فرآیند جامع مدیریت ریسک در پروژه

به همراه آموزش نرم افزار

Risk Analysis

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انواع تکنیک‌های شناسایی ریسک

Types of Risk Identification Techniques

- Many risk identification techniques exist. Most are adaptations of management tools used for other purposes.
- This not only adds value to such tools, but also means that people in project stakeholder organizations are likely to be familiar with them already.
- The active ingredient common to every one of these techniques is brainstorming.

Types of Risk Identification Techniques

- Whatever technique is used, at relevant intervals in the risk identification process the workshop participants have to respond to the (threat risk) question we raised in what **could happen** in this particular context to **threaten** a satisfactory **outcome** for this organization on this project?
- The process is therefore largely **iterative.**

Activity-Related Techniques

تکنیک های مرتبط با فعالیت

Activity-Related Techniques:

- The activity-related risk **identification** techniques are overwhelmingly associated with project **delivery activities**.

- They are not risk-unique; that is they are not devised solely for risk management, but are essentially used for other purposes that can be adapted, usually by the inclusion of the questions.

Activity-Related Techniques:

Using these techniques in risk management relies on the availability of **sufficient documented** information about the **task**, **technology**, **resource**, and **organizational requirements** for delivering the project.

Activity-Related Techniques:

Examples of project risk identification through the adaptation of three different activity-related management tools:

- Work Breakdown Structures(WBSs)
- Bar Charts
- Critical Path Networks (CPNs)

Work Breakdown Structures (WBSs)

- Typically used in the construction industry, a WBS comprises a list of required activities conventionally displayed as a sequenced list.

WBS presented at a sub-activity level for a main activity.

Work Breakdown Structures (WBSs)

Casting cycle for reinforced concrete floor slabs in a multistorey building

Project activity
Reinforced concrete floor slab casting cycle
Assemble formwork materials
Setting out
Erect formwork
Rough-in services
Position block-outs
Assemble steel bar/mesh reinforcement
Fix reinforcement
Mix/order concrete (arrange pump?)
Pour concrete
Take test cubes
Cure concrete
Strip formwork
Clean and reassemble forms for next cycle
Take test cores

Work Breakdown Structures (WBSs)

WBS example, typical brainstormed answers to the question might include:

1) Weather issues

2) Material supply issues

3) Material specification issues

4) Labor supply issues

5) Labor quality issues

6) Labor productivity issues.

A WBS can be a powerful tool for risk identification.

Bar Charts

- Bar charts align project activities against a time axis.
- Bar chart uses a specific format and time measure for this.
- Depending upon the nature of the project, the measure may be in minutes, hours, days, weeks, or years.

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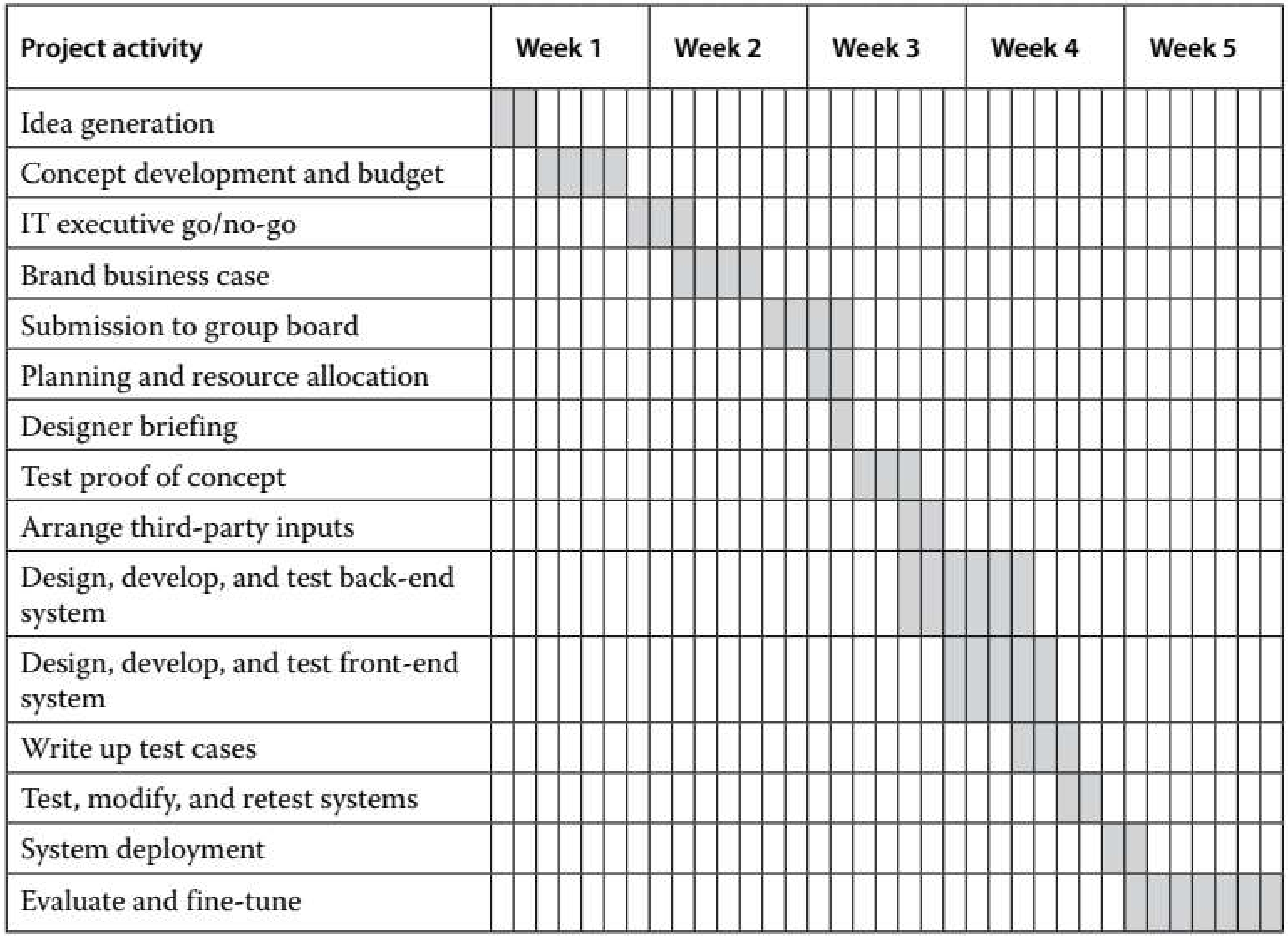

Project activity
Week 1
Week 2
Week 3
Week 4
Week 5
Idea generation
Concept development and budget
IT executive go/no-go
Brand business case
Submission to group board
Planning and resource allocation
Designer briefing
Test proof of concept
Arrange third-party inputs
Design, develop, and test back-end system
Design, develop, and test front-end system
Write up test cases
Test, modify, and retest systems
System deployment
Evaluate and fine-tune

Bar Charts

- For project risk identification takes the process just one step beyond that achieved by simply using the list of activities alone.
- For each activity, the additional question is:

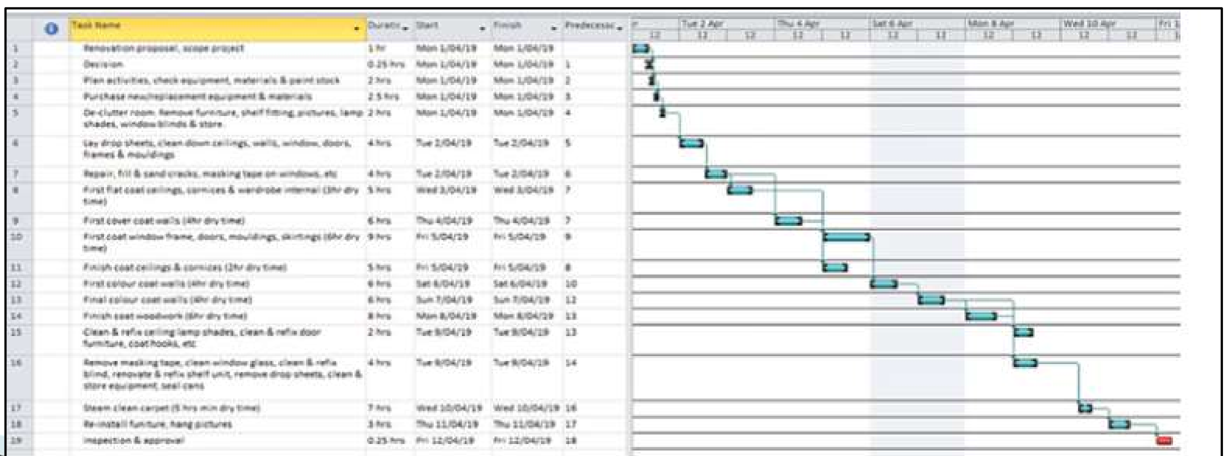
What **uncertainties** could affect the **satisfactory** completion of this activity in the scheduled time?

- For a threat risk, this would Imply an event occurring that would lead to **exceeding** the planned duration, whereas **faster** completion might indicate the presence of an **opportunity** risk.

Critical Path Networks

CPN analysis explores the time relationships and dependencies between the discrete activities required to deliver a project.

CPN diagram Availability of a suitable computer application (such as Microsoft Project™ or Primavera P6), a CPN can be prepared. In order to do this, start times and durations for each activity must be determined, together with the precedence logic. The CPN diagram for the sample project is shown as a bellow.



Analytical techniques

تکنیک های تحلیلی

Analytical techniques

Analytical techniques include:

- Decision Tree Analysis (DTA)
- Event Tree Analysis (ETA)
- Fault Tree Analysis (FTA)
- Failure Mode and Effects Criticality Analysis (FMECA)
- Hazard and Operability Studies (HAZOPS)
- Safety Hazard Analysis (SHA)

Decision Tree Analysis

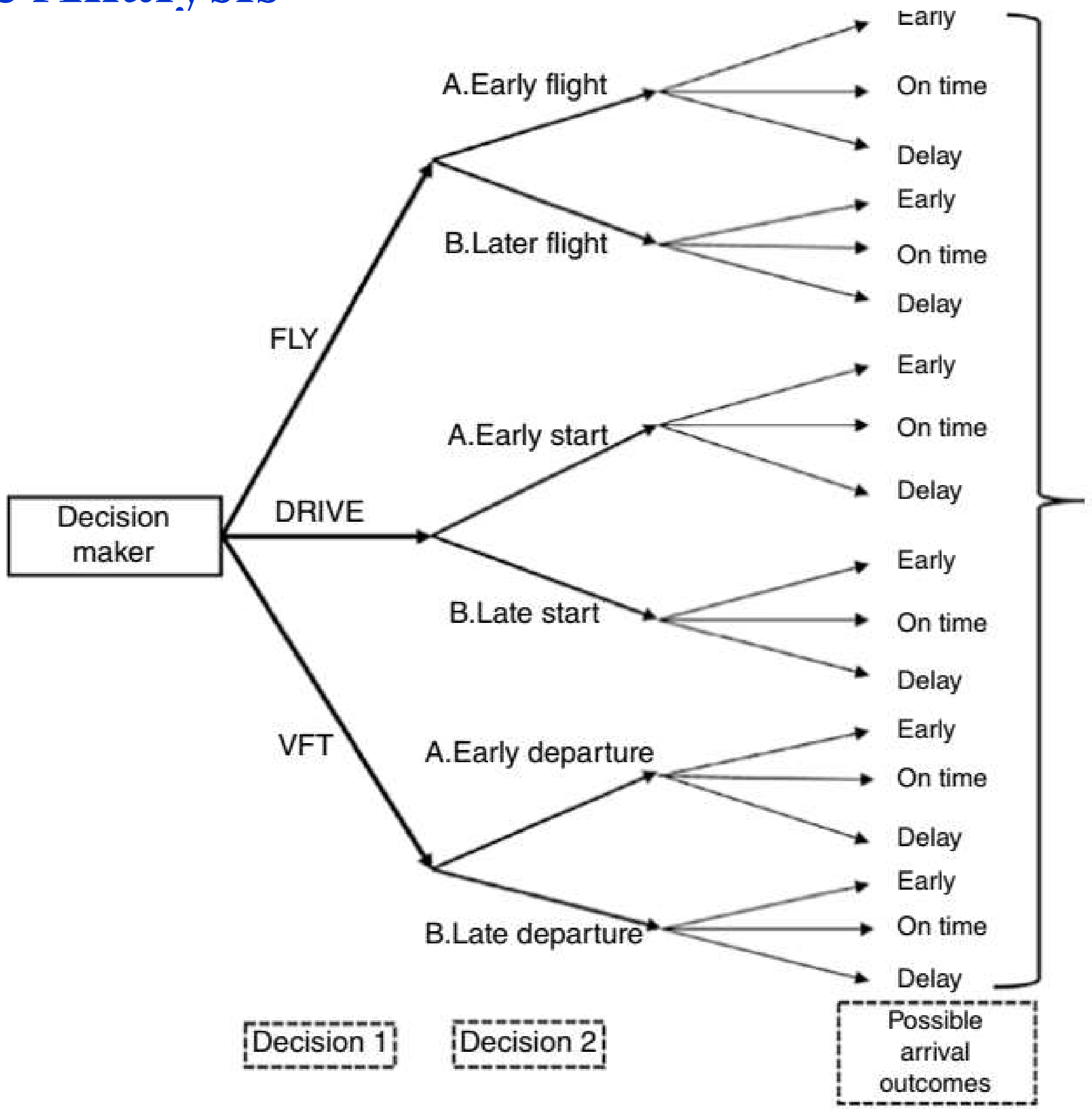
- DTA identifies logical consecutive decision nodes and explores their possible outcomes.
- It associates objectives with the decision making required to fulfil them.

Decision Tree Analysis

The risk identification questions are:

- What is the objective?
- What are the decision alternatives associated with the objective?
- What events can happen to affect each decision alternative?
- What are the possible consequences of those events?

Decision Tree Analysis



Event Tree Analysis

- روش تحلیل درخت رویداد، همانند یک ابزار در ارزیابی ریسک است که می تواند به صورت کیفی و یا کمی بکار گرفته شود. اگر به صورت کیفی بکار رود ابزاری در خدمت شناسایی مخاطرات است و در صورتیکه کمی شود در ارزیابی ریسک کاربرد خواهد داشت. هنگامی که عملکرد موفق یک سیستم وابسته به عملکرد تعیین شده زیر سیستم های مربوطه باشد، درخت رویداد ابزار مناسبی جهت تحلیل این سیستم ها خواهد بود. این تحلیل عموماً برای سیستم های پیچیده کاربرد دارد.
- این روش تکنیکی برای ارزیابی حوادث خطرناکی است که پیشگیری از آن نیاز به مراقبت های ویژه دارد.

Event Tree Analysis

- ETA inductively traces a sequence of possible consequences flowing from an event.

- It is essentially the downstream adjunct to the FTA technique.

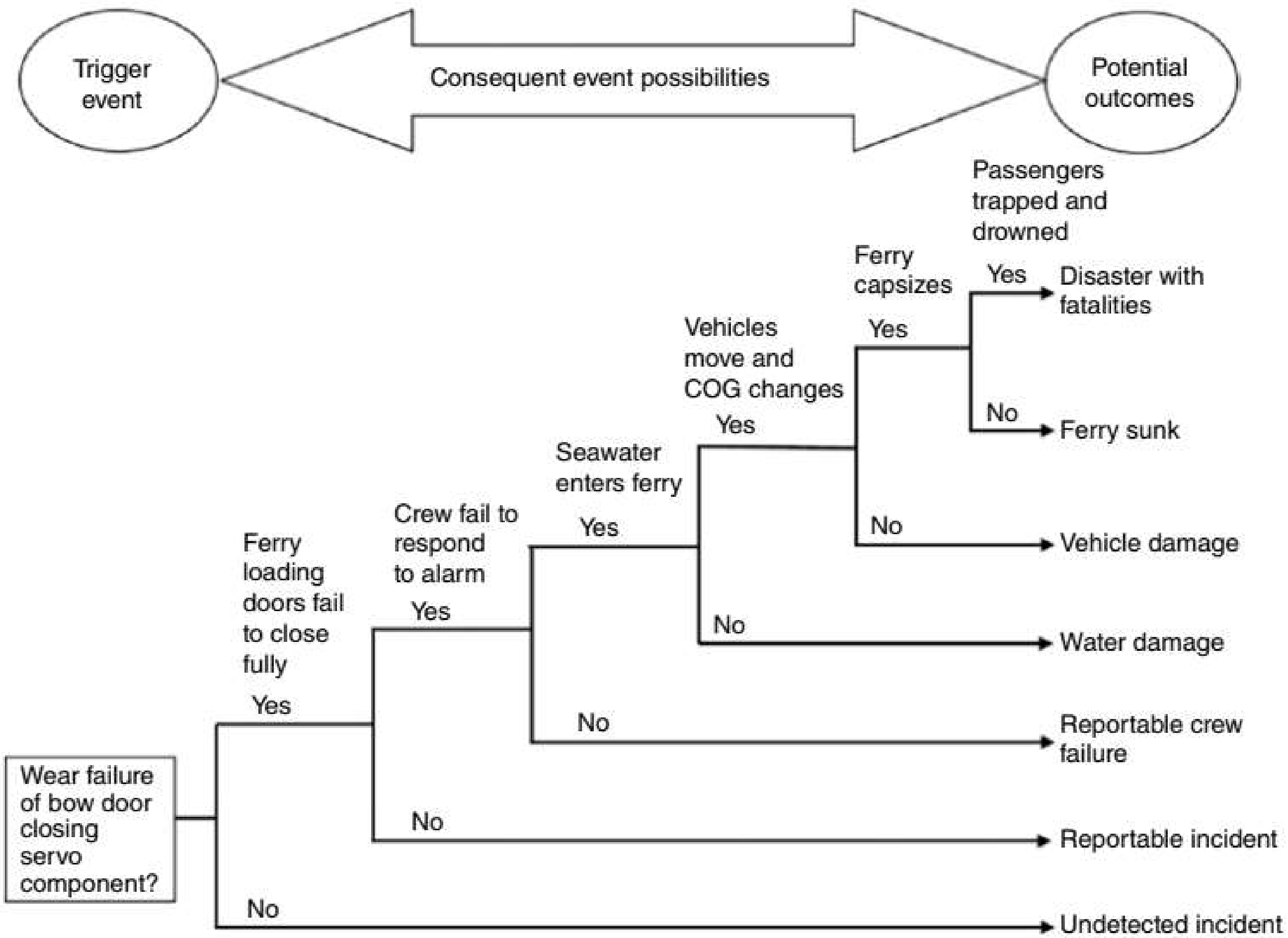
Event Tree Analysis:

- For risk identification, ETA requires the primary 'trigger' event to be established first, and then the question becomes: What flow-on events can occur as a result of this one?
- Since other means must be used to identify the primary risk event, the use of ETA is somewhat limited in risk identification, but, by following chains of events, it is helpful in preparing full risk statements.

Event Tree Analysis:

- Example that could derive from the operational phase of a maritime ferry service project. Here, the nodes are dichotomous yes/no possibilities for flow-on events, each with its associated uncertainty.

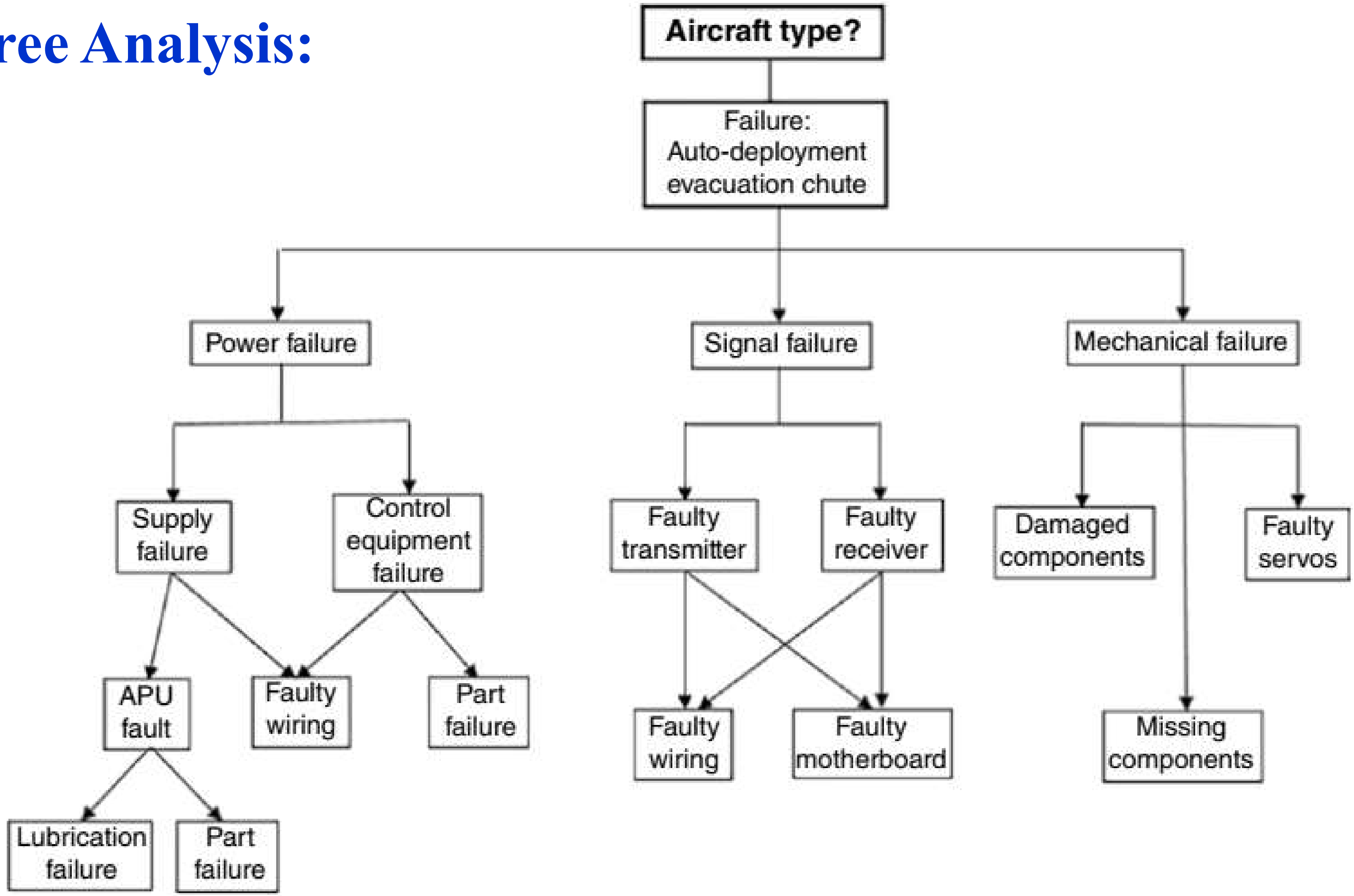
Event Tree Analysis:



Fault Tree Analysis

- FTA employs a top-down deductive process by starting with a risk impact.
- Like DTA and ETA, FTA tends to be used more in risk analysis than in the risk identification process.
- FTA then traces a logical sequence of possible causal or contributory factors to the primary consequence.

Fault Tree Analysis:



Hazard and Operability Studies

- HAZOP یکی از تکنیک های حوزه ریسک می باشد که در آن مخاطرات بالقوه عملیاتی به صورت سیستماتیک، مدیریت می‌شوند.
- تحقیقات HAZOP به فعالیتی گفته می‌شود که راجع به خطرات و مشکلات موجود در سیستم بر روی اهداف طراحی و عملیاتی انجام می‌شود و می‌تواند به شناسایی و ارزیابی مشکلات و خطراتی که میتوانند ریسکی را به محیط زیست و یا تجهیزات وارد کند کمک نماید.
- HAZOP در طی مراحل طراحی یک فرآیند یا پروژه جدید، برای تغییرات عمده فرآیند و برای بررسی دوره ای خطرات موجود در عملیات پیش رو استفاده می‌شود.

Hazard and Operability Studies

- سازمان ایمنی و بهداشت شغلی ایالات متحده (OSHA)، و همچنین سایر تنظیم کنندگان استاندارد ها در سراسر جهان ، روش HAZOP را به عنوان یک روش قابل قبول برای ارزیابی خطر تشخیص میدهد.

Hazard and Operability Studies

- The HAZOPS technique is predominantly used in the petrochemical processing industries in the design phase of projects, to explore potential hazards arising in the operational phase, with a view to preventing their occurrence or containing their effects through appropriate redesign.

Hazard and Operability Studies

Item	Reference	Specification	Question	Guide	Situation	Result
1	Dwg. A/21/123	Section: A21	What if ...	no ...	flow occurs through Flask AF1?	aaa...
2	Dwg. B/78/456	Section: B05	What if ...	more ...	pressure than specified occurs at Valve BV6?	bbb...
3	Dwg. C/51/789	Section: C48	What if ...	less ...	temperature than specified is generated at Purifier CP2?	ccc...
4	Dwg. D/032/099	Section: D03	What if ...	reverse ...	flow occurs at Filter DFL12?	ddd...
5	Dwg. E/83/004	Section: ???	What if ...	as well as ...	XX and YY chemical wastes both flow in Channel EC9?	eee...
6 etc.	???...	???...	What if ...	???...	???...	fff...
7 etc.	???...	???...	What if ...	???...	???...	ggg...

Safety Hazard Analysis (SHA)

- Over recent years, increasingly greater attention has been given to issues of health and safety in the workplace.
- For safety particularly, such attention has spread to other environments including the home, school, university, and places used for business, leisure, sport, entertainment, and other social and religious activities; as well as to external environments and modes of transport.

Safety Hazard Analysis (SHA)

Many countries have established authorities to monitor the observance of safety regulations, investigate the need for further regulation, and encourage safer behaviors among citizens.

Safety Hazard Analysis (SHA)

ISO 45001 (2018) is an international standard for promoting occupational health and safety, requiring a risk-based approach with decision maker/worker consultation and third-party verification processes.

Safety Hazard Analysis (SHA)

Work safety hazard analysis record				Ref. no.
Project				**Variations (including dates and authority)**
Location:				
Client:				
Contractor:				
Subcontractor:				
Planned activity:				
Activity location(s):				
Confined spaces?				
Equipment and services requirements:				
Planned dates:				
Planned times:				
Supervisor(s):				
Work crew(s):				
	Hazard description	Severity (H/M/L)	Proposed treatment and control	
Hazard 1:				
Hazard 2:				
Hazard 3:				
Hazard 4:				
Hazard 5:				
WSHA Prepared by:		Date:	Signature:	
Reviewed by:		Date:	Signature:	

Functional Value Technique

- The functional value technique is quite restricted for application in project risk identification.

- This process interrogates the required function and economy of project design at various.

Functional Value Technique

System or component levels by asking the following questions:

- What is this system/component?
- What is it required to do (its function)?
- What does it cost?
- What is its functional value (worth to the project client)?
- What else would fulfil the function?
- How much does that cost?
- What is the functional value of that alternative?

Matrices

- Techniques in the matrices type of risk identification mainly use combinations of techniques in a tabular matrix format.

- This can be a powerful approach, especially when risk classification is part of the matrix.

Simulation and Visualization Techniques

- Although now prolific in project design processes, the use of simulation and visualization techniques is still quite rare in project risk identification.
- Most of these techniques harness graphics application software properties and the power of computers to create virtual reality or augmented virtual reality representations of physical projects.

Structural and Management Tools

- Structural or management tools that can be used to identify project risks include: organizational structures (for both the project and the stakeholder), governance and operational procedures (for the procurement and operational phases of the project if the latter is relevant to the stakeholder), and specific project management frameworks and applications.

Structural and Management Tools

- Using any of these to identify project risks essentially entails exploring.
- The relevant material, be it structure, governance mechanism, procedure, framework, or application, by auditing and interrogating the inherent decision points – usually concentrating on the major decisions affecting the project – and asking what could affect a satisfactory outcome from that decision.

تحلیل کیفی و کمی ریسکهای پروژه

Risk Classification Based upon Project & Organizational Structure

- Classifying risk is important in risk management as it enables a project stakeholder to consider risks within an organized and coherent framework.
- Classifying risk should also provide us with a universal and uniform risk language.
- Any risk classification system should be capable of grouping risks by the type of source event.

A Generic Source-Event Risk Classification System

- In a generic source-event risk classification system, the top tier of separation is between **natural systems** and **human systems** risks.

- Natural systems risks arise from sources beyond human agency.
- Human risks arise in terms of human involvement in some capacity.

A Generic Source-Event Risk Classification System

- Humankind has little or no capacity to influence the occurrence of natural risk events, but some limited ability to deal with their consequences.
- For human systems risks, there is far greater ability to influence both their likelihood of occurrence and their impacts.

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Natural risk systems categories	Human risk systems categories
Astronomical	Cultural
Climatological	Economic
Geological	Financial
Biological	Health
Ecological	Legal
	Management
	Political
	Sociological
	Technical

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

Natural risk systems categories	Examples
Astronomical	Solar radiation
	Tidal variation
	Meteorite strike
Climatological	Hurricane
	Typhoon
	Tornado
	Lightning strike
Geological	Earthquake
	Volcanic eruption
	Geomorphological state
Biological	Human biology
	Animal biology
	Marine biology
Ecological	Plant environment

Human Risks

- Risks arising out of human agency are more difficult to categorize than natural risks, due largely to the overlapping and inter relational characteristics of many humanly devised systems.

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

Human risk system categories	Example
Cultural	Religions
	Cultural customs
Economic	Material Supply
	Labor supply
	Inflation
	Tariffs
	Fiscal policies

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

Human risk system categories	Example
Financial	Exchange rate
	Interest rate
	Credit rating
	Capital supply
	Cash flows
	Rentals
	Fees and charge

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

Human risk system categories	Example
Health	Epidemies
	Surgery
Legal	Contract clauses
	Regulations
	Codes of practice

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

Human risk system categories	Example
Management	Communications
	Productivity
	Quality assurance
	Cost control
	Human resource Management
	Safety management

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

Human risk system categories	Example
Political	War
	Civil disorder
	Industrial relations actions
Social	Criminal acts
	Civil torts
	Substance abuse

طبقه بندی ریسک های شناسایی شده بر اساس سازمان و پروژه

The technical category of risk involves events attributable to a humanly designed technical system.

Human risk system categories	Example
Technical	Design failure
	Equipment and system failure
	Estimation error
	Criminal acts
	Civil torts
	Substance abuse
	Collision and accident
	Communication system failure

Risk Classification Based upon Organizational Structure

- Another way to classify risks is by the structure of the stakeholder organization that is exposed to them.

- Governance, operational, and administrative units can be identified in other types of organizations including public authorities, universities, schools, hospitals, and other public services and utilities.

Risk Classification Based upon Organizational Structure

Risk classification by organizational structure.

Governance and structure
Board
Human resources
Quality management
Occupational health and safety
Purchasing
Design and planning
Production
Transport
Financial administration
Information and computer technology (ICT) and communications
Marketing and sales
Customer and public relations
Research and innovation
Legal affairs
Project management

Project Risk Analysis and Evaluation

- Risk analysis may be undertaken quantitatively or qualitatively. Sometimes this is also described as 'objective' or 'subjective' assessment, but this interpretation is somewhat misleading.

- In risk analysis, essentially we are looking at recognizing, understanding, and dealing with uncertainty.

- The uncertainty may relate to the likelihood of occurrence of a risk event; the nature, magnitude, and occasion of its consequences; or all of these.

- For most organizations, qualitative risk analysis will be carried out first, as a rapid means of triaging threat risks.

- For many projects this is all that is required.

- qualitative risk analysis should take place immediately after risk identification has been completed.

Qualitative Analysis

- Qualitative approaches to risk analysis reflect the perceptions, opinions, and value mechanisms of the assessors.
- Qualitative analysis usually is regarded as subjective because it relies almost entirely upon human judgment.
- That judgement will be influenced by experience and by personal biases that may lead to errors.

Qualitative Analysis

Errors in human judgement include those arising from biases such as:

- Selective recall (remembering only certain facts or incidents and ignoring other evidence)
- Base rate fallacies (e.g. assuming that a particular trend line will continue at the same rate into the future)
-

Qualitative Analysis

- Over-pessimism
- Over-optimism
- Overconfidence in the assessment
- Inappropriate search for patterns in data
- Inappropriate framing of the situation

Qualitative Analysis

- The outcome of qualitative risk analysis should be a list of project threat risks that the stakeholder organization faces, categorized according to type and grouped or ranked in terms of the level of severity they represent.
- The analytical data can be used to populate the stakeholder's project risk register (PRR)
- In qualitative risk analysis, these measures are most often linguistic, using words as descriptors for value or quantity estimates.

Qualitative Analysis

- The most basic linguistic assessment measure is: low, medium, and high

High			
Medium			
Low			
↑ Likelihood Impact →	Low	Medium	High

Qualitative Analysis

Five-point risk assessment measures.

Probability/likelihood scale interval label (AS/NZS 4360)	Defining description (AS/NZS 4360; AS/NZS HB 436)	Possible project frequency basis
5. Almost certain	Expected to occur in most circumstances	75 or more out of 100 projects
4. Likely	Will probably occur	Fewer than 75/100 projects
3. Possible	Might occur at some time	Fewer than 50/100 projects
2. Unlikely	Could occur at some time	Fewer than 10/100 projects
1. Rare	May occur in exceptional circumstances	Fewer than 5/100 projects

Source: Adapted from AS/NZS HB436 (2004).

Qualitative Analysis

Alternative five-point measures of likelihood

Probability/likelihood	Description
5. Almost certain	• >75% probability *or* • occurrence is imminent *or* • could occur within 'days to weeks'
4. Likely	• ≤75% probability *or* • on the balance of probability will occur *or* • could occur within 'weeks to months'
3. Possible	• ≤50% probability *or* • may occur but a distinct probability it will not *or* • could occur within 'months to years'
2. Unlikely	• ≤10% probability *or* • may occur but not anticipated *or* • could occur in 'years to decades'
1. Rare	• ≤5% probability *or* • occurrence requires exceptional circumstances *or* • very unlikely, even in the long-term future *or* • only occurs as a '100 year event'

Assessing Impacts

- In exploring assessment measures for the impacts of risk events, our focus will be upon threat risks, and the consequences will thus be negatively framed.
- For three-point qualitative measures of impact (low, medium, and high)

Qualitative Impact

Five-point measures of impact.

Impact/consequence (AS/NZS 4360)	$Loss	Harm
5. Catastrophic	Huge. Greater than $d (or financial collapse of organisation)	Death occurs
4. Major	Major. Less than $d	Serious injuries; hospitalisation; long-term disability
3. Moderate	High. Less than $c	Medical treatment needed
2. Minor	Medium. Less than $b	First aid treatment required
1. Insignificant	Low. Less than $a	No injuries

Source: Adapted from AS/NZS 4360 (1999) and AS/NZS HB436 (2004).

Qualitative Impact

Where multiple consequences can arise for any risk, the highest impact category rating should be assigned to the whole risk.

Evaluating Risk Severity

- Great care is necessary in devising measures for evaluating threat risk severity, particularly where qualitative measures have been used for assessing likelihood and impact.
- In quantitative risk analysis, risk severity is a straightforward matter of calculating the product of the probability and impact values for each risk as each is represented by data values that are continuous in type.

Evaluating Risk Severity

Multiple-Impact risk assessment measure

Rating	Financial	Safety	Environmental	Social	Legal	Reputational
5. Catastrophic	Loss greater than \$d (= financial collapse)	Death occurs	Irreversible long-term environmental harm National/international impacts	Adverse effects on whole organisation	Major litigation/ prosecution likely	Medium/ long-term adverse media inquiry
4. Major	Loss less than \$d	Severe irreversible disability; off work more than six months	Measurable environmental harm Medium/long-term recovery Required to inform government authority Local/regional impacts	Adverse effects on sub-organisation	Significant litigation involving lawyers and senior counsel	Medium-term adverse media attention
3. Moderate	Loss less than \$c	Significant medical treatment; long-term recovery or off work less than six months	Medium-term recovery Some local effect	Can be managed within organisation	Breach of regulation with internal investigation and report to authority Prosecution and heavy fine possible	Short-term adverse national press attention
2. Minor	Loss less than \$b	Medium-term largely reversible disability or off work less than one month	Short-term recovery Minimal local effect	Can be managed within sub-organisation	Minor non-compliance or breach of regulation Small fine possible	Short-term adverse local press attention
1. Insignificant	Loss less than \$a	First aid or minor medical treatment; not required to be off work	Little or no impact	Entirely a project issue; no further action needed	No legal breach	Little damage

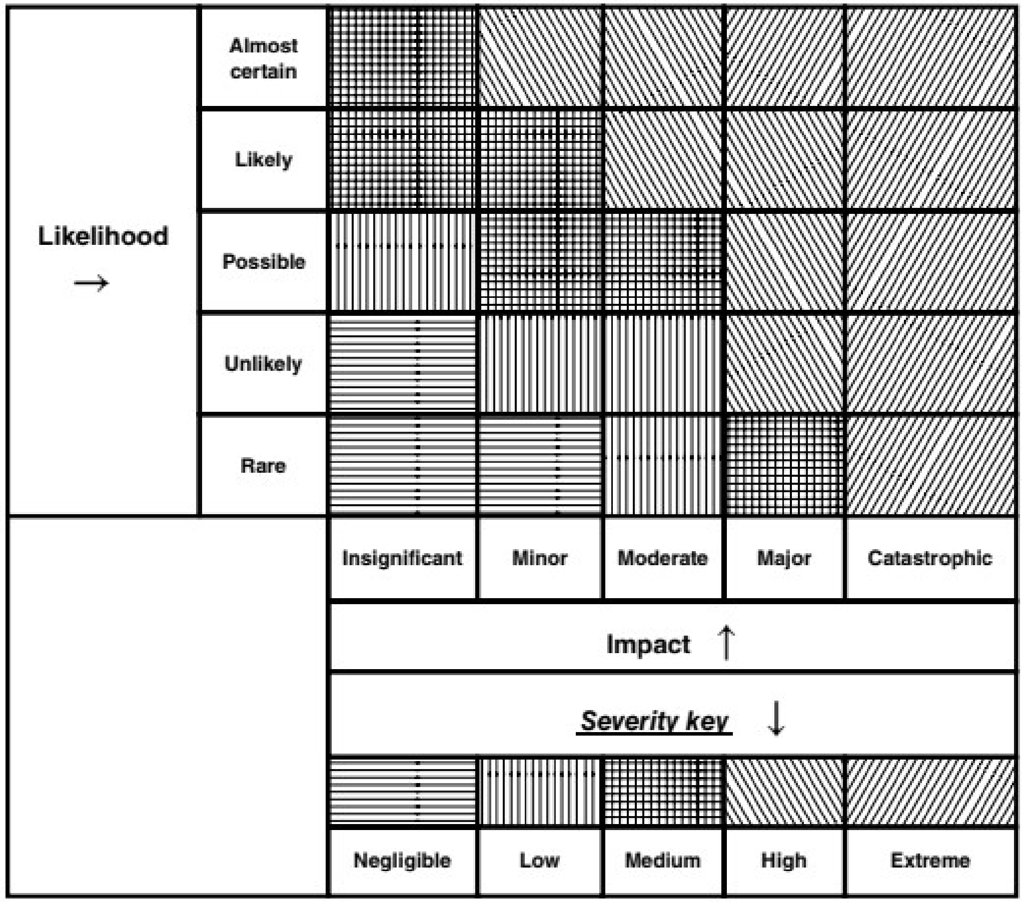
Evaluating Risk Severity

Three-point measure of risk severity

Likelihood	High	R7, R9	R5	R6 ***High***
	Medium	R4, R8, R13 R18, R19, R20, R21	R12, R14 ***Medium***	R2, R10, R16
	Low	R11 ***Low***	R1, R3, R22	R15, R17
Severity		Low	Medium	High
		Impact		

Evaluating Risk Severity

Five-point measure of risk severity



Source: Adapted from AS/NZS HB436 (2004).

Quantitative Analysis

- Quantitative risk analysis involves mathematical analysis, risk severity can be calculated as the product of likelihood and impact and used for valid relative comparisons between risks.
- The benefits of valid risk severity comparisons derived from quantitative approaches do not come without cost. Several issues must be considered and dealt with, Including:

Quantitative Analysis

- Availability and sufficiency of essential input data
- Nature, accuracy, and reliability of input data
- Reliability of the analytical and modelling techniques involved
- Competent application of techniques
- Nature, accuracy, and reliability of output data
- Competent interpretation of outcomes
- Time availability
- Costs of analysis

Quantitative Analysis

- Quantitative approaches to investigating uncertainty in project risks generally use mathematically based statistical analyses of historic data and may involve simulation.
- At a simple level, the analysis might comprise sensitivity testing of the critical variable values.
- changing the value of one variable by one incremental step at a time and observing the effect on the outcome.

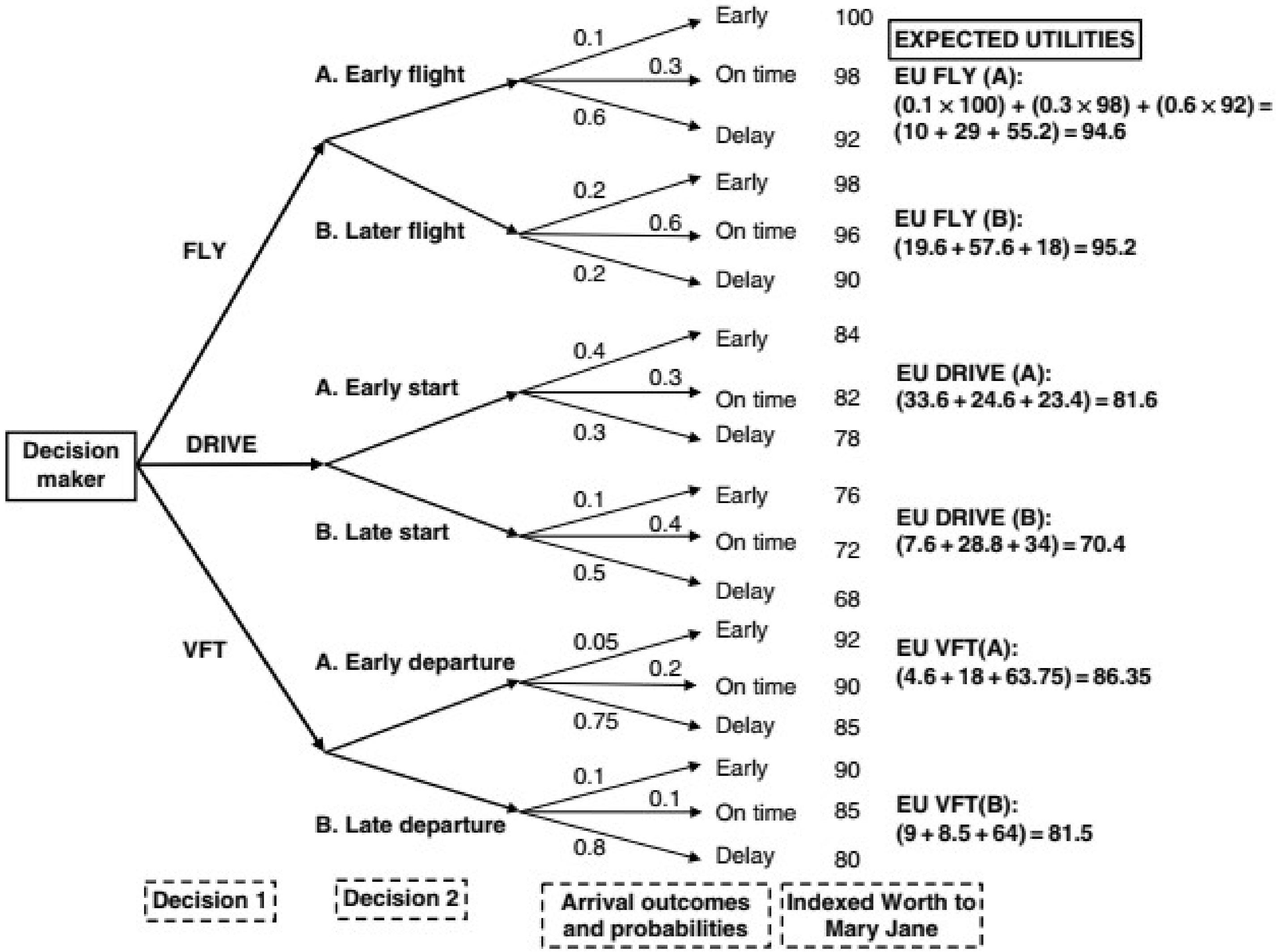
Quantitative Analysis

- The limitation of sensitivity testing is that it is not suitable for exploring the effect of multiple changes in several variables at the same time.
- At a more sophisticated level, Bayesian analysis, fuzzy sets, Monte Carlo simulation, and other techniques may be appropriate

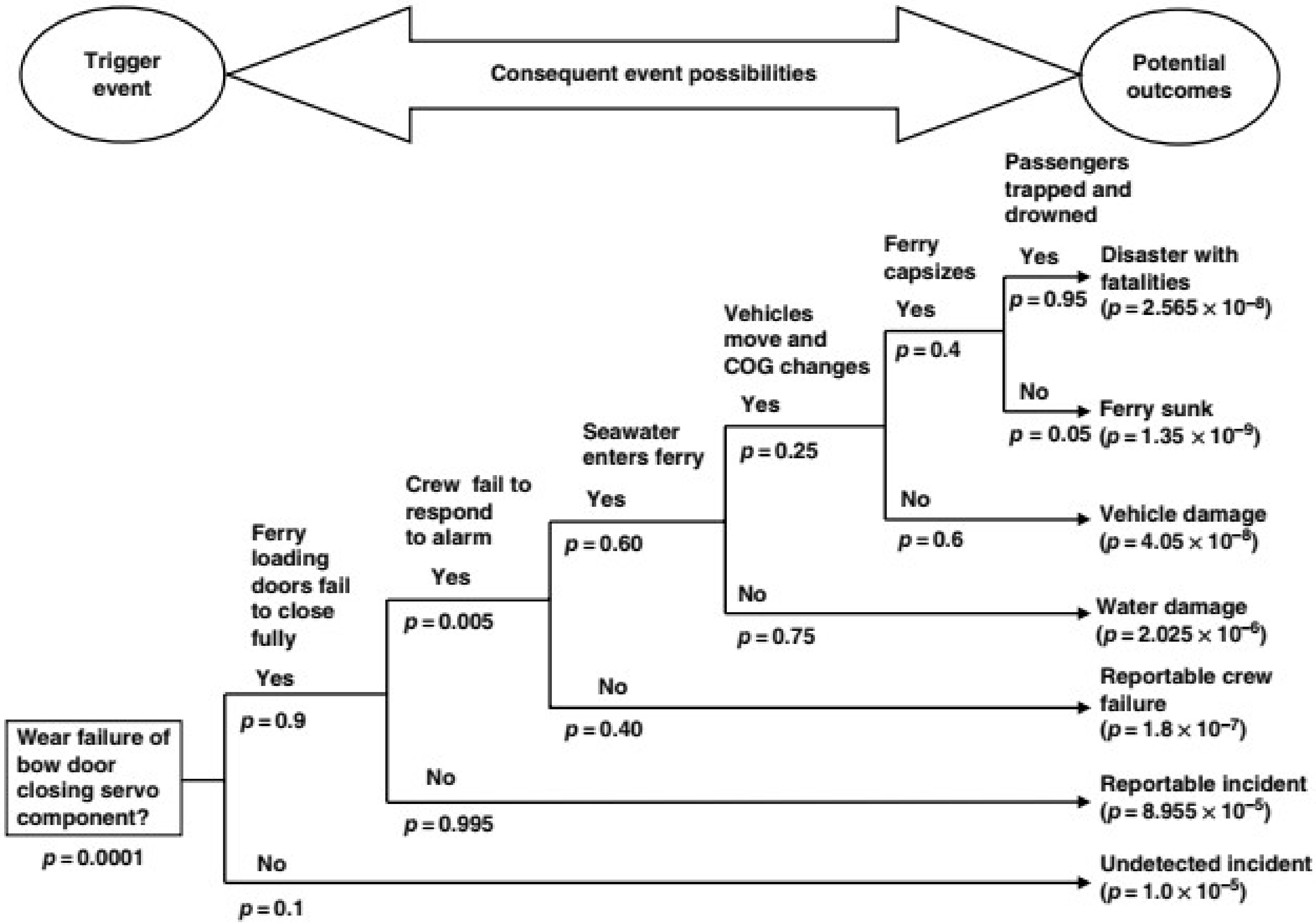
Quantitative Analysis

- Quantitative analysis at this level cannot be rushed simply to meet the time pressures associated with contemporary projects.
- It is also likely to be expensive, particularly if domain experts and specialists have to be hired and briefed to carry out the analytical work.
- To demonstrate some of these issues, we return to the decision tree analysis (DTA), event tree analysis (ETA), and fault tree analysis (FTA).

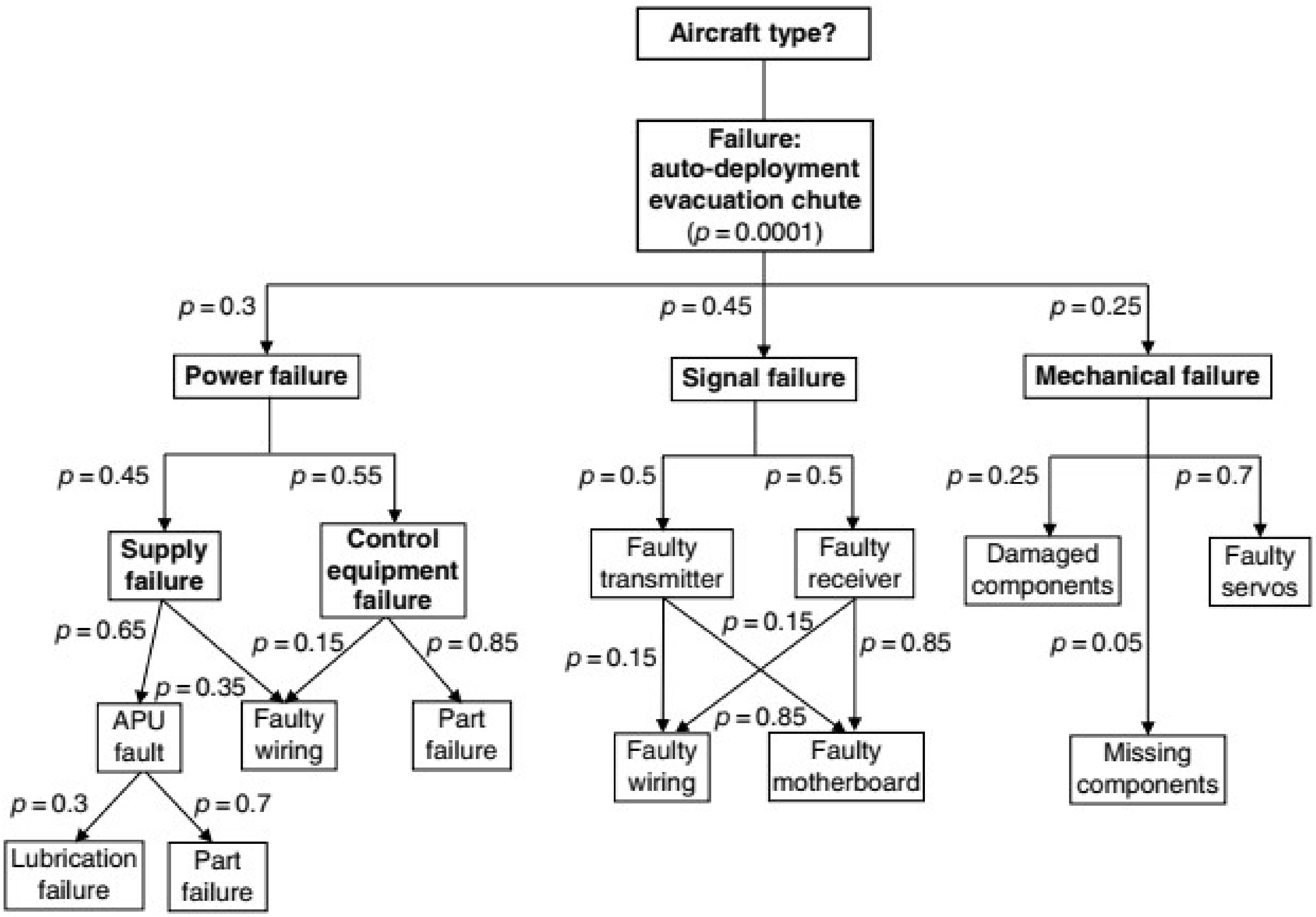
Expected utilities for DTA of travel outcomes



Outcome probabilities for ETA of ferry vehicle loading door incident



FTA causal factor probabilities for chute deployment failure.



Risk Mapping

- Risk mapping is a very under-utilized tool in project risk management.
- Perhaps the simplest approach is to map project risks according to severity level.
- The coded risks can be mapped onto the matrix according to the severity assigned to each one.
- This information is useful as it could be compared with severity matrices from previous similar projects.

Risk Mapping

Comparative project risk severity assessment

	Risk 1	Risk 2	Risk 3	Risk 4	Risk 5	Risk 6	Risk 7	Risk 8	Risk 9	Risk 10
Project A	100	90	80	70	60	50	40	30	20	10
Project B	85	85	60	80	40	65	30	70	45	50
Project C	60	95	110	40	75	35	60	50	60	30

Risk Mapping

Risk severity spider chart