, we have quantified the potential costs and benefits
 - Now we must move to specific action plans (Module 6)

End Module 5