Identifying and Managing Risk – Student Guide

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Preface for Students

About the Student Guide

This Student Guide is designed to supplement the presentation on Identifying and Managing Risk. It includes:

- PowerPoint slides
  The PowerPoint presentation highlights the key points, concepts, illustrations and diagrams associated with the course. This guide contains a grab of each slide in that presentation.

- student learning objectives
  The presentation is divided into a number of lessons. Each lesson is then further subdivided into a number of topics. A topic is stand-alone piece of instruction that has a specific, demonstrable learning objective. You should begin each lesson by taking a moment to review the objectives.

- supplementary notes
  Supplementary notes appear with each slide, adding detail to what has been covered in the presentation. It is recommended that you review these notes following each presentation.

Lesson 1: Introduction to Risk Management

Topic 1: Definition of Uncertainty and Risk

Topic 2: Stakeholder Risk Tolerance

Topic 3: Definition of Probability and Impact

Topic 4: Preparing a Risk Management Plan

Topic 5: A Risk Management Plan Template

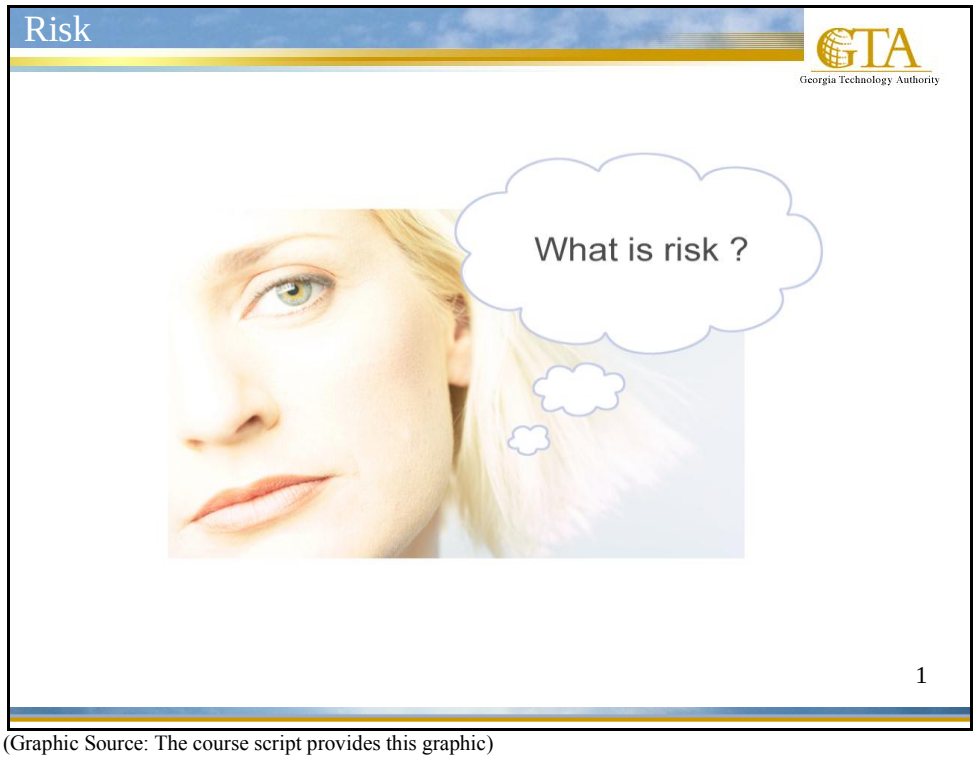
Topic 6: Using a Risk Management Plan

Student learning objectives

After completing this lesson, you should be able to

- define uncertainty and risk and how they relate to each other
- describe how project stakeholders' risk tolerance affects project management
- explain the concepts of probability and impact in risk management
- identify the elements of a risk management plan
- prepare and use a risk management plan

Topic 1: Definition of Uncertainty and Risk



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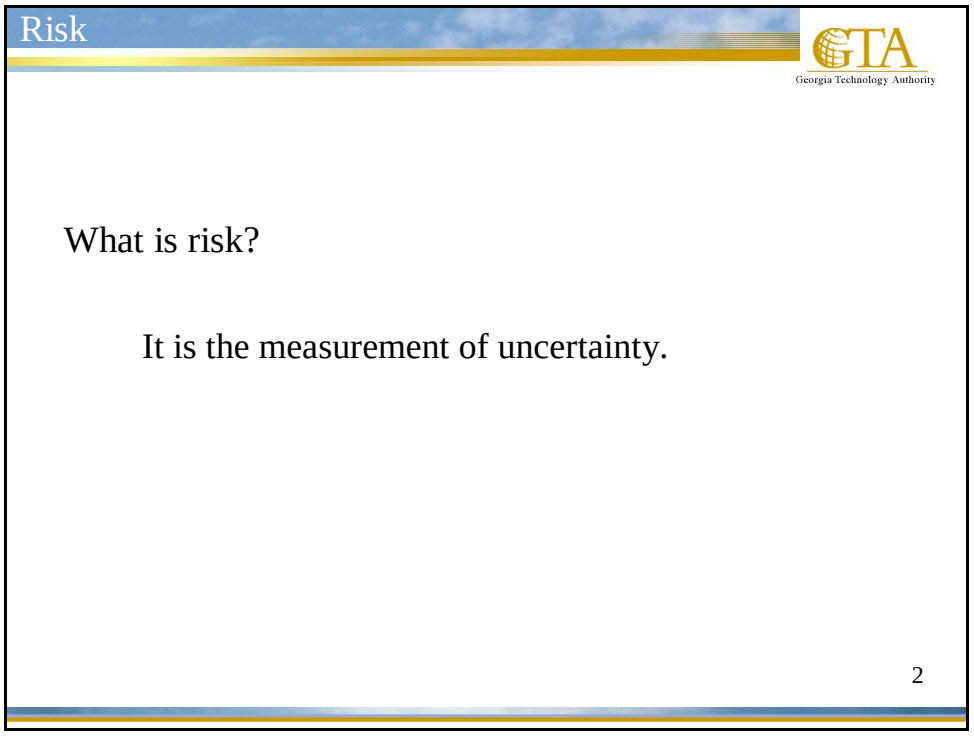
Topic 1: Definition of Uncertainty and Risk (cont'd)



Risk
Risk and uncertainty describe the possibility of different potential outcomes. Some projects feature inherent randomness, such as games of chance. In business, the risks and uncertainties reflect unknowns and variability in nature, materials and human systems.

Risk is a means of measuring the quality of the project. It may be that a project is evaluated based on the amount of associated risk. Projects that are high-risk may be avoided. Likewise, low-risk projects may have a lower return than their high-risk counterparts.

Informally, "risk" is used when there is a large, usually *unfavorable,* potential impact. Typically, the contingency event either happens or does not – for example, risk of failure.

Because there is no good antonym in English for a "good risk," many of us allow risk to encompass undesirable or desirable outcomes, or both.

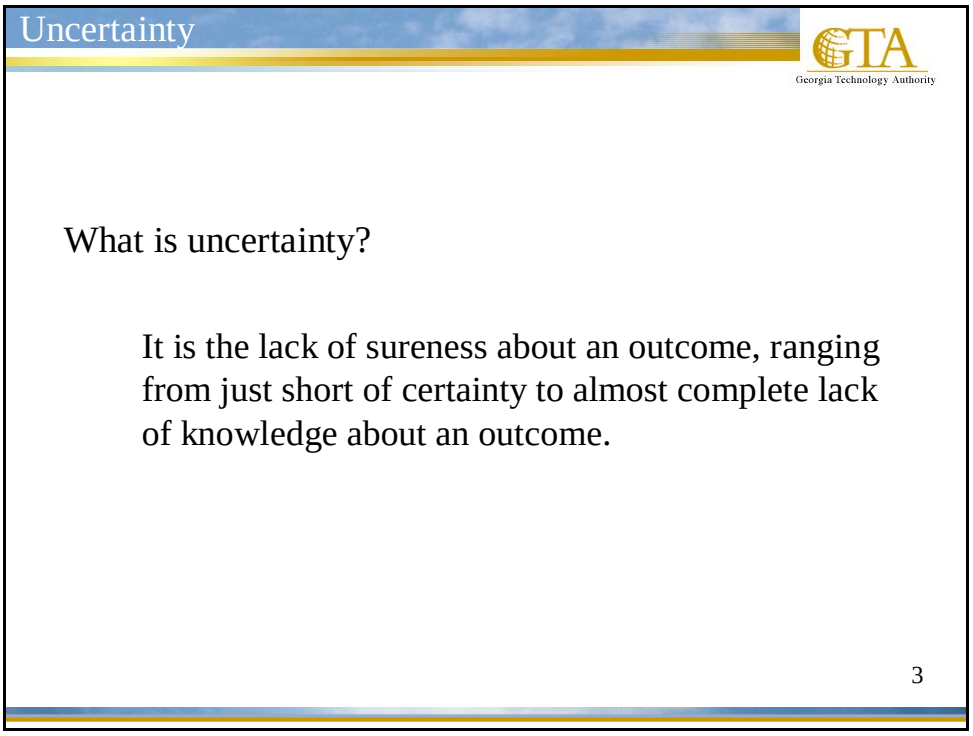
Risk outcomes are measured using

- **probability** of an uncertain event occurring or the likelihood of occurrence
- **impact** that the event will have on the project

Risk and uncertainty can have a positive (opportunity) and a negative (threat) outcome. **Pure risk** is associated with the analysis of events that provide projects with both opportunities and threats.

Risk management is identified as a core function of project management because of the presence of uncertainty and the need to measure it.

Topic 1: Definition of Uncertainty and Risk (cont'd)



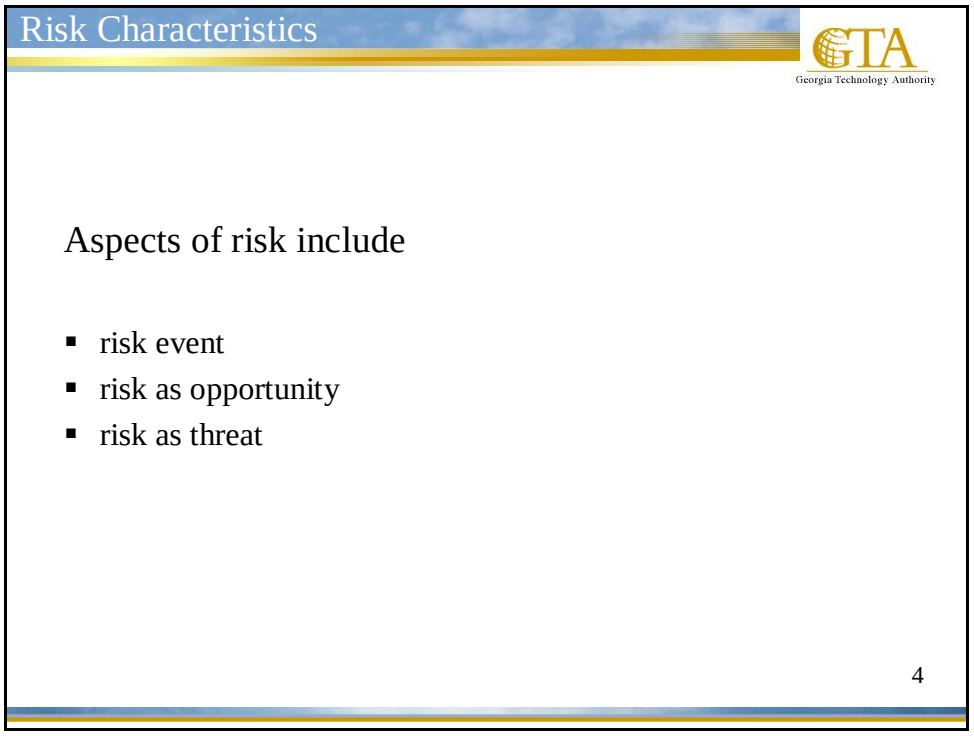
Uncertainty

Uncertainty is the variability in a value and gives rise to opportunity and risk. For example, when dealing with foreign currency exchange rates, we know there is going to be a rate against the dollar. The uncertainty is what the rate will be at future points in time.

Project uncertainty is the likelihood of an event occurring when project uncertainty is prevalent throughout the lifecycle. This **uncertainty can be both positive** (events that will advance the project and enhance the product) and **negative** (events that will detract from the objective of the project).

Uncertainty is present throughout a project. Risk management attempts to measure uncertainty and identify appropriate measures to deal with it.

Topic 1: Definition of Uncertainty and Risk (cont'd)



Organizations consider risk in terms of threats to project success or opportunities to enhance the chance of project success. Risks that threaten the project outcome may be accepted if the risk may also result in a reward. For example, adopting a fast track schedule that may not be met is sometimes a risk worth taking to achieve an earlier completion date.

Risk Event

A **risk event** is a discrete occurrence that may affect the project positively or negatively.

Risk as Opportunity

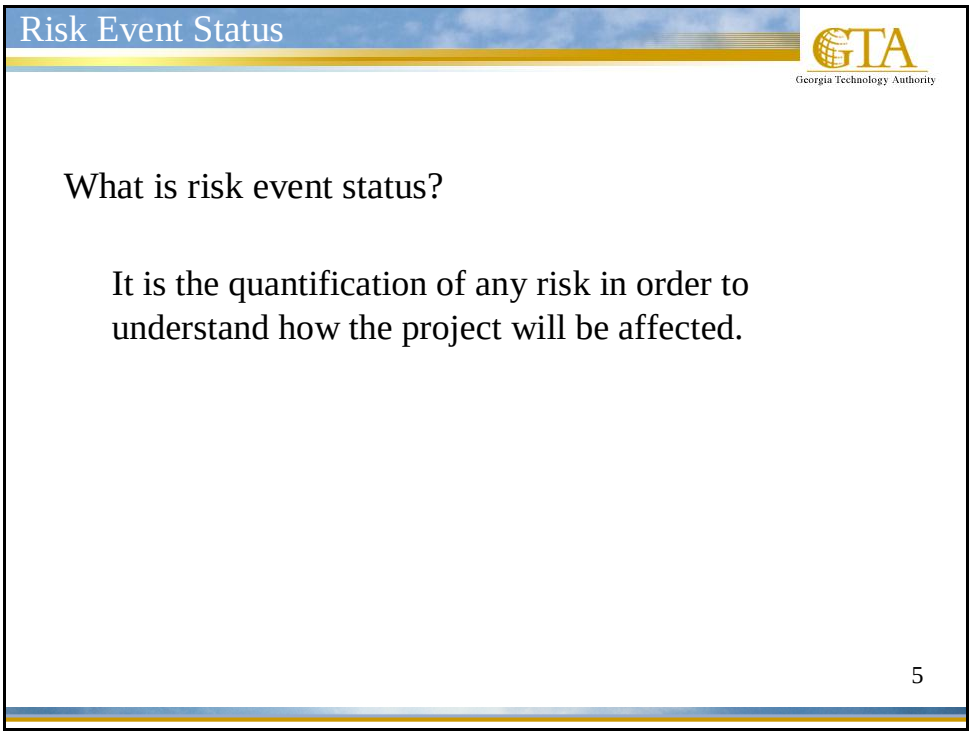
When the possible occurrence of an event has an outcome that is favorable, the **risk is a potential opportunity**.

Risk as Threat

When the possible occurrence of an event has an outcome that is unfavorable, the **risk is a potential threat**. This is measured through likely impact.

Project risks may be known or unknown. Known risks have been identified and analyzed, and it may be possible to plan for them. Unknown risks cannot be managed, although general contingency plans based on previous experience can be helpful.

Topic 1: Definition of Uncertainty and Risk (cont'd)



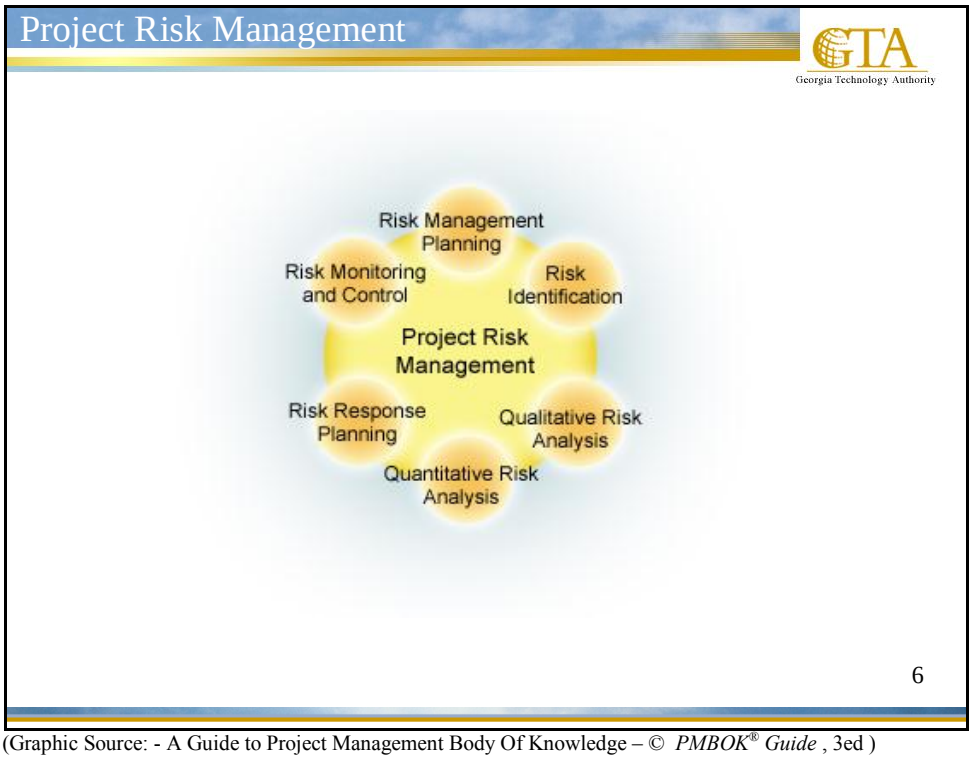
Project risk is an uncertain event that can have a positive or negative effect on a project objective. Risks have causes and, if they occur, consequences. For example, in a building demolition project, a cause may be requiring a permit or having limited machinery resources assigned to the project.

The risk event is that the permit may take much longer than expected, or that available machinery may not be adequate for the task. If either or both of these uncertain events take place, there will be a consequence on the project cost, schedule, and quality. Risk conditions could include such factors as poor project management practices or dependency on external participants or resources that cannot be controlled.

Remember that project risk also includes opportunities to improve on project objectives. For example, the cost of procuring machinery may prove to be much lower than planned for, which will positively impact the final project cost.

Identifying the **risk event status provides quantification of any risk**, which enables you to understand the level of associated opportunity or threat. The risk event status is the measure of severity that the risk could have on the project.

Topic 1: Definition of Uncertainty and Risk (cont'd)



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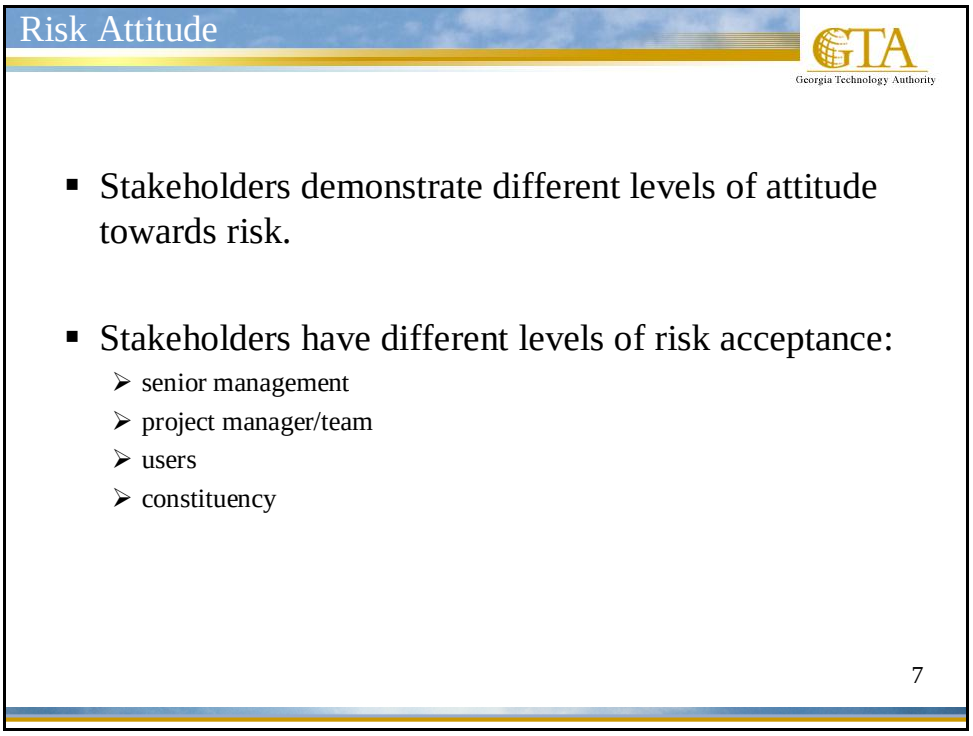
Sequence of Activities:
Risk Management Planning →Risk Identification → Qualitative Risk Analysis → Quantitative Risk Analysis → Risk Response Planning → Risk Monitoring and Control

Topic 2: Stakeholder Risk Tolerance

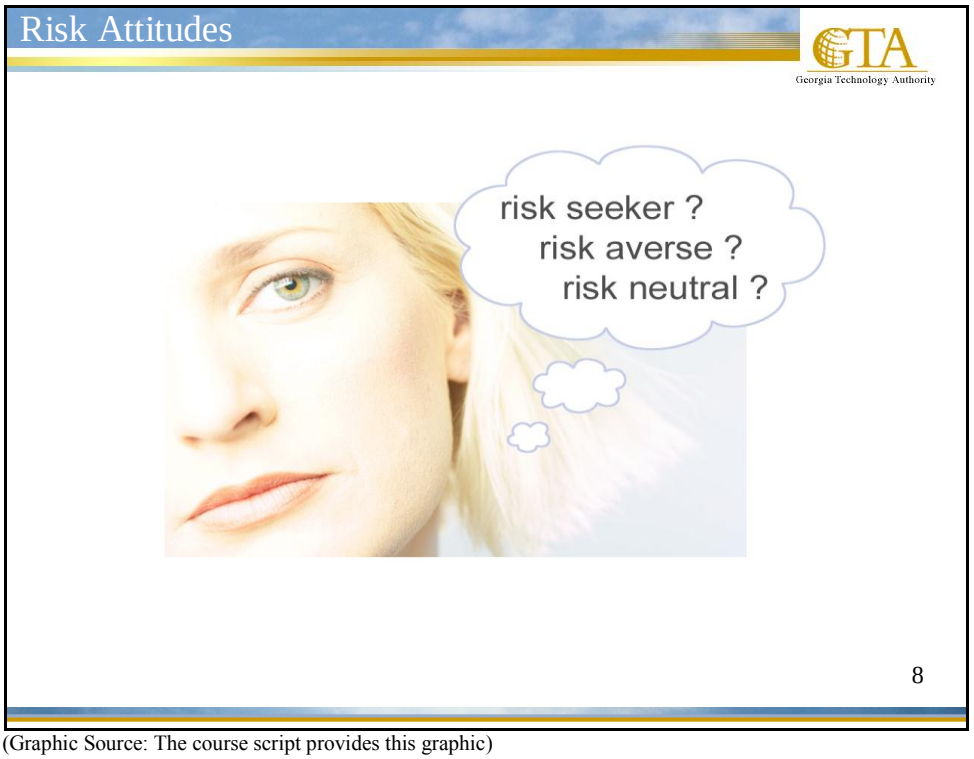


Understanding individuals' and organizations' attitudes to risk is an important part of project management, enabling better project evaluation, decisions, and negotiations.

Project stakeholders that exhibit excessive conservatism with regard to risk may make choices that are inconsistent with their long-term objectives. However, better stakeholder risk management and analysis can enable organizations to better balance risk and objectives.

Organizations need to decide the level of risk that is appropriate on a project-by-project basis. One way of deciding how much risk is appropriate for an organization is to compare the possible project outcomes to the collective net worth of the stockholders. When the project's value is large in comparison to the outcomes of a particular decision, the project manager generally will be better off using a neutral attitude toward risk when evaluating alternatives.

Topic 2: Stakeholder Risk Tolerance (cont'd)



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The three types of stakeholder attitudes toward risk are

- **risk seeker –** a willingness to take risks – and accept the outcome – in anticipation of positive outcomes
- **risk averse –** a reluctance to take risks or to expose projects to the possible adverse consequences of unplanned events or conditions
- **risk neutral –** an indifference to risk whereby it does not play a role in decision making

The following example illustrates these different stakeholder attitudes.

A **government project** needs to have an expensive component manufactured by a supplier, and there is a substantial manufacturing contingency that potentially will quadruple the component's manufacturing work and cost.

Assume that there is a cost-plus contract in place so that the government as buyer will bear the cost risk. The risk is a 90% chance of the project costing $1 million and a 10% chance of it costing $4 million. The expected cost is $1.3 million.

Before the company closes the deal, the supplier offers to change from a cost-plus contract to a fixed-cost contract. What fixed price should the company agree to pay, given its knowledge of the cost risks using a cost-plus contract?

Topic 2: Stakeholder Risk Tolerance (cont'd)

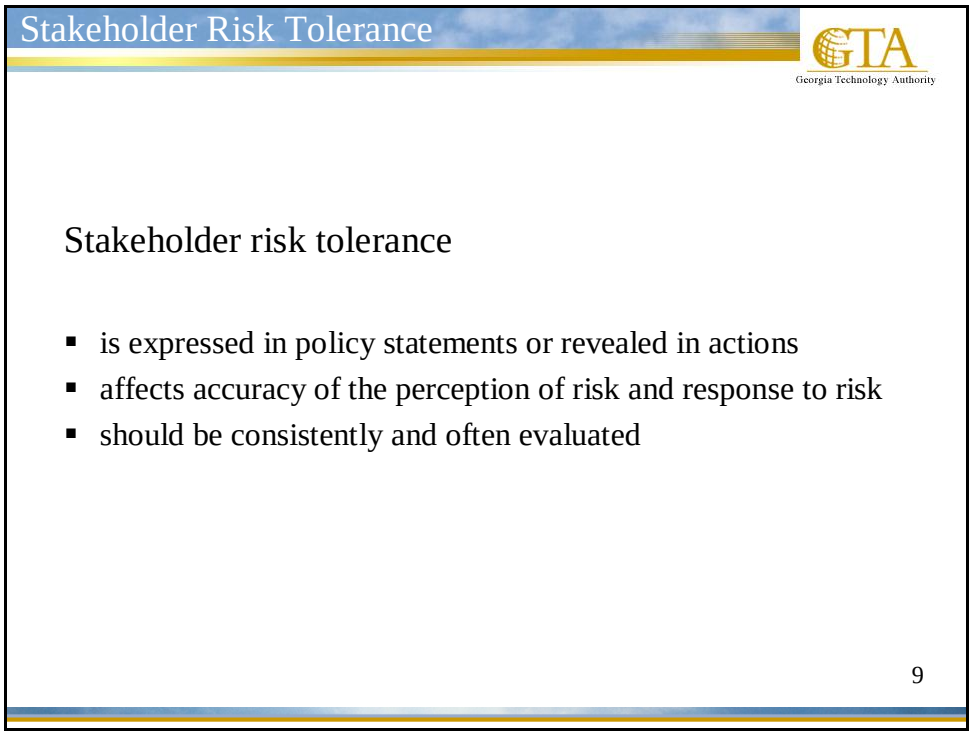
The answer depends on the project's attitude towards risk:

- The **risk-neutral company** would be indifferent to paying a fixed $1.3 million or accepting the cost-plus contract risks.
- The **risk-averse company** would be willing to pay somewhat more than the $1.3 million expected cost.
- The **risk-seeking company** would stick with the cost-plus contract.

Decision makers can afford to be risk neutral for small decisions, although substantial value adjustments for risk attitude may be appropriate when the outcomes become large compared to company net worth.

For large, public projects, risks are shared by many investors and so risk seeking may be appropriate. However, for individuals and small private projects, a conservative risk attitude is more suitable.

Topic 2: Stakeholder Risk Tolerance (cont'd)



Stakeholder Risk Tolerance

Different individuals and organizations have different tolerances for and **attitudes toward risk** – risk seeking, risk averse, risk neutral – and these may be expressed in policy statements or revealed in actions. These varying tolerances and attitudes affect both the accuracy of the perception of risk and the way organizations respond to risk.

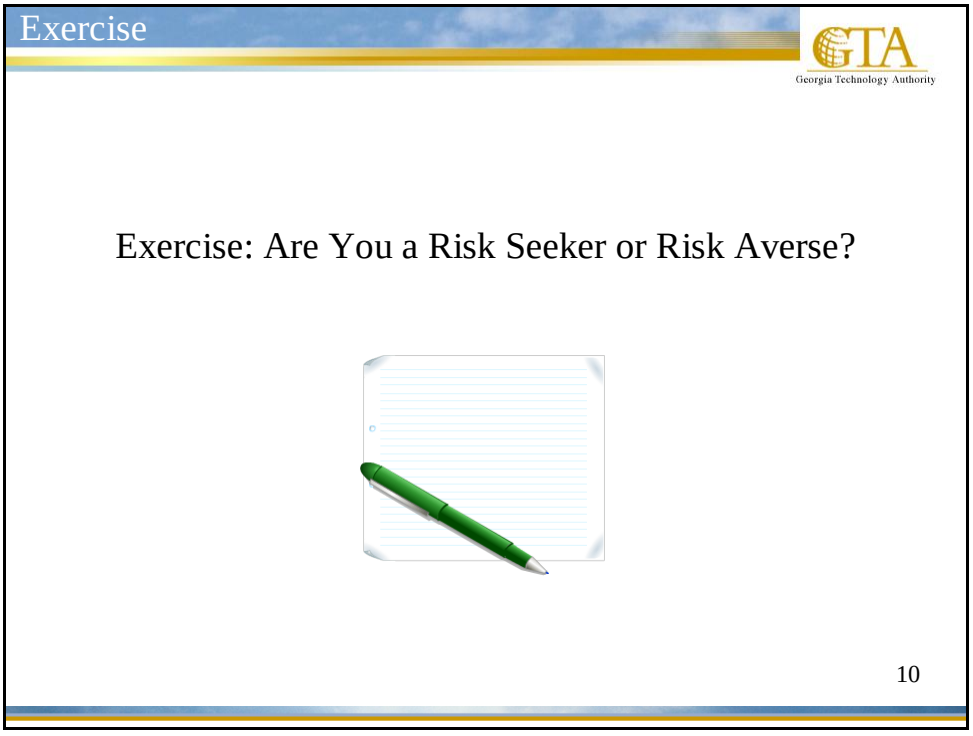
Remember that organizations consider risk in terms of threats to project success or opportunities to enhance chances of project success. Organizations may accept risks that threaten the project outcome if the risk is potentially rewarding.

Where possible, **attitudes about risk should be made explicit**. In addition, a consistent approach to risk that fulfils an organization's requirements should be developed for every project, and communication about risk and its handling should be open and honest.

Laws and regulations also contribute to stakeholders' tolerance for risk. In particular, government projects operate under practices and tolerances established by voters through their elected representatives.

These practices and **tolerances cover such issues as air and water quality, noise prevention, or archeological protection**. These types of issues are often addressed collectively in environmental protection laws – which are effectively risk management laws that inform project managers about the limitations on projects and the risks the voters will not accept.

Topic 2: Exercise – Are you a risk seeker or risk averse?



Read the excerpts that follow and decide which option you would choose.

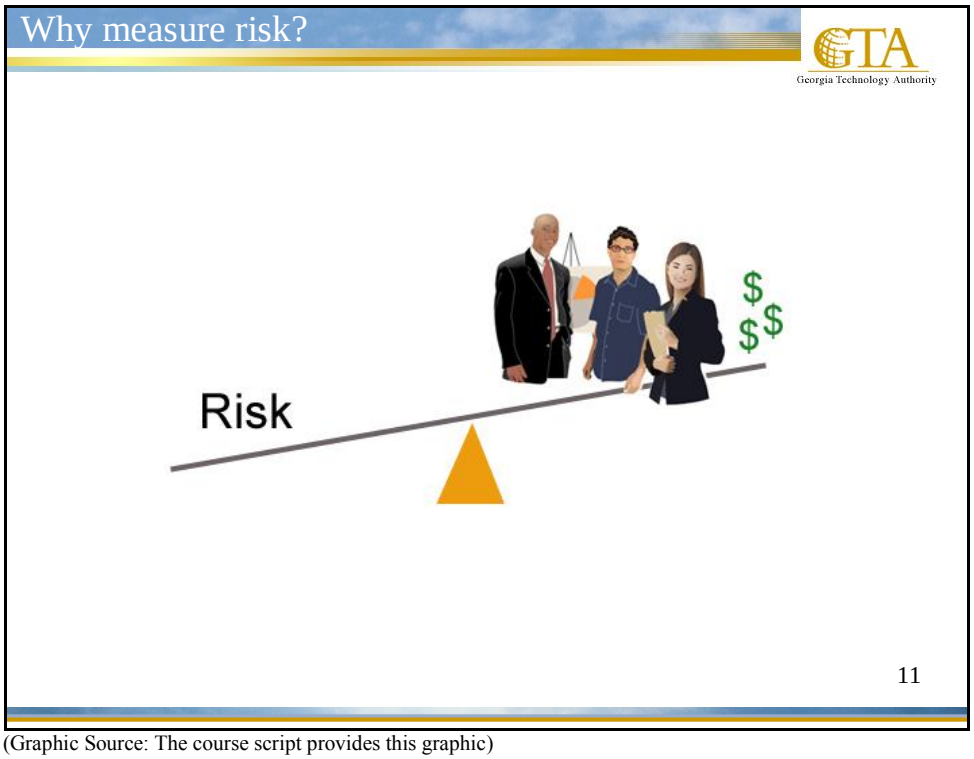
A project manager is sourcing equipment for a new IT project. The project has to choose between two vendors, Best Retailer IT and New Retailer IT. To simplify the problem, the project manager decides to estimate the potential profit of these vendors on the basis of product reliability.

- Through research and talking to other project managers, the manager finds that Best Retailer IT has a 60% chance of providing reliable equipment, and its parts cost $300,000 (this includes costs of installations and maintenance).
- There is, however, a 40% chance that the equipment will fail – in which case, costs can increase to $850,000.
- On the other hand, if New Retailer IT is chosen, there is an 80% chance of high reliability at a cost of $750,000 and a 20% chance of failure.
- New Retailer IT provides lifelong guarantees and maintenance services.

Would you choose Best Retailer IT or New Retailer IT?

Exercise Worksheet

Topic 3: Definition of Probability and Impact



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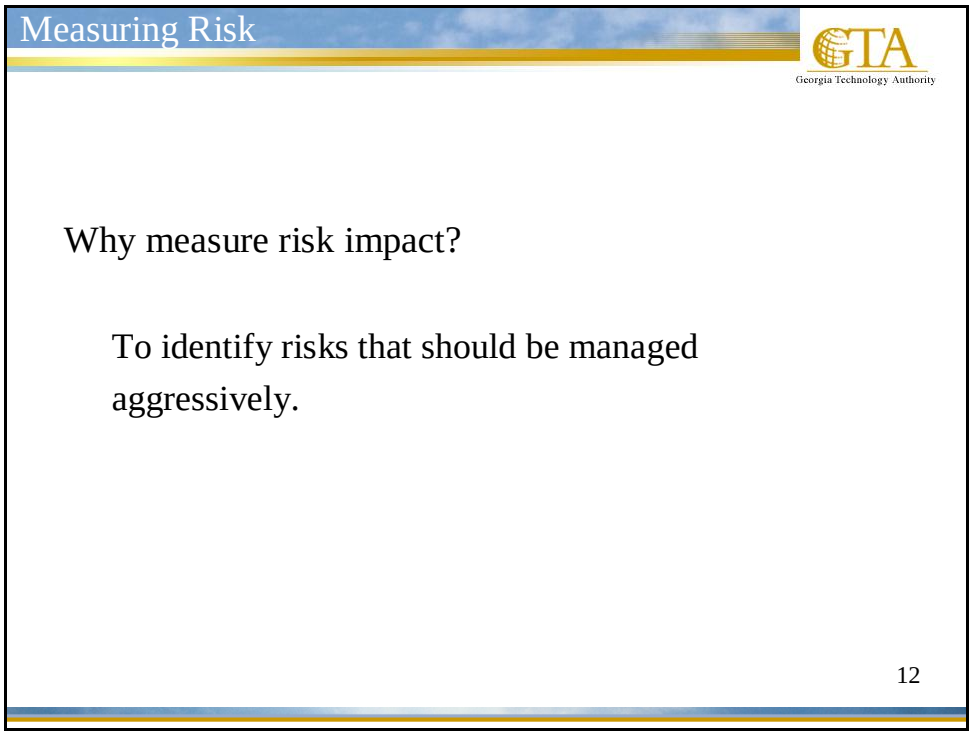
Topic 3: Definition of Probability and Impact (cont'd)



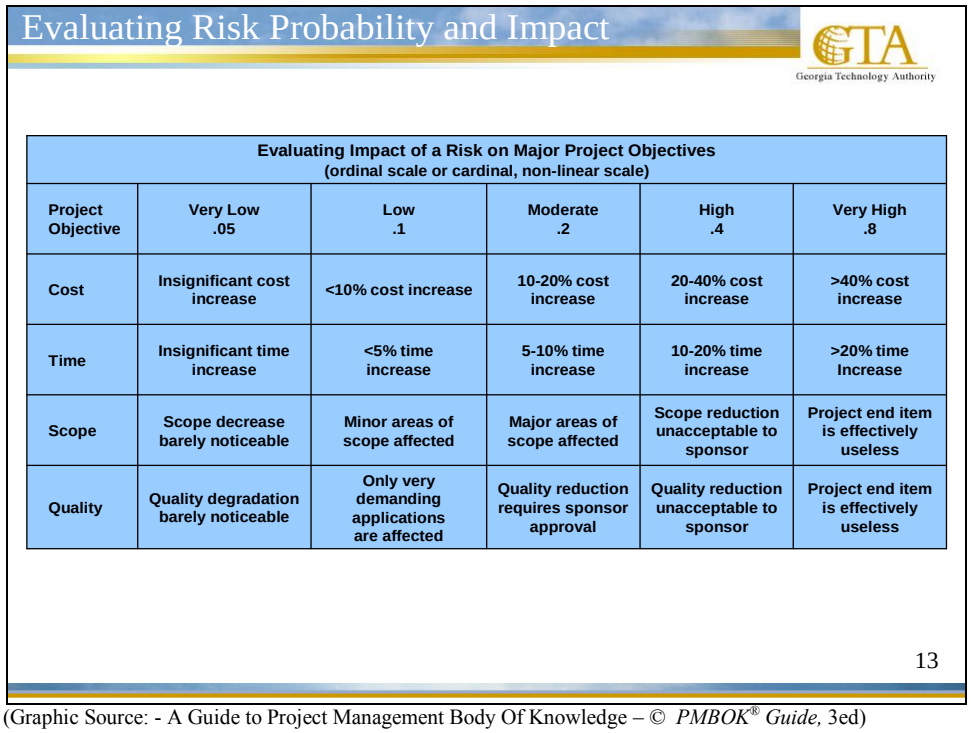
Why Measure Risk?

Risk probability is the likelihood that a risk will occur, whereas risk consequence is the effect on project objectives if the risk event occurs, and risk impact is a measure of the risk.

Risk probability and **risk consequences**, which are applied to specific risk events rather than to the overall project, may be described in qualitative terms, such as very high, high, moderate, low, and very low.

Analyzing risks using these two dimensions helps identify which risks should be managed aggressively.

Topic 3: Definition of Probability and Impact (cont'd)



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Evaluating Risk Probability and Risk Impact

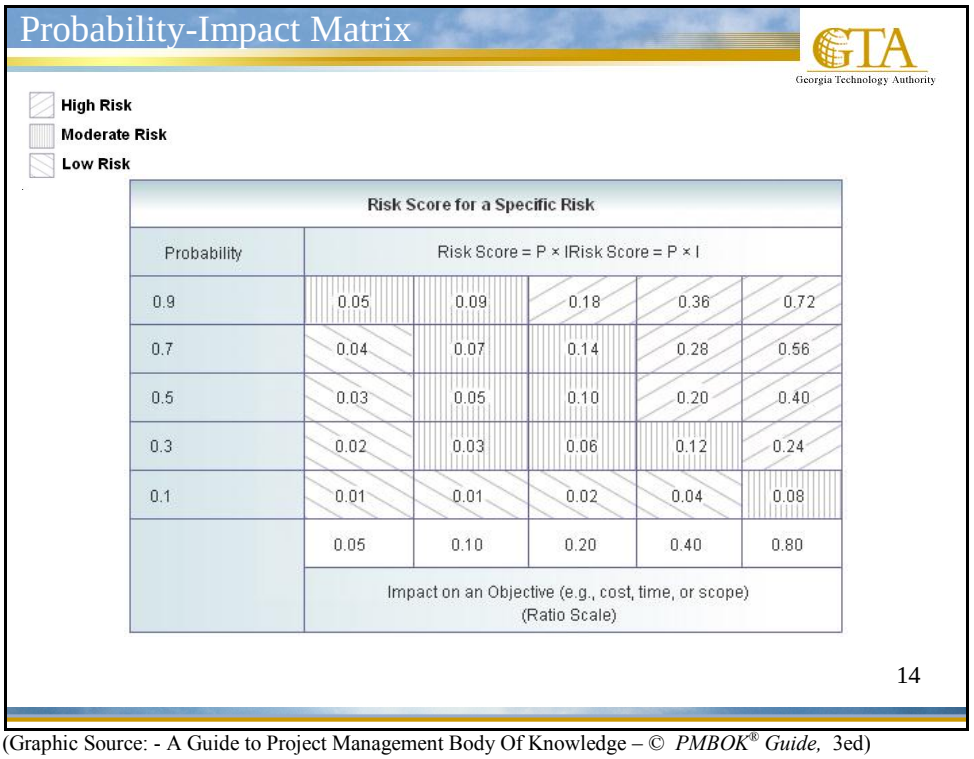
To evaluate risk probability and impact, project managers often use a **matrix** that assigns risk ratings (very low, low, moderate, high, and very high) to risks or conditions based on a combination of probability and impact scales. The risk rating is determined using a **matrix and risk scales for each risk**.

A risk's **probability scale** naturally falls between 0.0 (no probability) and 1.0 (certainty), and the risk's **impact scale** reflects the severity of its effect on the project objective.

Impacts can be ordinal (rank-ordered values, such as low or moderate) or cardinal (numerical values assigned to impacts), depending on the culture of the organization conducting the analysis. Cardinal values are generally linear (for example, 0.1, 0.3, 0.5, 0.7, 0.9), but they can be non-linear (for example, 0.05, 0.1, 0.2, 0.4, 0.8), reflecting the imperative to avoid high-impact risks.

The slide illustrates an example of evaluating risk impacts by project objective, using both the ordinal and cardinal approaches. These scaled descriptors of relative impact should be prepared before the project commences.

Topic 3: Definition of Probability and Impact (cont'd)



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This slide presents a **Probability-Impact (P-I) matrix** illustrating the simple multiplication of the scale values that are assigned to estimates of probability and impact. This is a common way to combine these two dimensions in order to determine whether a risk is considered low, moderate, or high.

Each risk is rated on its probability of occurring and the impact if it does occur. The risk thresholds – **low (down diagonal background pattern), moderate (vertical background pattern), or high (up diagonal background pattern)** – determine the risk's scores.

The risk event status is the value derived from a combination of the probability and impact. Using the matrix in the slide, if a risk event has a 0.9 probability of occurrence and a 0.4 impact on the project objective, the risk event status is 0.36. Given that this status is in the high threshold, it can be labeled as a high (red) risk.

Topic 4: Preparing a Risk Management Plan

(Graphic Source: The course script provides this graphic)

Risk Management Plan

A **risk management plan** describes how risk management – which entails identification, qualitative and quantitative analysis, response planning, monitoring, and control – is structured and performed on a project (a sample risk management plan is included in Appendix 1: Tools & Templates).

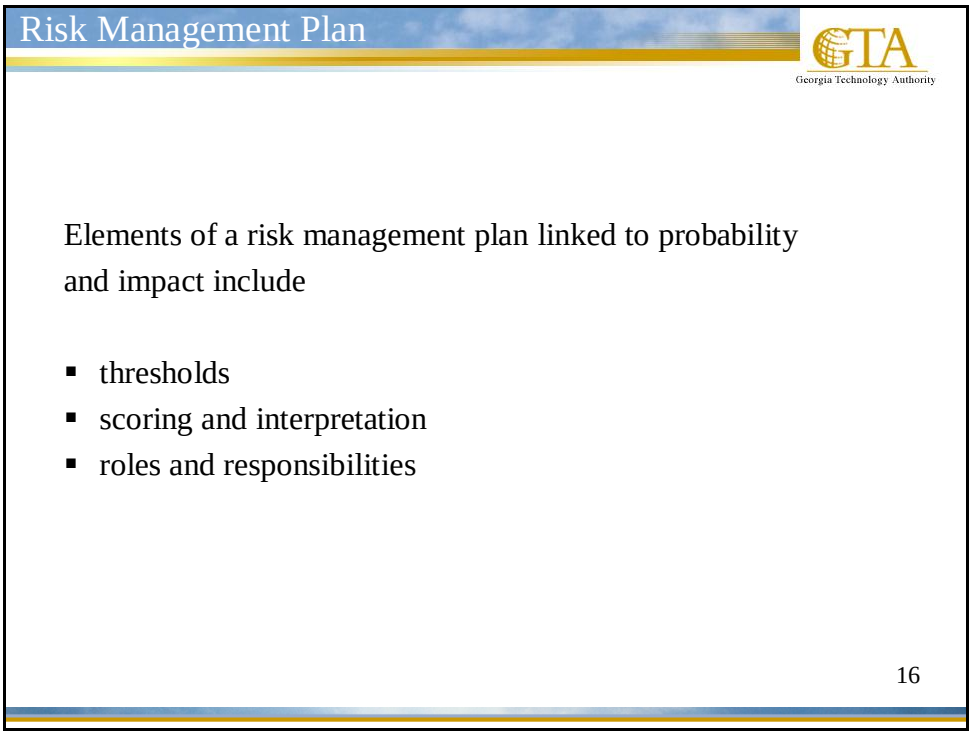
A risk management plan includes the following elements:

- **methodology** defines the approaches, tools, and data sources used to perform risk management. Different types of assessments can be used depending on the project stage, amount of information available, and flexibility remaining in risk management.
- **budgeting** determines a risk management budget for the project and assigns resources as required.
- **timing** establishes how frequently the risk management process will be performed throughout the project life cycle. Results should be made available early enough to affect decisions, and these decisions should be revisited periodically during project execution.
- **formats** describe the content and format of the risk response plan. The reporting formats determine how the results of the risk management processes are documented, analyzed, and communicated to the project team and to internal and external stakeholders.
- **tracking documents** is the name given to the process of recording all risk activities, so that information can be used for the benefit of the current project and to inform future needs. Tracking also records if and how risk processes will be audited.

Topic 4: Preparing a Risk Management Plan (cont'd)

- **risk categories** provide a structure for identifying a consistent level of risk detail that contributes to the effectiveness and quality of risk identification. Organizations often use a previously prepared categorization of typical risks. However, these categories may need to be tailored, adjusted, or extended to new situations before they are used on a current project.

Topic 4: Preparing a Risk Management Plan (cont'd)



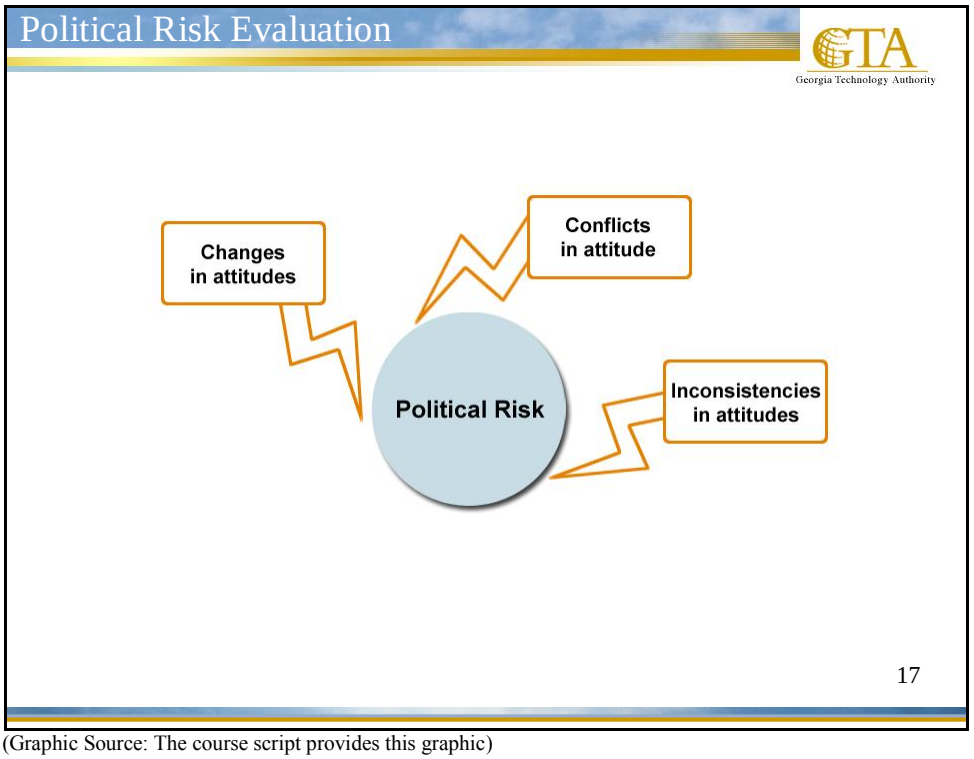
Elements of a risk management plan that are linked to probability and impact can be described as follows:

- **thresholds** establish risk criteria that will be acted upon, by whom, and in what manner. Stakeholders may have different risk thresholds. The acceptable threshold is the target against which the project team will measure the effectiveness of the risk response plan execution.

- **scoring and interpretation** determine the most appropriate methods (determined in advance to ensure consistency) for the type and timing of the qualitative and quantitative risk analysis being performed.

- **roles and responsibilities** define the lead, support, and risk management team membership for each type of action in the risk management plan. Risk management teams organized outside of the project office may be able to perform more independent, unbiased risk analyses of projects than those from the sponsoring project team.

Topic 4: Preparing a Risk Management Plan (cont'd)



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Political risk evaluation is an important element of a government project risk management plan that measures opinions.

In democratic societies, there is a fundamental assumption that decisions are correct. Therefore, a project manager on a government project is ethically bound to carry out the will of the associated project stakeholders – not to ignore or evade it. The will of the project stakeholder is displayed through election results and conveyed to the project manager from elected representatives through the executive.

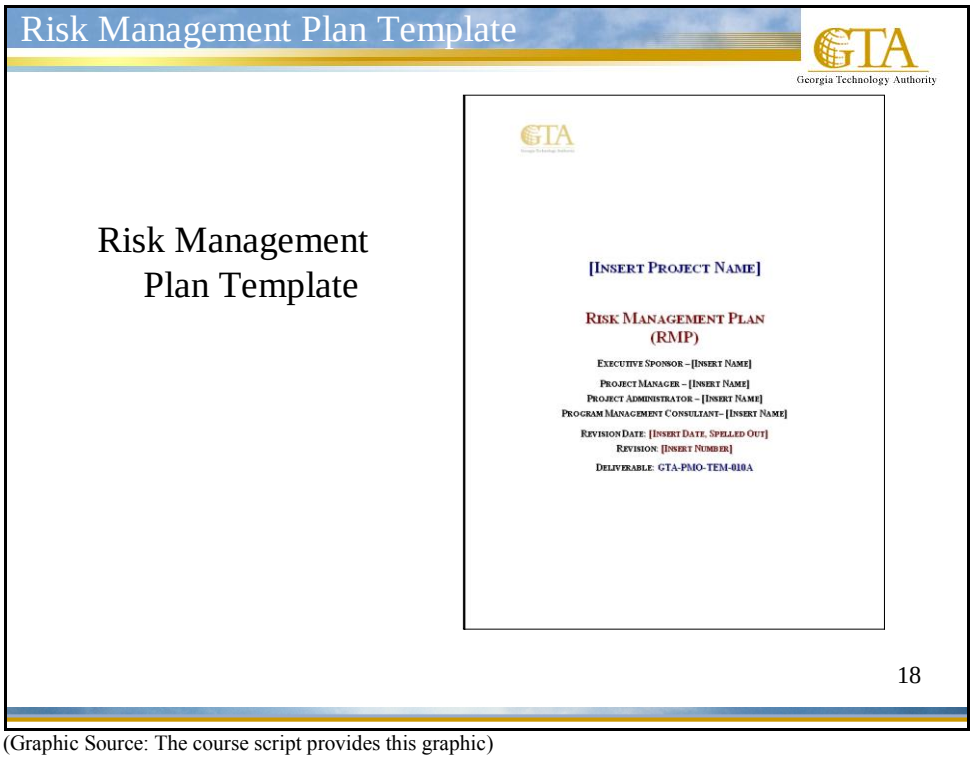
Issues to consider when evaluating political risk include

- **conflicts between national, regional, and local levels** – for example, national or regional elections may want a facility (for example, a nuclear energy plant) that local voters living beside the proposed facility oppose

- **inconsistencies** – for example, stakeholders may not want to car pool but also not want air pollution

- **changes over time** – for example, stakeholders may support a project in its early stages but oppose it later as the cost of the project increases

Topic 5: A Risk Management Plan Template



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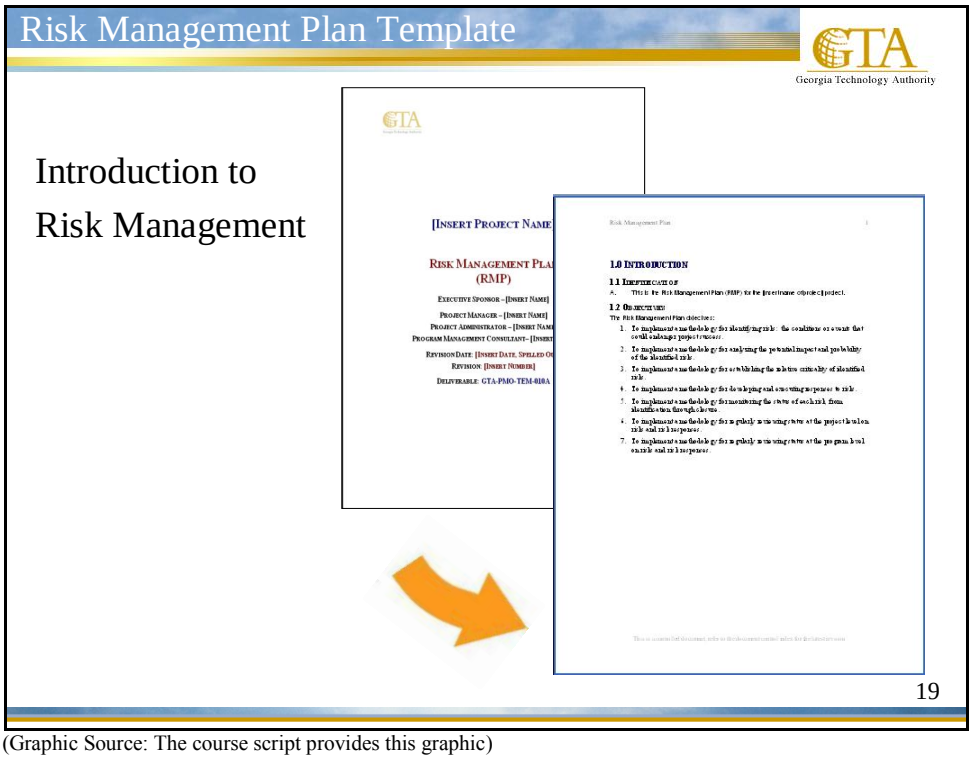
A risk management plan template is provided in Appendix 1. Note that this is a sample template that may differ from project to project.

A sample risk management plan includes

- an introduction describing the context for the risk management process and general information about the risk management plan
- the risk management strategy, including mitigation plans and risk response planning
- the organization and structure to manage risks
- a table of related documents

Topic 5: A Risk Management Plan Template (cont'd)



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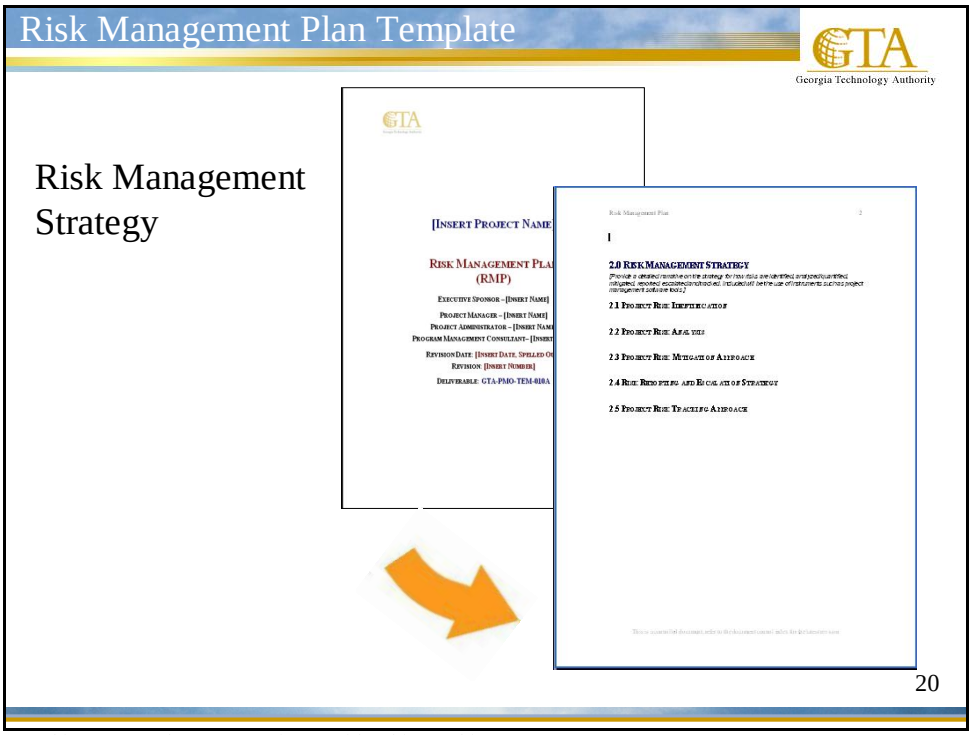
Introduction to Risk Management

Risk management includes activities concerned with identifying, quantifying, and responding to project risks. It entails maximizing the results of positive events and minimizing the consequences of adverse events.

It is an iterative process, initiated at the start of the program and continued throughout the life cycle.

The introduction to the risk management plan outlines the objective of the plan and sets out the methodology that will be used to achieve those objectives.

Topic 5: A Risk Management Plan Template (cont'd)



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Risk Management Strategy

The risk management strategy section of the risk management plan includes the following:

- risk identification
- risk analysis (qualitative and quantitative analysis)
- mitigation and risk response development
- risk response control

Risk Identification

Risk identification involves determining which risks are likely to affect the project and documenting the characteristics of each. Risk identification is not a one-time event; it should be performed on a regular basis throughout the project.

Risk identification should address both **internal and external risks**. Internal risks represent issues that the project team can control or influence, such as staff assignments and cost estimates. External risks represent issues which are beyond the control or influence of the project team, such as market shift or government actions.

Topic 5: A Risk Management Plan Template (cont'd)

An issue is recorded by the person who initially identifies it. Identification takes place using a risk response plan. After identification, a preliminary analysis of the risk event is performed at the appropriate technical or managerial level. At this point, the event may be considered a reportable risk (as opposed to an easily resolvable technical issue – for example, a bug).

Risk Analysis

Each risk is explicitly identified and recorded in the risk response plan. The following is a summary of categories of risks:

- **political** – the risk that parts of the project implementation will be rejected by the state on the basis of non-technical or non-operational grounds (e.g. the product does not comply with government standards)
- **safety and security** – risks associated with the safety of persons and property during project
- **organizational** – risks concerning the interactions of the project team, and constraints placed on the project by other projects within the organization
- **contractor specific** –risks concerning possible lapses by the contractor, including late delivery, poor supplies, etc.

Risks can have an effect on schedule, cost, quality, and performance of the project:

- **risk impact** – where possible, a quantitative measure is used to estimate the risk event status. This is documented explicitly in the description of the risk. In general, however, risk event status is categorized according to low (e.g. 1) to high (e.g. 10) impact. A risk can be rated between these values but not beyond.

- **risk event status** – according to the rates for impact of the identified risks, the objective is to have a short list (with a maximum ten items) containing the most important risks for the project

Mitigation and Response Development

A mitigation plan is a subset of risk response development. It is concerned with the development of an appropriate risk response strategy and the process to ensure the strategy is adhered to.

Responses to threats generally fall into one of four categories:

- **avoidance** – eliminating the threat, usually by eliminating the cause
- **mitigation** – reducing the expected monetary value of a risk event by reducing the risk event status value, the probability of occurrence or the impact of whatever constraint is applicable
- **acceptance** – accepting the consequences, which can be active (e.g. developing a contingency plan) or passive (e.g. accepting a lower profit or whatever the consequence may be)
- **transference** – transferring the consequence and impact of the risk to a third party

A mix of management and technical staff, as appropriate to the specific risk, determines which of the above strategies will be applied to each identified risk. Close liaison with the principal and suppliers can greatly assist in mitigation activities.

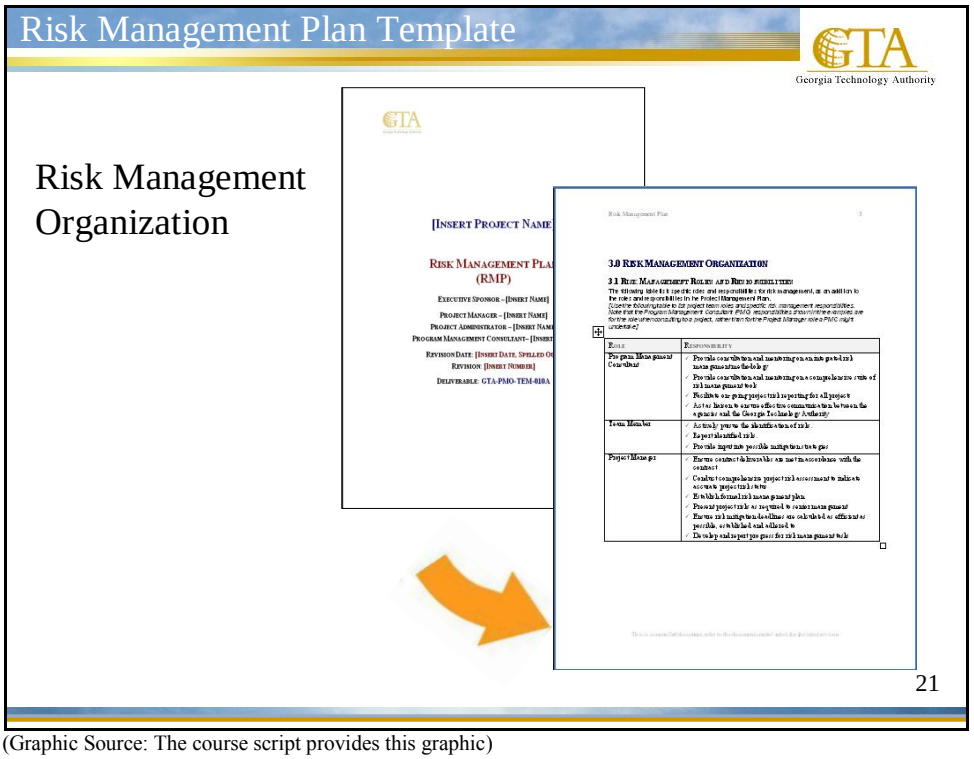
Risk Response Control

Risk response control relates to the means and procedures put in place within the project to respond to the risks (e.g. the assignment of risks to individuals responsible for developing plans and managing their allocated risks).

Topic 5: A Risk Management Plan Template (cont'd)

The project manager is responsible for the assessment of the probability and severity of identified risks, for the development of mitigation strategies, and for the assignment of assets to implement a response in their individual areas. If needed, these will be discussed with the program manager, especially when common or program-wide risks are at stake. Risks are escalated to the senior management when they are likely to affect the overall program.

Topic 5: A Risk Management Plan Template (cont'd)



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Risk Management Organization

This section describes the organization with respect to the handling of risks. In particular, it identifies the responsibilities assigned to individuals and their role in managing the assigned risks. The risks are rated using impact and probability assessments. It also defines how reporting procedures are applied.

Roles and Responsibilities

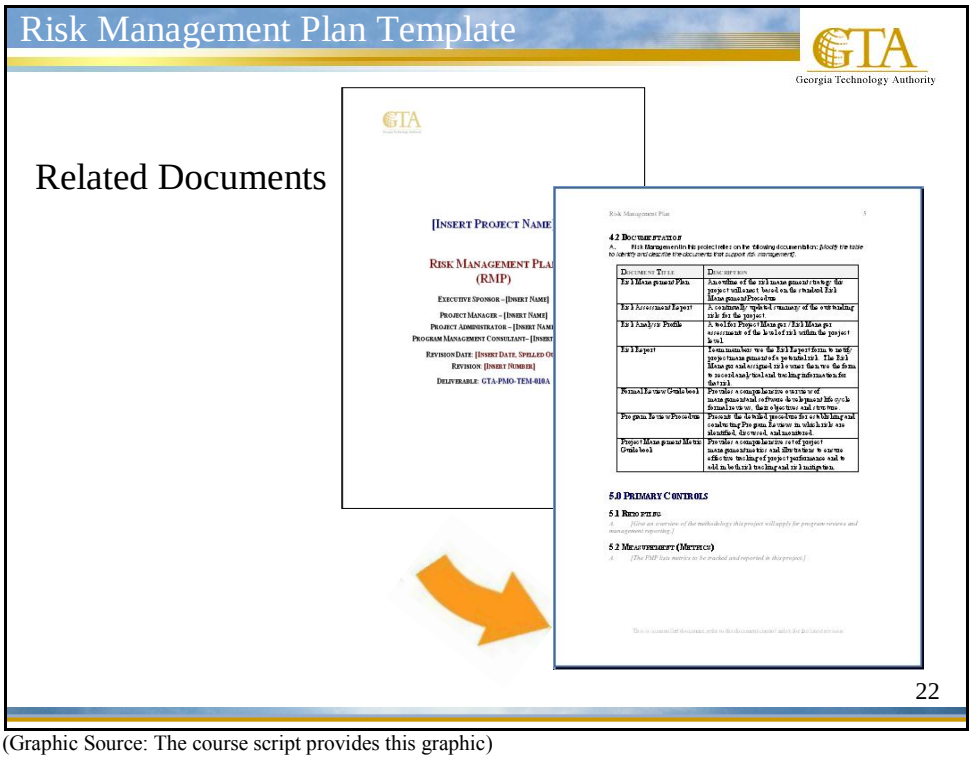
The various bodies and individuals playing roles in the risk management process are identified according to four levels of responsibility.

- Level 1 – refers to the project manager of the respective project. A decision to amend a work package is within the scope of the project manager's authority. In general, the authority of the project manager is limited to risk management strategies that have no overall impact on the schedule or scope of their work package.
- Level 2 – refers to the program manager, and relates to decisions that involve re-scoping the project constraints. The program manager can delegate this authority to individual project managers within a portfolio of projects.

Topic 5: A Risk Management Plan Template (cont'd)

- Level 3 – refers to the senior management who are associated with the project. This level involves decisions about re-scoping the program. This level of risk involves a possible change in scope of the requirements, which may not have a significant impact on the overall objectives or constraints of the project.
- Level 4 – refers to the top management within the organization and stakeholders outside the organization. This level covers decisions about terminating, extending, or extensively redesigning the project. This level of risk involves a major budgetary, schedule, or scope impact, which may significantly affect other projects. Stakeholders must be part of this decision group because they are directly affected.

Topic 5: A Risk Management Plan Template (cont'd)



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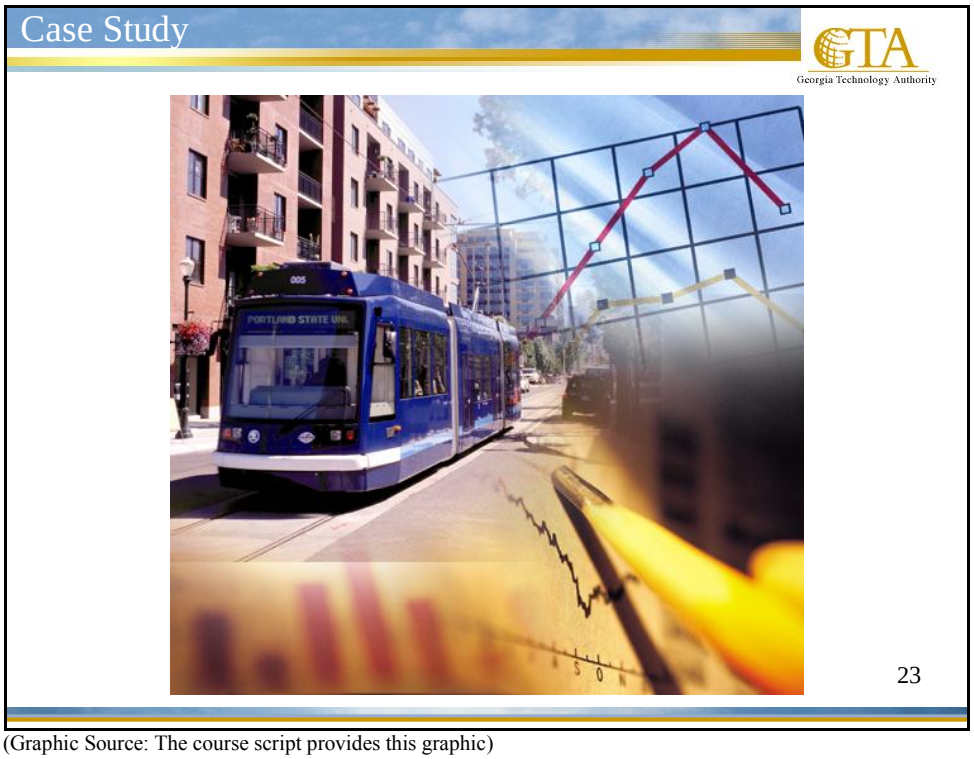
Related Documents

This portion of the risk management plan contains a listing of any additional documents that are required for the risk management process.

Topic 6: Using a Risk Management Plan



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The following fictional case study illustrates how in major infrastructure projects distinct project phases and life cycles must be completed before a project proceeds.

The Georgia Rail Project

Introduction

Traffic flow, congestion, and pollution are major issues for the state of Georgia. According to statistics gathered over the past ten years,

- the number of licensed drivers has increased by 44%
- on average, 21% extra people travel into the major cities between 8:00 am and 1:00 am each working day
- there has been a 47% increase in the use of automobiles during a working week
- automobile ownership was increased by 7% per year
- over 77% of Georgia drivers now travel alone to work, whereas just over 14% avail of the carpool facility, and 4% avail of public transport
- incidents of crashes are up 4%

Project History

Georgia's transport needs have been under consideration for some time. In 1994, the state initiated an investigation, which led to the publication of a transport strategy report in 1997.

Topic 6: Using a Risk Management Plan (cont'd)

The report found that the public did not consider the current public transportation system to be an adequate alternative to auto transport, resulting in a high reliance on the car. Drawing on this information, the report suggested that the state incorporate a series of measures into its transportation policy. These measures are to

- review the current public transportation system and invest in new and alternative modes of public transportation in urban commuter areas
- encourage and educate auto users, so they see the benefits of alternative transportation with an emphasis on reducing "auto-reliance"

After a period of discussion among various government bodies and other stakeholders, a committee – Transport 2000 – was formed in 1999 to investigate the different alternatives. The committee evaluated alternatives based on expert opinion and historical information, as well as public opinion. The committee also identified the public as a key stakeholder in any transportation project and sought public opinion.

For historical data and expert opinion, the committee looked to developments in Arizona, where a state-of-the-art, $1.13 billion project proposes to link three cities (Phoenix, Tempe, and Mesa) by rail. Funded by the Arizona state government and the three cities, the Central Phoenix/East Valley Light Rail Transit system is scheduled for completion in August 2007. However, because of the success of the project, parts of the rail line will open to the commuter population in December 2006 and April 2007[1].

The Central Phoenix/East Valley Light Rail Transit system has the capacity to transport around 5000 passengers in each direction every hour. A private company will operate the system under a five-year franchise.

Project Proposal

In late 2000, the Transport 2000 committee proposed the establishment of a rail-based public transportation system between the major urban cities of the state. The objective was to provide a speedy, efficient, and cost-effective commuter system, allowing the state population to travel within and between urban districts.

The committee detailed its plans to the state by breaking down the project specification into three sections:

- an urban rail system linking each urban "business" area with a reliable light-rail system
- an inter-city connection providing rail segments that join each urban rail system
- vendor management as a key aspect for the success of the project

The government accepted much of the committee's evidence and findings, but a major stumbling block was the budget. The state did not accept that the committee could justify the level of investment required for the project with sufficient tangible benefits. It did not help that Phoenix's system was not up and running at the point of the committee reporting.

After lengthy discussion and analysis, the committee was disbanded in mid-2001 with its findings and proposals sitting in the governor's office.

[1] Information on Phoenix Rail System sourced from article in PM Network 2004 (Admed H. Chilmeran, PMP; Keep Costs under Control; PM NETWORK, FEB 2004)

Topic 6: Using a Risk Management Plan (cont'd)

Project Implementation Alternative

During 2002, the statistics continued to show an increase in auto use coupled with a slight increase in road fatalities. The state authorities accepted that the Transport 2000 proposal should be reexamined, although a thorough feasibility study would first be required. In late 2002, a feasibility team was established to present project implementation alternatives. The objective for the team was to highlight implementation objectives, alternatives, and critical success factors.

Matching Business and Project Objectives

The feasibility team, in collaboration with government bodies, identified the business and strategic objectives:

No.	Business Objective	Strategic Objective
1	Reduce the number of people using auto transport	1. Minimize traffic congestion 2. Minimize road fatalities 3. Increase public transportation options
2	Upgrade and "re-invent" the current public transportation system	1. Minimize traffic congestion 2. Increase appeal of state for new business location
3	Provide a reliable and efficient service to accommodate both professional and private use	1. Increase commuter confidence in public transportation 2. Increase appeal of state for new business allocation
4	Establish a system that generates revenue for the government	1. Focus on making a profit 2. Maximize sales potential

The feasibility team, like the previous committee, identified the public as a key factor in the success of any public-service project.

The public was broken into three categories:

- public users: potential customers with direct access to the rail system
- impacted users: people directly impacted by the construction of the railway system (i.e. land or property owners along the rail routes)
- operating users: rail operators that will work and maintain the system and provide a support function to the public users

Topic 6: Using a Risk Management Plan (cont'd)

The project objectives can be summarized as follows: -

Project Objective No.	Business Objective No.	Project Objective Description
1	1,2,3	Provide light-rail system within major urban areas that will facilitate professional and private commuters
2	4	Provide a rail system between major urban areas that will facilitate professional and private commuters
3	1,2,3	Provide a transportation system that will reduce the number of auto users
4	1,2,3,4	Implement – in a seamless fashion – a new system that has minimal impact on current operations
5	3,4	Educate public on transportation alternatives to ensure each individual understands new system
6	1	Provide transportation system that is cost effective and geared toward profits

The feasibility team evaluated specialized contractors in order to recruit a team to establish detailed specification around the structural aspects of the project. The government also allocated a budget to invest in highly capable individuals who could provide a complete structural solution.

Project Implementation

Specialists recruited by the feasibility team subsequently presented a work breakdown structure (WBS) for the project, which subdivides the project work into the major elements and then their sub-elements. For example, a major element of work is the civil/track work, which is subdivided into five line sections. The system's work is split into light rail vehicles, the traction power/overhead contact system, fare collection machines, and light rail transit signals and communications. Other work elements, such as the station finishes, are treated as whole contract units.

The specialists developed the lower tiers of the WBS hierarchy in isolation. This practice provides flexibility and full control over respective responsibilities:

- WBS level 1 – Program: local and federal programs identified
- WBS level 2 – Project: the project's major work elements
- WBS level 3 – Project units: the main units/packages associated with each project
- WBS level 4 – Sections: the main sections of each unit
- WBS level 5 – Contract: the main contracts that can be offered
- WBS level 6 – Contract unit: level of work effort required, such as engineering and project management

Topic 6: Using a Risk Management Plan (cont'd)

The specialist team proposed that once the contracts and contract units were identified, the project could then be outsourced to different contractors, including, most likely, a consortium.

Project Management

The feasibility team has proposed that a dedicated project management team be established within the government. The team would have total control over budgets and schedules and would report directly to the state legislature.

The control, planning, and management of the project present complex logistical issues. The scheme may entail numerous individual contract packages, which will require coordination.

At a very early stage, the feasibility team settled the key project management objectives as

- effective and efficient communication of information
- utilization of thorough project control techniques
- efficient and widely understood procurement and contractor processes

This standardization is necessary to ensure that all contractors are working in unison. To furnish timely and accurate cost reports, the project control team needs a comprehensive system that integrates cost and schedule, provides reporting capabilities consistent with the project requirements, and improves operating efficiency.

The system has to be capable of processing and analyzing a vast amount of incoming monthly cost data quickly and accurately. In addition, the team could use integrated systems to perform risk and schedule simulation analysis where the relationship between the schedule and cost is not always clear.

Although technology has simplified data collection and scheduling, the feasibility team has identified that professionals must carefully study and analyze the system output to provide a logical, meaningful explanation of the causes of any cost and schedule variances. In this way, sound project control methodologies reduce cost overruns, control cost growth, help meet project schedule objectives, and ultimately satisfy the client's expectations.

Feasibility Report

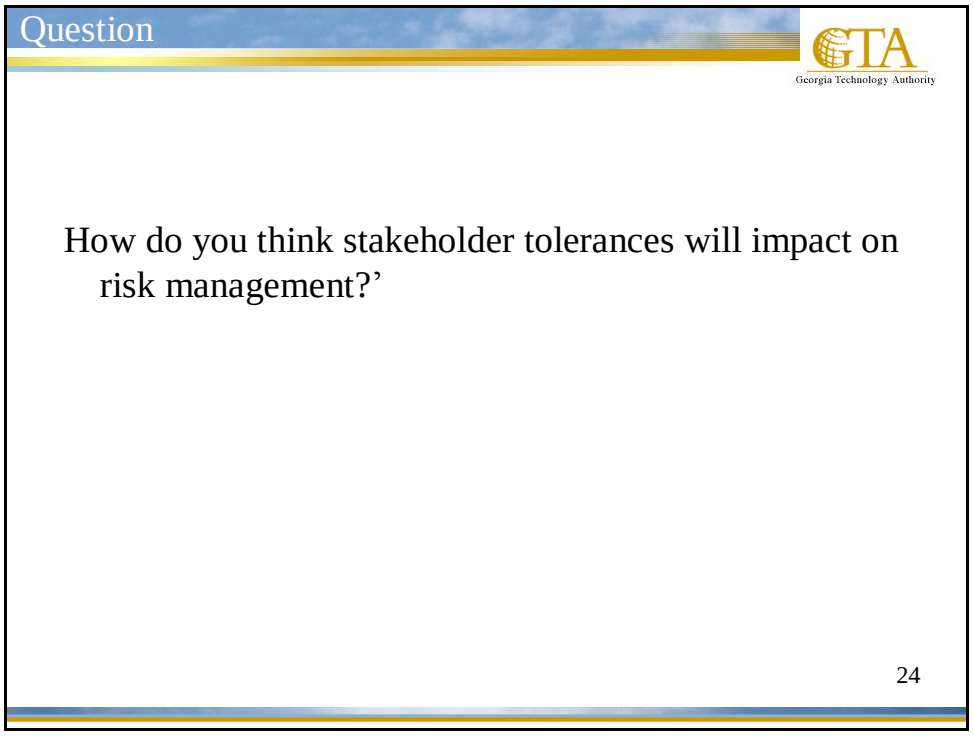
The feasibility team completed their study on schedule with an outline of strategy, detailed recommendations, and a list of preferred suppliers.

The main outcomes from the team are the following:

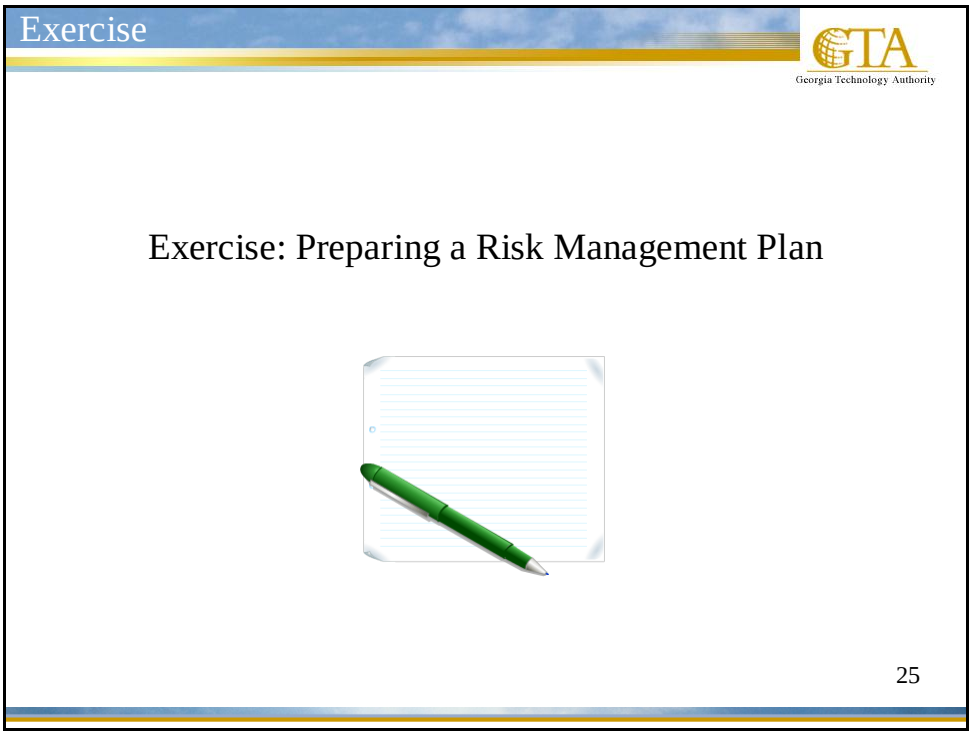
- The light-rail system should be piloted in one city. Based on the relative success of the pilot and after a period of "customization", the transportation initiative can be deployed in other areas.
- Contractor participation is a key aspect to the success of the project, and the government should establish and work with a set of preferred suppliers.
- The government should establish a detailed project management office that has the authority to manage and control the project and report to senior government officials.

The feasibility team gave the green light for the project based on these recommendations.

Topic 6: Exercise – Preparing a Risk Management Plan



Topic 6: Exercise – Preparing a Risk Management Plan



Assume that the state authority has sanctioned the rail project. You are part of the assembled dedicated risk management team. The first set of tasks entails identifying a risk management plan, including key aspects for consideration by the project sponsors.

A risk management template is provided for guidance.

Exercise Worksheet

Risk Management Template
Executive Summary
Risk Management Methodology **Methodology** **Risk categories** **Roles and responsibilities**
Budgeting and Timing
Scoring and interpretation
Reporting formats and tracking

Exercise Worksheet

Lesson 1: Summary

The lesson is now completed and the following topics have been covered:

Topic 1: Definition of Uncertainty and Risk

- Risk is the measurement of uncertainty. It can be both **positive** and **negative.**

- **Uncertainty** is the lack of sureness about an outcome, ranging from just short of certainty to almost complete lack of knowledge about an outcome.

- Aspects of risk include **risk events** (a risk event is a discrete occurrence that may affect the project positively or negatively), **risk as opportunity** (when the possible occurrence of an event has an outcome that is favorable, the risk is a potential opportunity) and **risk as threat** (when the possible occurrence of an event has an outcome that is unfavorable, the risk is a potential threat).

From this topic you should **take away** the following:

- an understanding of uncertainty and how it ties into risk
- the ability to identify the risk management processes as described by the *PMBOK® Guide*, 3ed

Topic 2: Stakeholder Risk Tolerance

- A project manger must understand organizational and stakeholder attitude towards risk in order to develop an effective risk management plan

- There are three types of stakeholder attitude toward risk; risk seeker, risk averse, and risk neutral.

- Understanding individuals' and organizations' attitudes to risk is an important part of project management, enabling better project evaluation, decisions, and negotiations.

From this topic you should **take away** the following:

- an understanding of the importance of stakeholder's tolerance towards risk
- the ability to identify attitude towards risk using probability analysis. This is exemplified in the exercise that is part of the topic.

Topic 3: Definition of Probability and Impact

- Probability and impact are the measures of risk in a project;
  - **risk probability** is the likelihood that a risk will occur, whereas risk consequence is the effect on project objectives if the risk event occurs
  - **risk impact** is a measure of the risk

- To evaluate risk probability and impact, project managers often use a **Probability-Impact (P-I) matrix** that assigns risk ratings (low, moderate, high, etc.) based on a combination of probability and impact scales. The risk rating is determined using a matrix and risk scales for each risk.

Lesson 1: Summary (cont'd)

- The probability of occurrence and the impact if the event occurs can be expressed **qualitatively** (using adjectives) or **quantitatively** (using numerical values).

- **Political risk evaluation** is an important element of a government project risk management plan. It measures opinions and takes into account conflicts between national, regional, and local levels, stakeholder inconsistencies, and political changes over time.

From this topic you should **take away** the following:

- the ability to evaluate risk using probability and impact
- an understanding of what a risk rating matrix is, and how probability and impact measures are used to establish one
- the ability to incorporate a risk rating matrix into the risk management process (i.e. risk management plan)

Topic 4: Preparing a Risk Management Plan

- A **risk management plan** describes how risk management is structured and performed on a project.

- It contains information on project methodology, budgeting, timing, reporting formats, related documentation, and categories of risk.

From this topic you should **take away** the following:

- an appreciation of what constitutes a risk management plan, with an understanding of the various sections it contains

Topic 5: A Risk Management Plan Template

- There is no single risk management plan template; rather they differ from project to project.

- A sample risk management plan might include an introduction describing the context for the risk management process, the risk management strategy, the organization and structure designed to manage risks, and a table of related documents.

From this topic you should **take away** the following:

- an ability to identify a sample risk management plan template and explain its sub-sections

Topic 6: Using a Risk Management Plan

- An exercise is presented to demonstrate how to prepare and use a risk management plan.

From this topic you should **take away** the following:

- using the risk management plan template, the ability to deliver a risk management plan for the Georgia Light Rail project
- an understanding of what a risk management plan is and what it is used for

Lesson 2: Identifying Risk

Topic 1: Sources of Risk

Topic 2: Risk Gathering Techniques

Topic 3: Preparing a Risk Identification Template

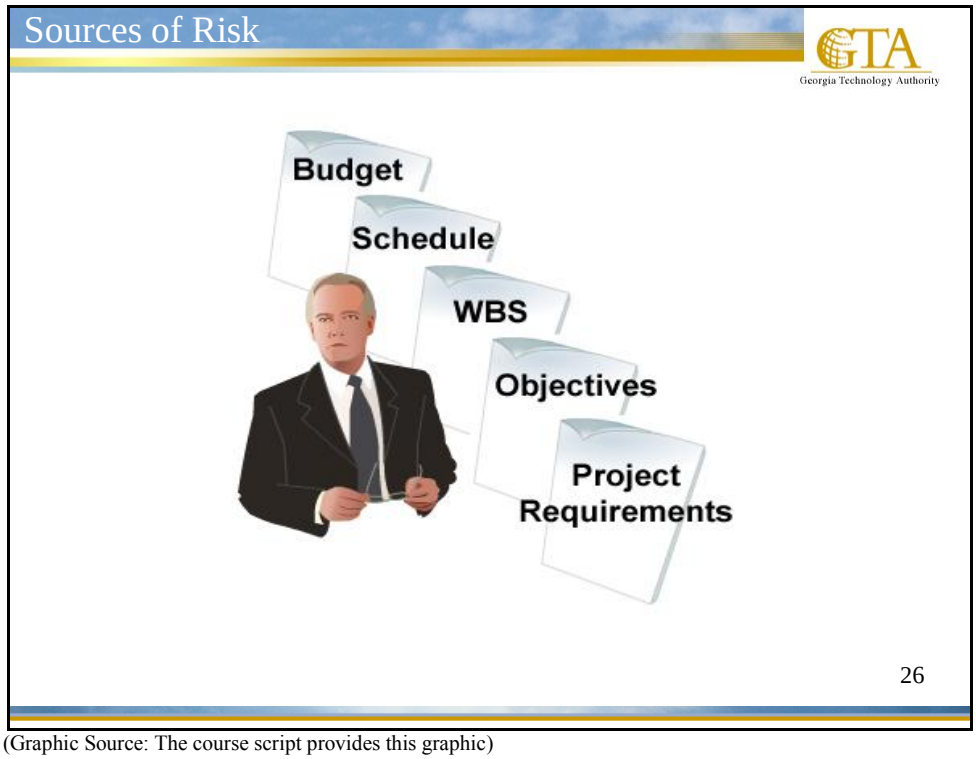
Topic 4: Using Risk Identification Tools and Techniques

Student learning objectives

After completing this lesson, you should be able to

- recognize that risk is constant in a project and that project managers should not focus on one particular area in identifying risk
- outline the various methods that can be used to identify and gather risk information
- describe the roles and responsibilities associated with risk identification
- explain how to structure and populate a risk identification template
- identify the various tools and techniques associated with risk identification
- prepare a unique risk identification for the associated case study

Topic 1: Sources of Risk



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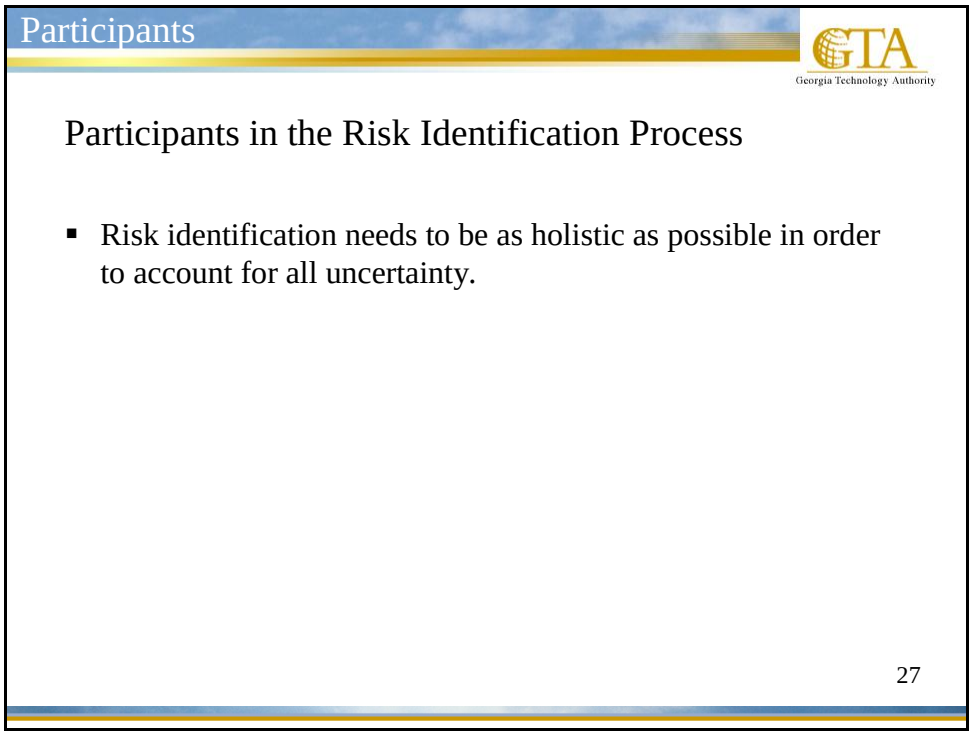
Topic 1: Sources of Risk (cont'd)



Risk identification is the process of determining which risks might affect the project and documenting their characteristics.

Participants in the risk identification process will usually include

- project team
- risk management team
- subject matter experts from other parts of the company
- customers
- end users
- other project managers, stakeholders, and outside experts

The **risk identification process is said to be iterative** in that new risks may become known as the project life cycle progresses.

The frequency of iteration and who participates in each cycle will be different with different projects.

The project team needs to be involved in the process so that it can develop and maintain a sense of ownership and responsibility for the risks and associated risk-response actions.

Additional objective information can be provided by persons outside the team.

The risk identification process usually leads to the qualitative risk analysis process, or it can lead directly to the quantitative risk analysis process when conducted by an experienced risk manager.

In some cases, an appropriate response is suggested simply by the identification of the risk, and these should be recorded for further analysis and implementation in the risk response planning process.

Topic 1: Sources of Risk (cont'd)

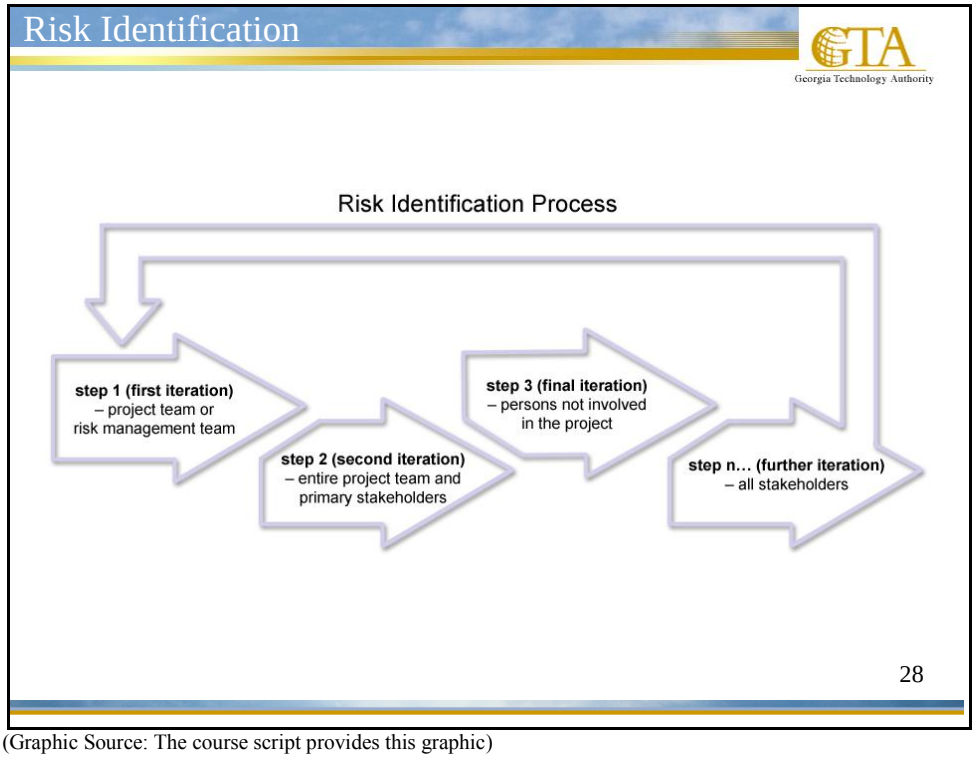
Risk identification needs to be as holistic as possible in order to account for all uncertainty. Risk identification is the starting point of any good risk management process – if it is done well, the ensuing analysis and responses will be good.

Risks can be classified based on their level of uncertainty. The Project Management Institute categorizes risks as follows:

- **external – unpredictable**, e.g. government regulations, natural hazards, and acts of God
- **external – predictable**, e.g. cost of money, borrowing rates, raw material availability
- **internal (nontechnical)** , e.g. labor stoppages, cash flow problems, safety issues, health and benefit plans
- **technical**, e.g. changes in technology, changes in state of the art, design issues, operations/maintenance issues
- **legal**, e.g. licenses, patent rights, lawsuits, subcontractor performance, contractual failure

External risks are outside of the project manager's control but may affect the direction of the project. Internal risks may be within control of the project manager and present uncertainty that may affect the project, while technical risks relate to the utilization of technology and the impact it has on the direction of the project. Legal risks relate to any infringements that may occur in contract obligations, licenses etc.

Topic 1: Sources of Risk (cont'd)



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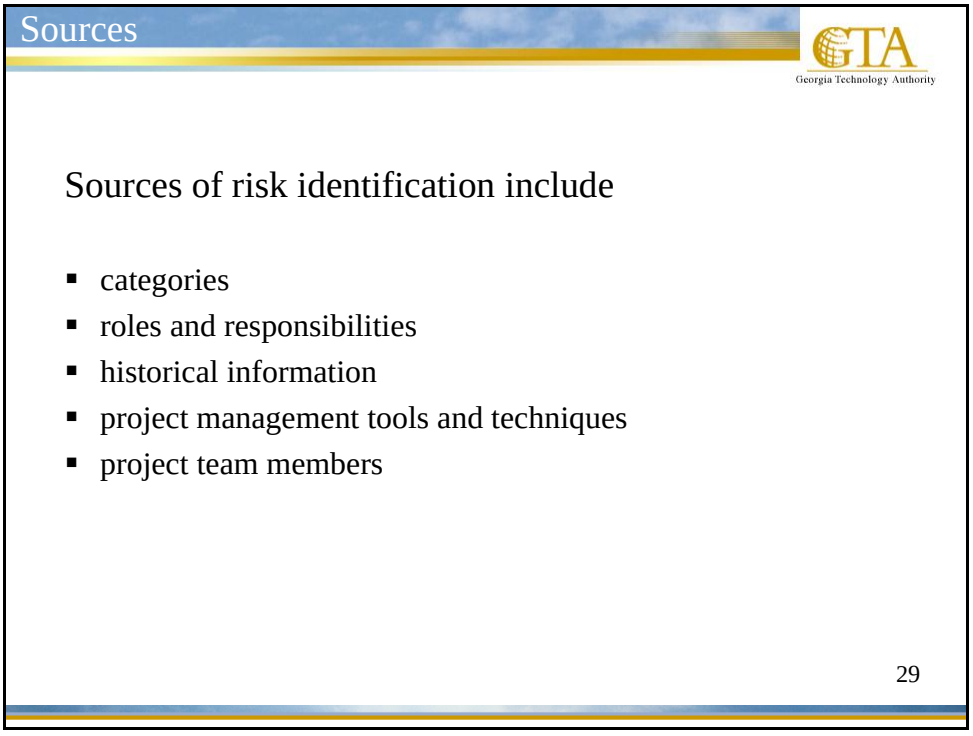
Risk identification is a continual process throughout the life cycle of the project. It proceeds in an iterative fashion using the following steps

- **step 1 (first iteration)** – usually carried out by a part of the project team or by the risk management team
- **step 2 (second iteration)** – usually carried out by a part of the project team or by the risk management team
- **step 3 (final iteration)** – usually carried out by persons who are not involved in the project, in order to achieve an unbiased analysis
- **step n… (final iteration)** – it is not known how many iterations are required and as the process proceeds, all stakeholders are involved

As soon as a risk is identified, simple and effective risk responses can be developed and implemented.

Topic 1: Sources of Risk (cont'd)



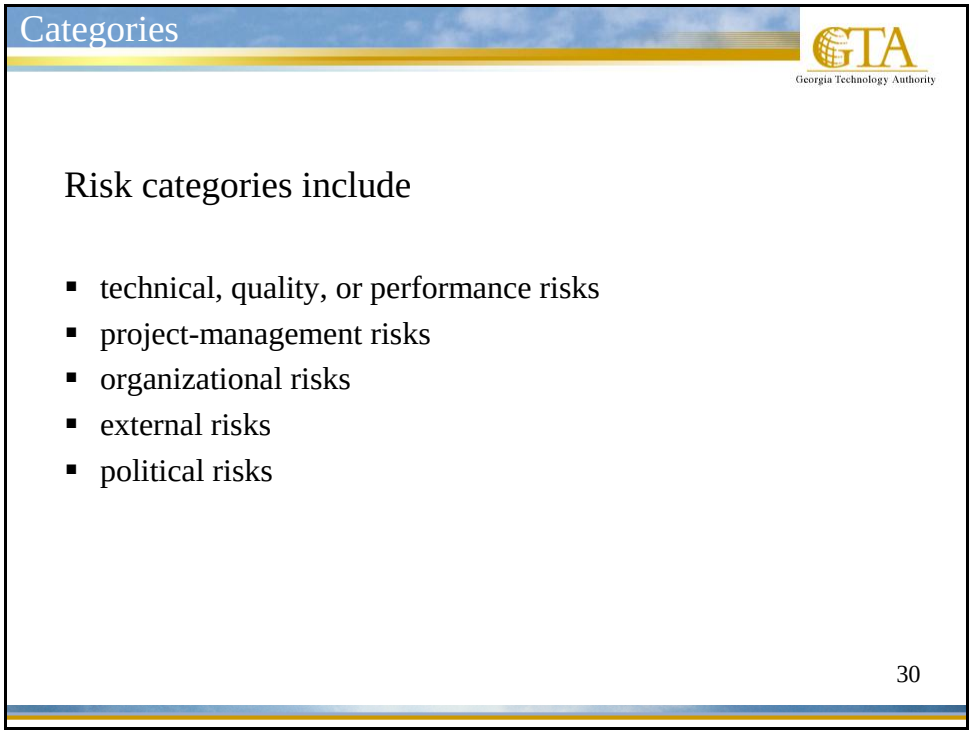
Sources of Risk Identification

The sources of risk for the risk identification process are

- **categories**
- **roles and responsibilities**
- **historical information**
- **project management tools and techniques**
- **project team members**

Risk is sourced from a combination of these elements – for example, historical information is sourced from planning techniques and categories.

Topic 1: Sources of Risk (cont'd)



Categories of Risk

Risks that affect a project can be identified and organized into risk categories. These categories need to be well defined and should reflect common sources of risk for the industry or application area.

Risk categories include:

- **technical, quality, or performance risks**

  Examples of this risk category include reliance on unproven or complex technology, unrealistic performance goals, and changes to the technology used or to industry standards during the project. Instances where technical categories are relevant include software installations, updates to technology, etc.

- **project-management risks**

  Examples of this risk category include poor allocation of time and resources, inadequate quality of the project plan, or poor use of project management disciplines.

- **organizational risks**

  Examples of this risk category include cost, time, and scope objectives that are internally inconsistent; lack of prioritization of projects; inadequacy or interruption of funding; and resource conflicts with other projects in the organization.

Topic 1: Sources of Risk (cont'd)

- **external risks**

  Examples of this risk category include shifting legal or regulatory requirements, labor issues, changing owner priorities, country risk, and weather. Force majeure risks – such as earthquakes, floods, and civil unrest – usually require disaster recovery actions rather than risk management.

- **political risk**

  This is a measure of the stakeholders' opinion of the project and is the main criterion on government projects.

  A basic assumption in societies is that the stakeholders' decisions are correct. A government project manager is ethically bound, therefore, to carry out their will – not to ignore it or evade it. The will of the stakeholders is conveyed to the project manager from the elected representatives through the executive.

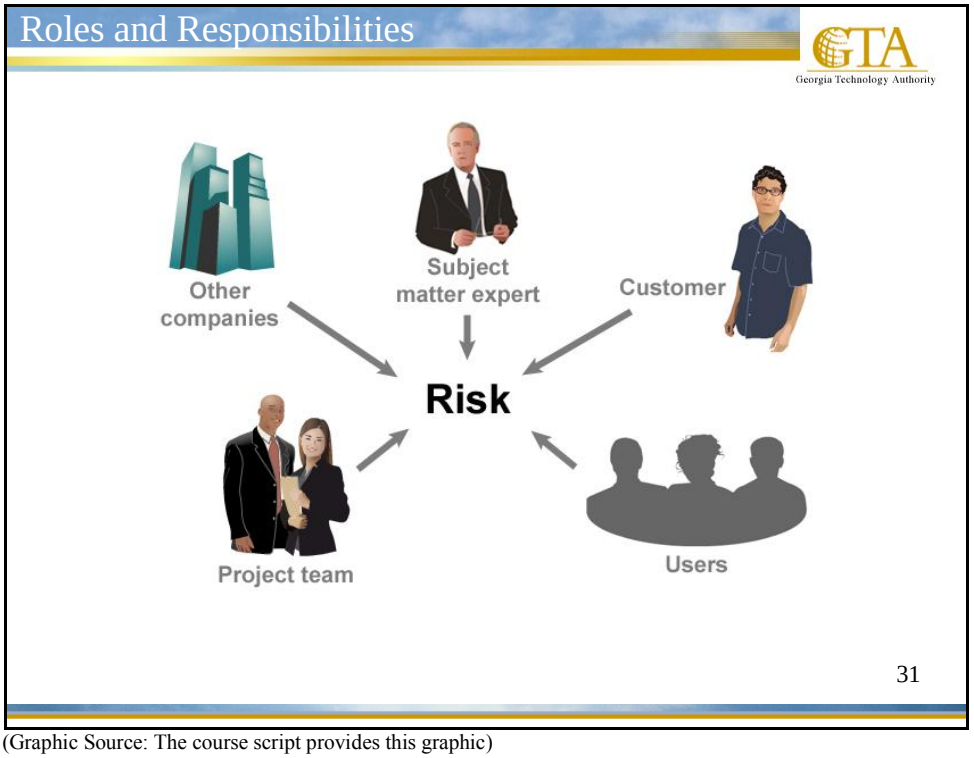
  There are many variations in opinion. These include

  - conflicts between national, regional, and local levels – for example, national or regional elections may want a facility (for example, a nuclear energy plant) that local voters living beside the proposed facility oppose

  - inconsistencies – for example, stakeholders may not want to car pool but also not want air pollution

  - changes over time – for example, stakeholders may support a project in its early stages but oppose it later as the cost of the project increases

Topic 1: Sources of Risk (cont'd)



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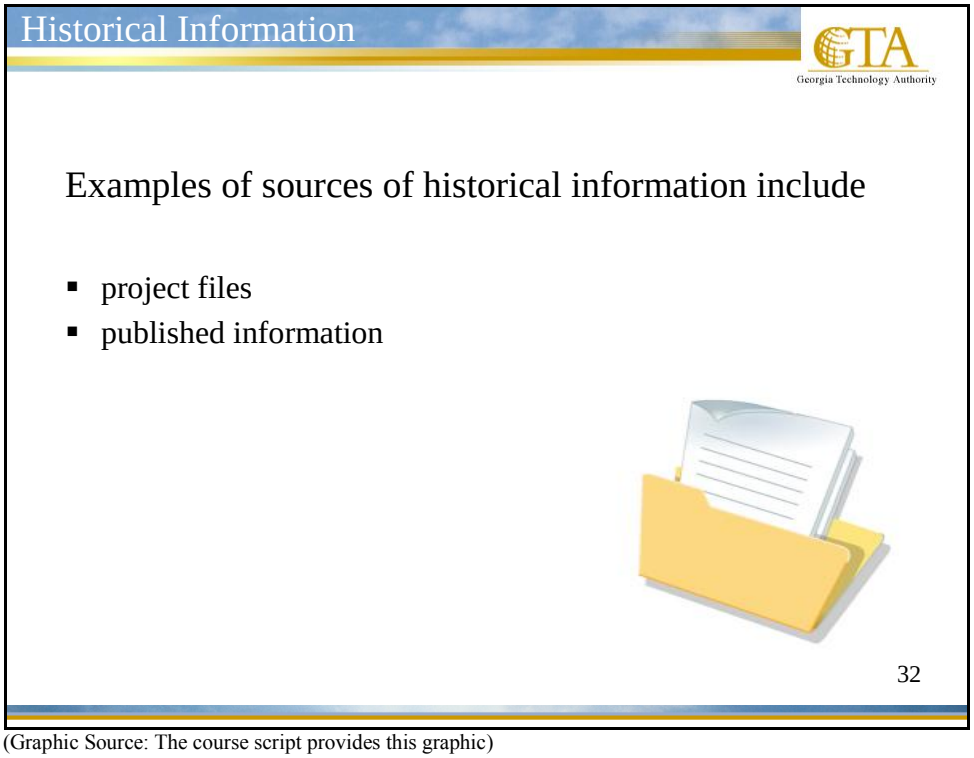
Roles and Responsibilities

As outlined above, participants in the risk identification process usually include

- **project team**
- **risk management team**
- **subject matter experts from other parts of the company**
- **customers**
- **end users**
- **other project managers, stakeholders, and outside experts**

Who participates in each cycle and what their responsibilities are will differ in different projects.

Topic 1: Sources of Risk (cont'd)



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Historical Information

Another useful source of input to the risk identification process is historical information gleaned from previous projects.

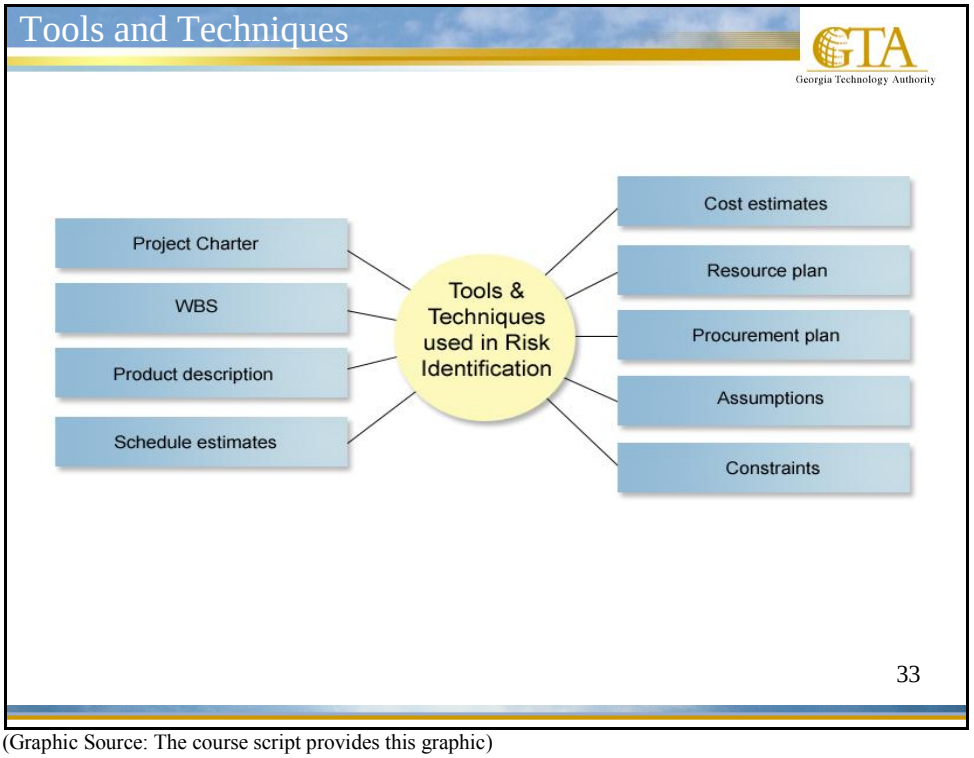
Examples of sources of historical information include

- **project files** – Organizations involved in the project may have records of the results of previous projects. These results, taken from final project reports or risk-response plans, can be used to identify risks.

  Project files may include organized "lessons learned" that describe problems and their resolutions. This information could also be available through the experience of the project stakeholders or others in the organization.

- **published information** – Historical information is also available from commercial databases, academic studies, benchmarking, and other published studies.

Topic 1: Sources of Risk (cont'd)



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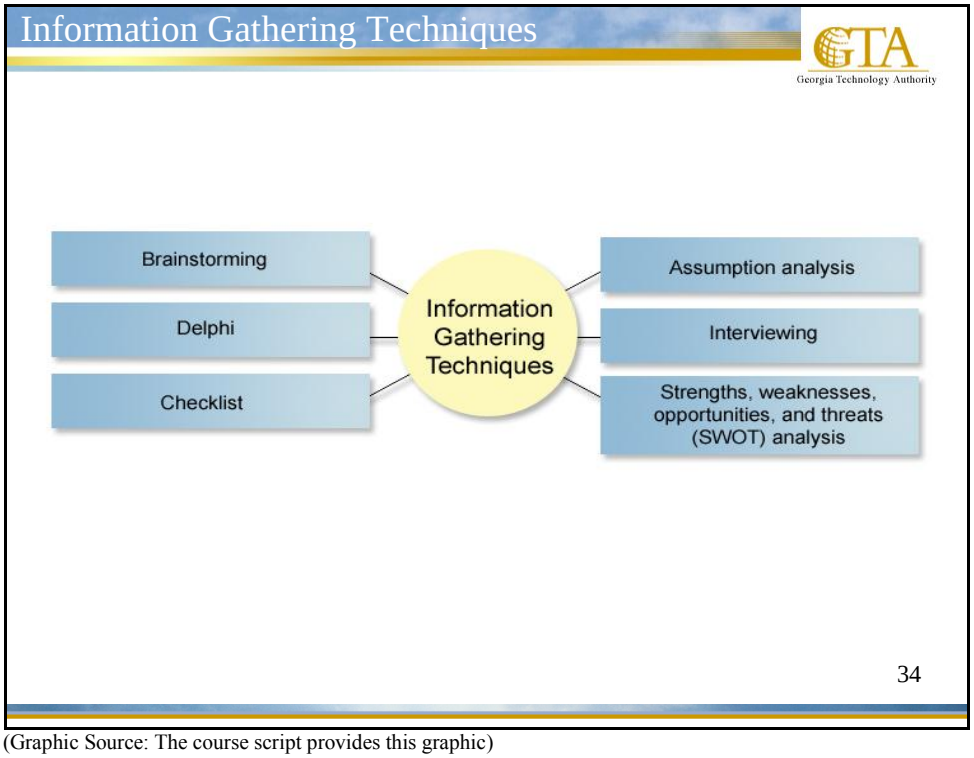
Project Management Tools and Techniques

To compliment the others sources of risk, a successful risk identification process will require an understanding of the project's mission and scope, as well as the objectives of the owner, sponsor, or stakeholders.

Outputs of other processes become inputs to the risk identification process. These outputs also need to be reviewed.

Topic 2: Risk Gathering Techniques



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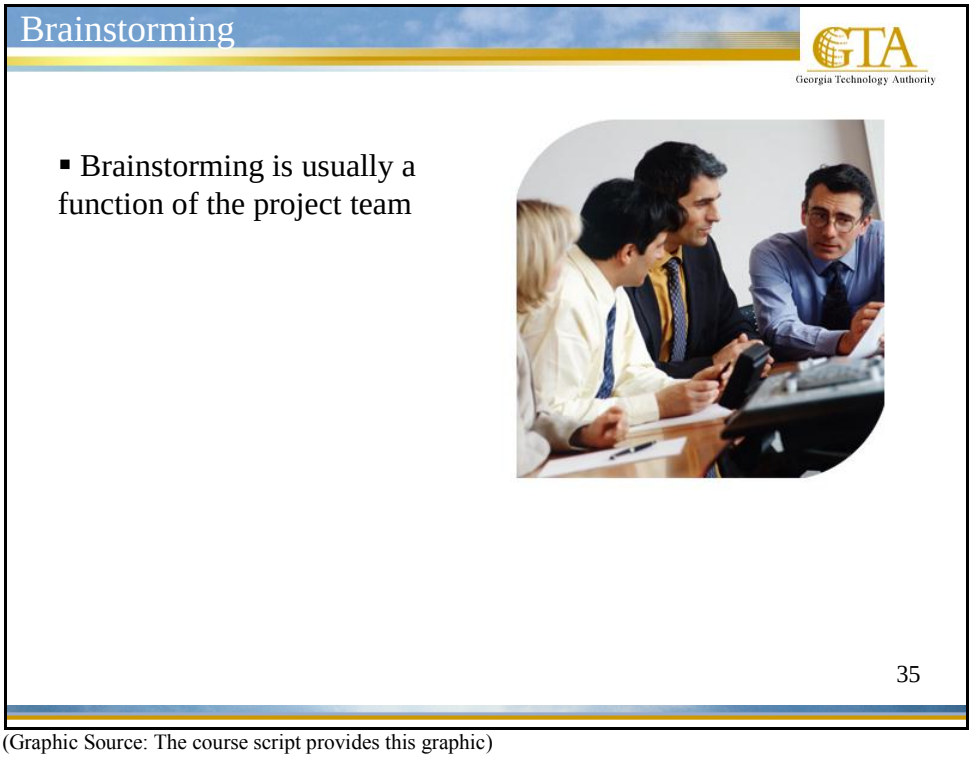
Risk gathering techniques and the tools that project managers and risk managers use to gather information from the various sources include

- **brainstorming**
- **Delphi**
- **checklist**
- **assumption analysis**
- **interviewing**
- **strengths, weaknesses, opportunities, and threats (SWOT) analysis**

Risk gathering is a combination of all of the above techniques, of which brainstorming, assumption analysis, and SWOT analysis are the most commonly used. It aims to determine a comprehensive list of risks and ensure that

- sources of risk are identified
- sources are posted for examination
- risks are categorized by type
- definitions are clearly identified

Topic 2: Risk Gathering Techniques (cont'd)



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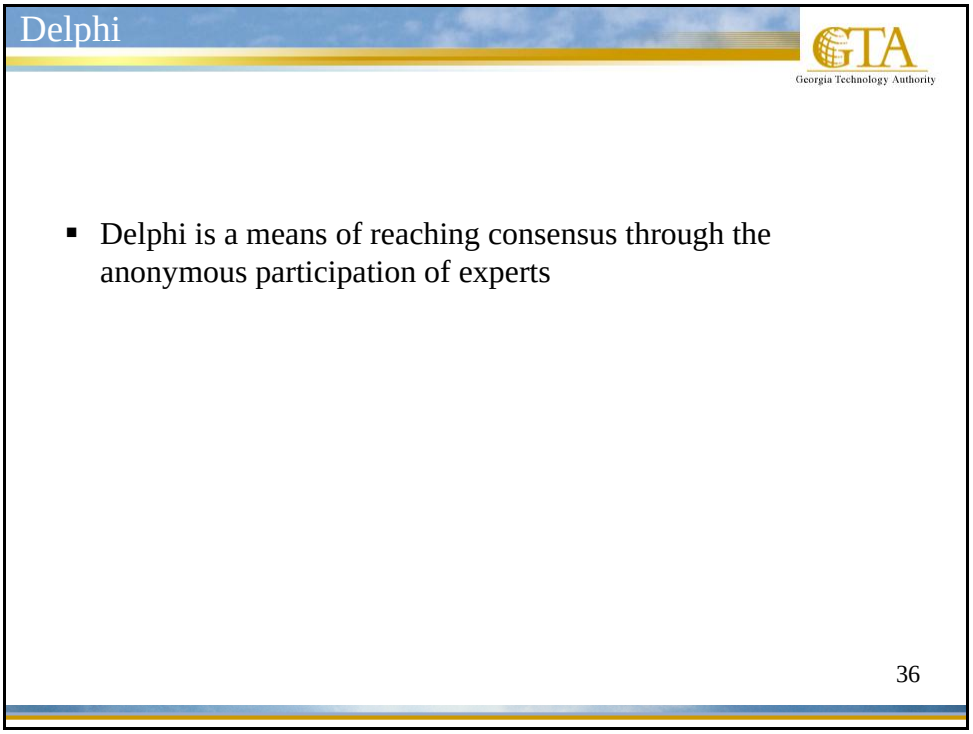
Brainstorming

In terms of techniques for identifying risk, brainstorming is probably the most commonly used.

Brainstorming is usually a **function of the project team**, although a multidisciplinary group of experts can also carry out this task. Under the leadership of a facilitator, these people generate ideas about project risk.

The **goal of brainstorming is to determine a comprehensive list of risks** that can be addressed later in the qualitative and quantitative risk analysis processes. Sources of risk are first identified in a general sense and then posted for all to examine during the meeting. The risks are then categorized by type, and their definitions are clearly identified.

Topic 2: Risk Gathering Techniques (cont'd)

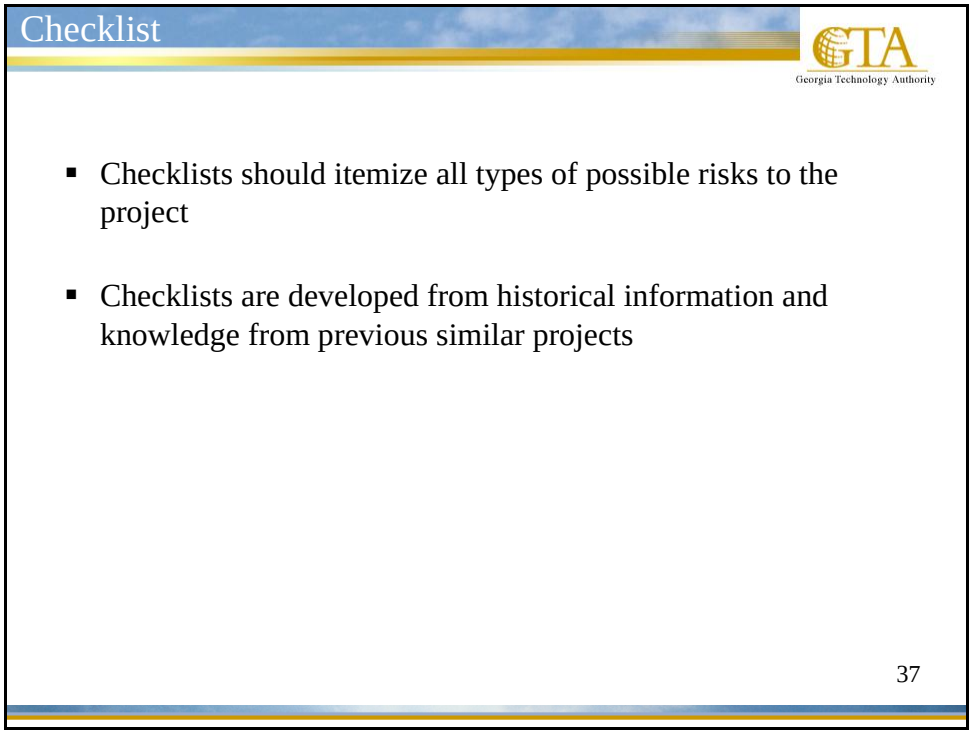


Delphi Technique

The **Delphi technique is a means of reaching consensus on a subject**, such as project risk, through the anonymous participation of experts.

A neutral facilitator solicits ideas about the important project risks using a questionnaire. The submitted responses are circulated to the experts for further comment. In a few rounds of this process, consensus on the main project risks can be reached. The non-interactive nature of the **Delphi technique helps reduce bias** in the data and prevents any one person from having undue influence on the outcome.

Topic 2: Risk Gathering Techniques (cont'd)



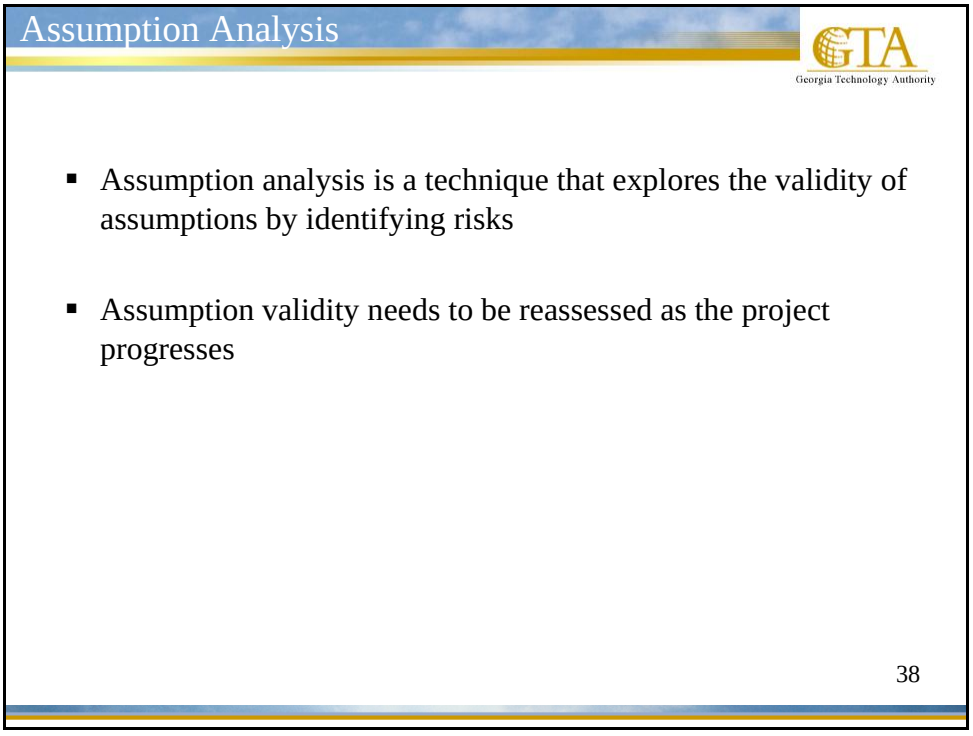
Checklists

Risk identification checklists can be developed from historical information, knowledge that has been accumulated from previous similar projects, and from other sources of information.

There are several good reasons for using checklists - the main benefit being that they are quick and easy to use. A possible disadvantage is that it is impossible to build an exhaustive checklist of risks. As a result, users may effectively limit themselves to the categories in the list. It is important to bear in mind that some items relevant to a specific project will not appear on a standard checklist.

Risk identification checklists should itemize all types of possible risks to the project. It is important to review the checklist as a formal step of every project-closing procedure, in order to improve the list of potential risks and to improve the description of risks.

Topic 2: Risk Gathering Techniques (cont'd)



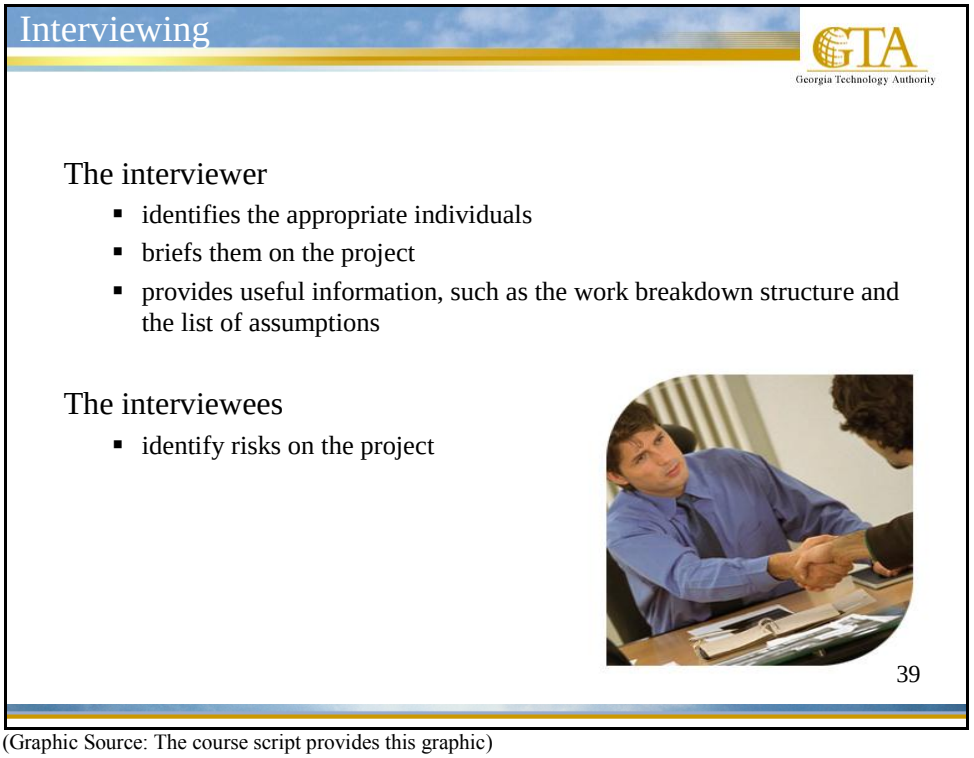
Assumption Analysis

Underpinning every project is the set of hypotheses, scenarios, or assumptions made initially. **Assumptions are any piece of project information that is believed to be true at a point in time but which cannot be validated.** As the project progresses, initial assumptions should be validated and incorporated into the plans.

If an assumption cannot be validated, it may become a risk. As the project progresses, you should reassess the validity of these assumptions.

Assumption analysis is a technique that **explores the validity of assumption by identifying risks to the project from inaccuracy, inconsistency, or incompleteness of assumptions**.

Topic 2: Risk Gathering Techniques (cont'd)



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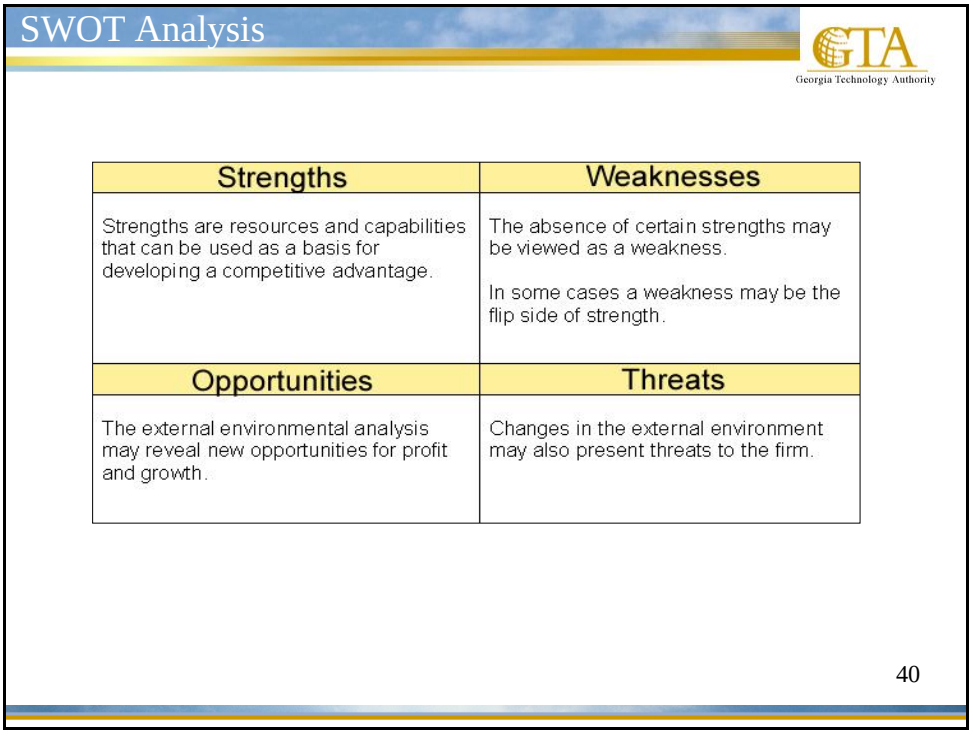
Interviewing

Interviewing experienced project managers or subject matter experts is a good technique for identifying risks.

In this technique, the interviewer identifies the appropriate individuals, briefs them on the project, and provides them with useful information, such as the work breakdown structure and the list of assumptions.

Based on their experience, project information, and other sources that they find useful, the interviewees identify risks on the project.

Topic 2: Risk Gathering Techniques (cont'd)



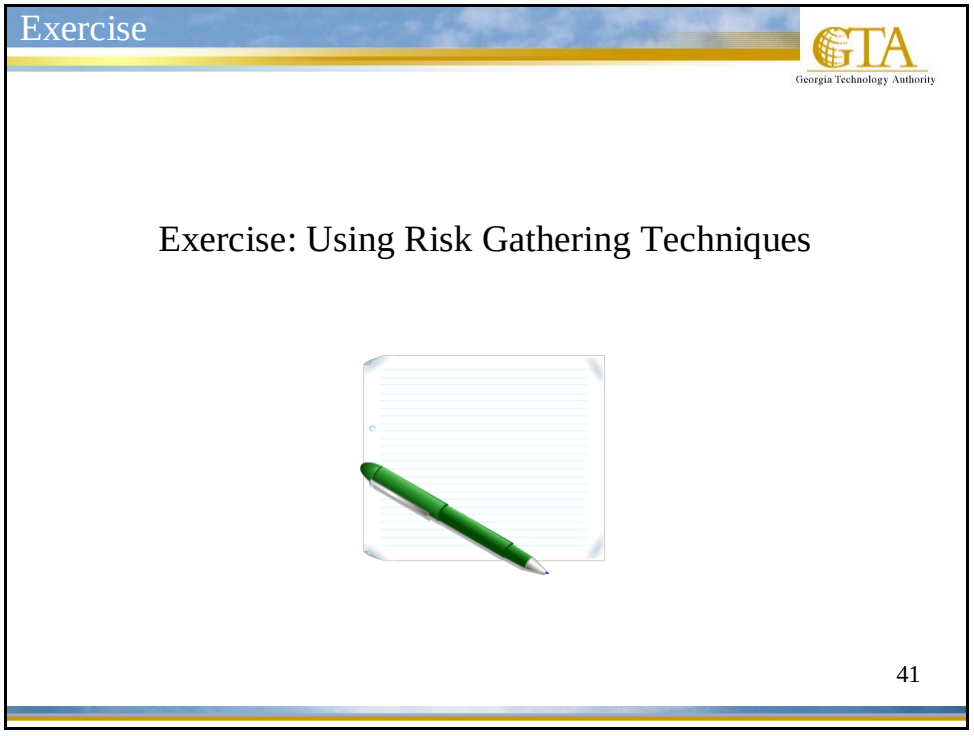
Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis

A SWOT analysis is a classification of situation analysis that focuses on the strengths, weaknesses, opportunities, and threats inherent in a project.

By examining each of the SWOT analysis perspectives in turn, the project team ensures that the breadth of the risks considered is maximized.

SWOT analysis is a useful technique in project management risk, where it is desirable to reduce the probability and impact of a threat and increase the probability and impact of an opportunity.

Topic 2: Exercise – Using Risk Gathering Techniques

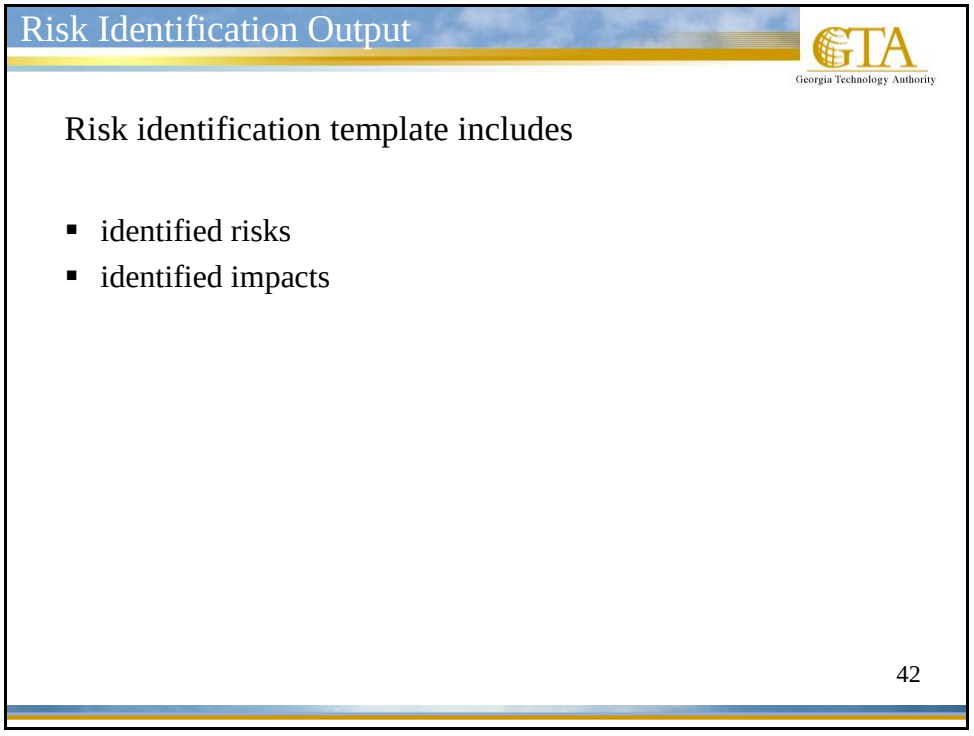


Having read The Georgia Rail Project case study, the state authority has sanctioned the project. As part of the assembled dedicated risk management team, you have delivered a risk management plan to the project stakeholders. The stakeholders have requested that a SWOT analysis be performed to highlight project strengths and opportunities.

Exercise Worksheet

Strengths	Weaknesses
Opportunities	**Threats**

Topic 3: Preparing a Risk Identification Template



Root Consequences

Root consequence identification is the process of inquiring into the essential cause of the risks associated with a project.

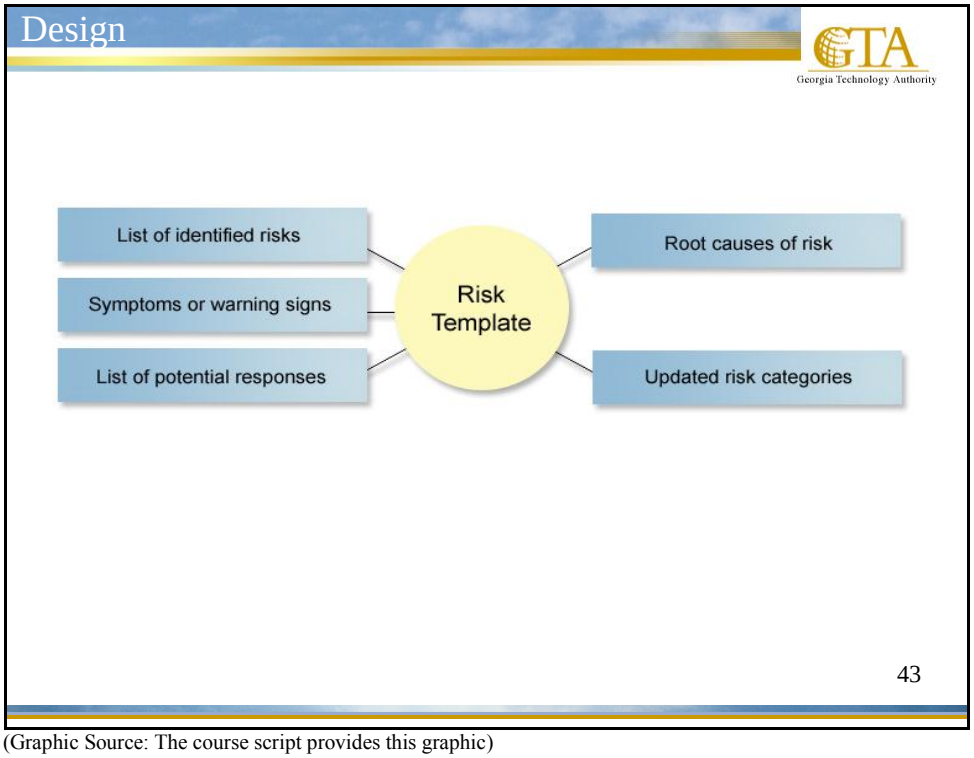
This process results in a sharper definition of the risk and facilitates the grouping of risks according to cause.

Addressing the root consequence of the risk means that effective risk responses can be developed.

When identifying risk, it is the consequence that needs to be understood.

For example, if poor quality of materials is detected during a structural project, this can be considered a risk event. The cause or consequence, however, may be that the materials supplier is unable to meet the project demands. To proceed with the risk analysis, the consequence is the information that will be used to determine appropriate response strategies.

Topic 3: Preparing a Risk Identification Template (cont'd)



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Design of a Risk Response Plan Template

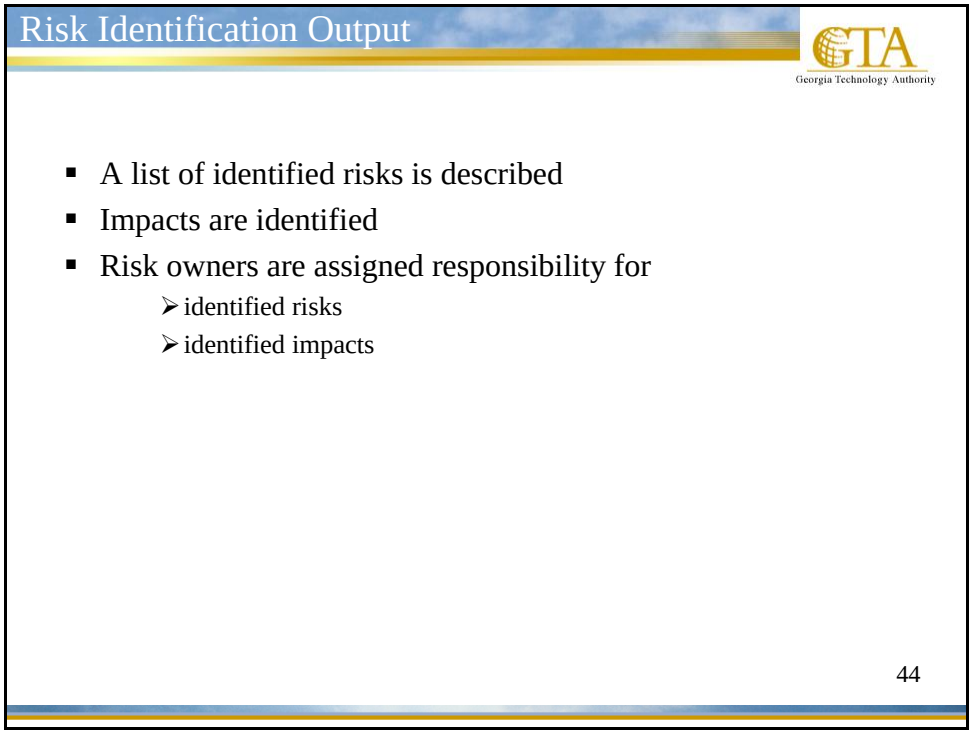
The outputs from risk identification are typically compiled into a document called a risk response plan template.

The initial entries into the risk response plan template are the primary outputs from the risk identification process. The risk response plan, in turn, becomes a component part of the project management plan.

A completed **risk response plan template** contains the results of risk analyses, prioritization, and responses after other risk management processes are conducted.

In the risk identification process, preparing the risk response plan template begins by compiling certain information, which becomes available to other project management and project risk management processes.

Topic 3: Preparing a Risk Identification Template (cont'd)



List of Identified Risks

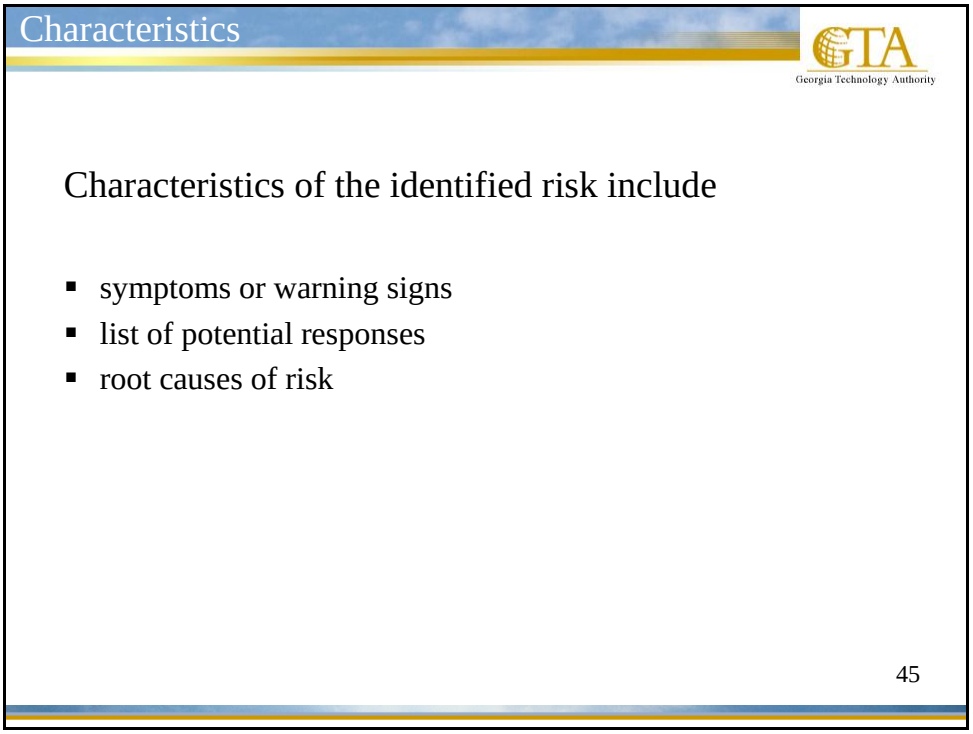
A **list of identified risks**, including their **consequences** and uncertain **project assumptions**, are first described. Their **impacts** are then identified, and persons (the risk owners) are subsequently assigned responsibility for further analysis, responses, and monitoring.

The production of this list, which is one of the most creative parts of project management, is vital to the remainder of the risk management process. Effective risk responses can create "win-win" situations that satisfy several competing groups of stakeholders.

Consideration of **potential responses** begins in the scope planning process. Potential responses are closely related to, and often dependent on, the identification of alternatives.

Potential responses include the "no go" option – this is variously referred to as "do nothing" and "no build". The voters must perceive the product of the project to have greater value than the sum of its economic, social, and environmental costs.

Topic 3: Preparing a Risk Identification Template (cont'd)



Symptoms or Warning Signs

Symptoms or warning signs are indications that a risk requires greater attention, or is about to occur. An event that has already occurred is no longer a risk but may be a problem or an issue.

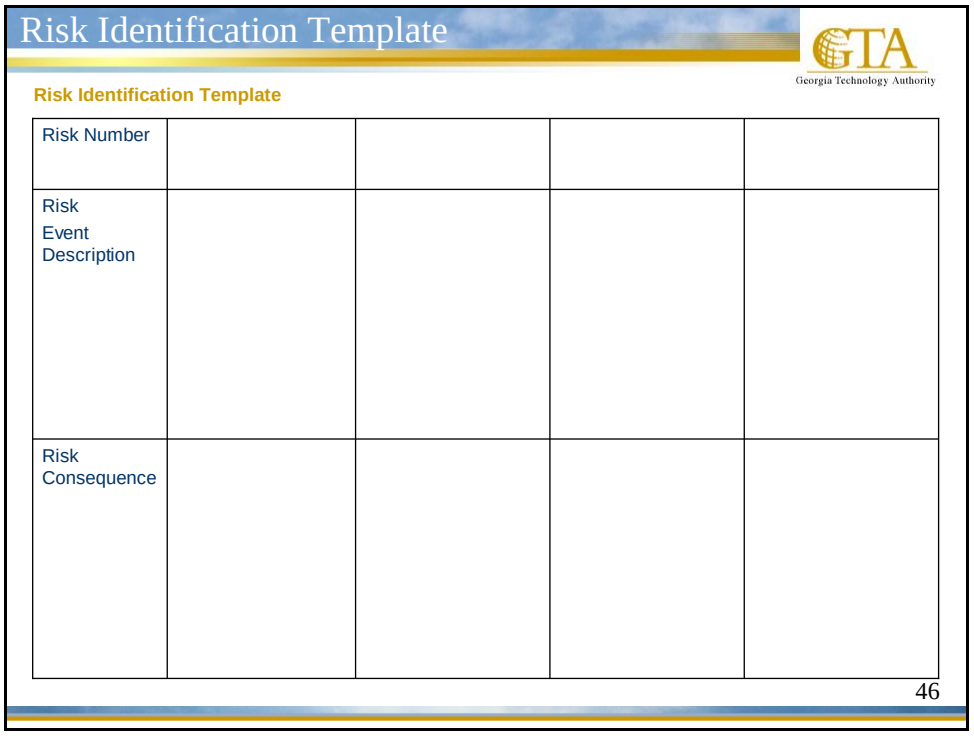
List of Potential Responses

During the risk identification process, potential responses to a risk may be identified. These responses serve as useful inputs to the risk response planning process.

Root Causes of Risk

The root causes of risk are the fundamental conditions or events that can trigger the identified risk. As root causes can give rise to more than one risk, tackling them can lead to very effective risk responses.

Topic 3: Preparing a Risk Identification Template (cont'd)



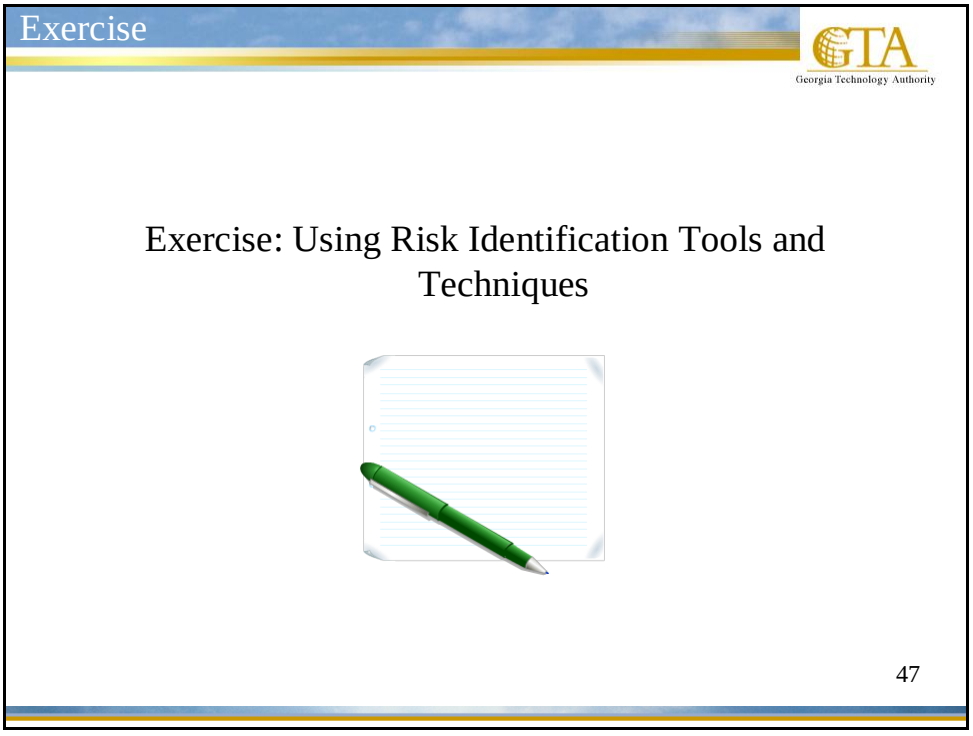
This is an example of a risk identification template.

Risk event is a discrete occurrence that may affect the project positively or negatively.

Risk consequence identification is the process of inquiring into the essential cause of the risks associated with a project. It provides a sharper definition of the risk and facilitates the grouping of risks according to cause.

Risk Number				
Risk Event Description				
Risk Consequence				

Topic 4: Exercise – Using Risk Identification Tools and Techniques



The state authority has sanctioned the light-rail project. You have completed the SWOT analysis and there are some apparent risks that need to be logged. You are tasked with putting a risk response plan together that will present

- risk event
- risk consequence

Once completed, you want to identify potential risk responses.

Exercise Worksheet

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	.	.		
Risk Consequence	.			

The following responses are based on identifying the consequence/cause of the risk. No detailed analysis has being performed as this stage.

Risk Response				

Lesson 2: Summary

The lesson is now completed and the following topics have been covered:

Topic 1: Sources of Risk

- **Risk identification** is the process of determining which risks might affect the project and documenting their characteristics. It is an iterative process that occurs throughout the life cycle of the project.

- **External risks** are outside of the project manager's control but may affect the direction of the project, while **internal risks** may be within control of the project manager and present uncertainty that may affect the project. **Technical risks** relate to the utilization of technology and the impact it has on the direction of the project.

- The sources of risk for the risk identification process include c**ategories, roles and responsibilities, historical information, project management tools and techniques,** and **project team members.**

From this topic you should **take away** the following:

- an ability to identify risk using the described tools and techniques
- an appreciation that risk identification is a holistic approach to capturing all relevant information at any given time in the project lifecycle

Topic 2: Risk Gathering Techniques

- Risk gathering techniques and the tools that project managers use to gather information from the various sources include **brainstorming, Delphi, checklist, assumption analysis, interviewing,** and **strengths, weaknesses, opportunities, and threats (SWOT) analysis.**

From this topic you should **take away** the following:

- an understanding of the application of the tools and techniques used to gather risks
- an understanding of the use of the SWOT template (i.e. combining expert judgement with brainstorming on project strengths, project weaknesses, project opportunities and project threats)

Topic 3: Preparing a Risk Identification Template

- The outputs from risk identification are typically compiled into a document called a risk response plan template.

- A **list of identified risks**, including their **consequences** and uncertain **project assumptions**, are first described. Their **impacts** are then identified, and persons (the risk owners) are subsequently assigned responsibility for further analysis, responses, and monitoring.

- Characteristics of identified risk include symptoms or warning signs, a list of potential responses, and the root causes of risk.

- A risk identification template contains a description of each risk event, and details of each risk consequence.

Lesson 2: Summary (cont'd)

From this topic you should **take away** the following:

- a starting point in developing a risk response template
- the data that should be entered when capturing identified risks

Topic 4: Using Risk Identification Tools and Techniques

- An exercise is presented to demonstrate how to deliver a risk response plan with identified risks.

From this topic you should **take away** the following points:

- the partial application of presenting a risk response template for the Georgia Light Rail project

-

Lesson 3: Analyzing Risk

Topic 1: Structuring Risk Analysis

Topic 2: Probability and Impact Assessment

Topic 3: Quantitative Risk Analysis

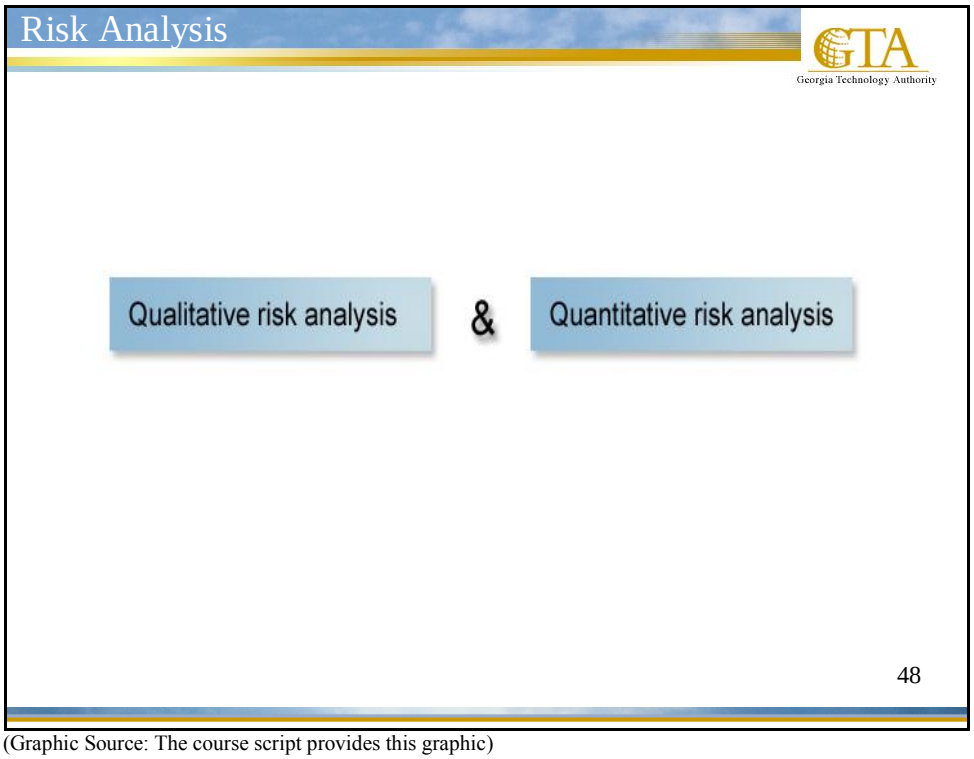
Topic 4: Performing Risk Analysis

Student learning objectives

After completing this lesson, you should be able to

- outline the various components of risk analysis, identify how they are used, and differentiate between them
- outline how to measure risk using probability and impact with relevant tools and techniques
- identify the various tools and techniques that are part of quantitative risk analysis
- understand how to analyze risk

Topic 1: Structuring Risk Analysis



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Risk Analysis

Risk analysis is carried out as part of the risk management plan.

Risk analysis is about understanding and evaluating the identified risks associated with a project and determining which risk events warrant a response.

A project's risk event status is determined from a combination of **probability** and **impact**.

Probability is defined as the likelihood of an event occurring and is usually expressed as a number from 0 to 1 (or equivalent percentages).

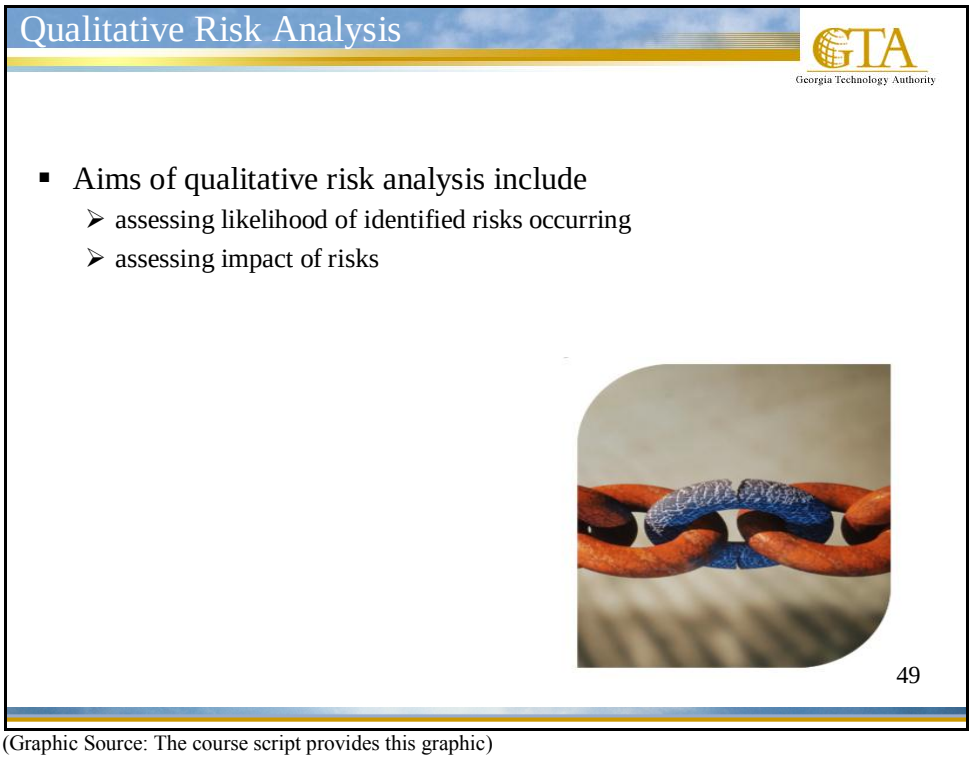
Impact is defined as the effect that a risk or opportunity will have on cost, schedule, or performance.

The risk management plan covers the

- probability of a discrete risk event occurring – these risk events can be either desirable (opportunities) or undesirable (threats)
- cost or time impact on the project if the risk event occurs

Risk analysis can be carried out using a **qualitative** or **quantitative** approach.

Topic 1: Structuring Risk Analysis (cont'd)



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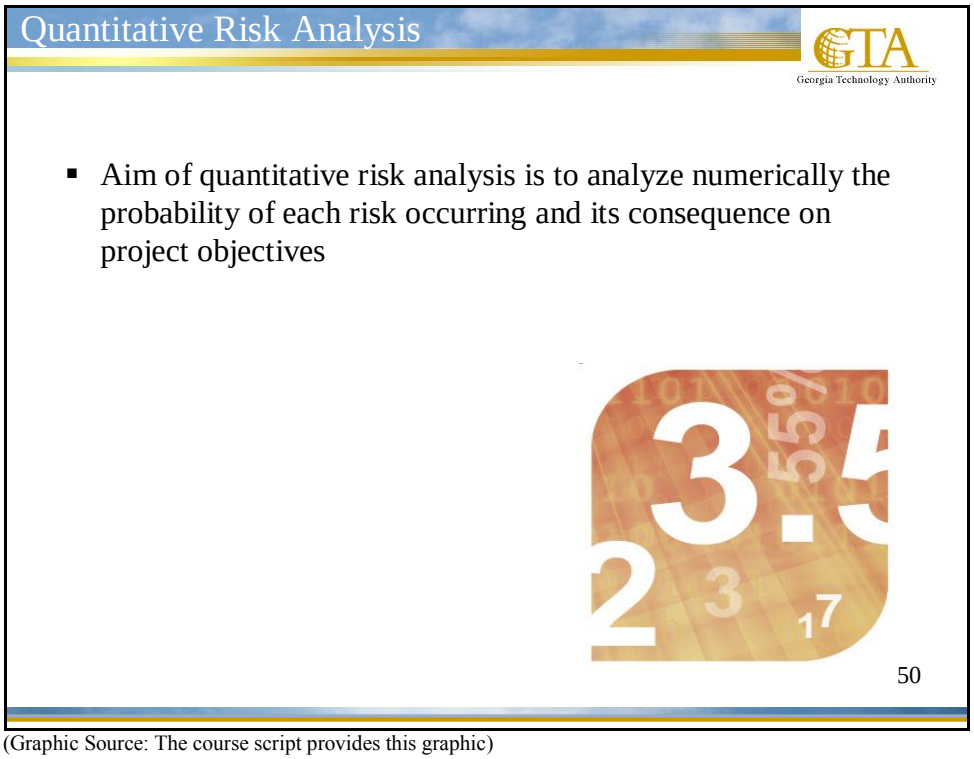
Qualitative Risk Analysis

Qualitative risk analysis prioritizes risks based on their potential effect on project objectives.

This type of analysis determines the importance of addressing specific risks and guiding risk responses. The importance of a risk may be magnified by the time criticality of the risk-related actions. Evaluating the quality of the available information helps modify the assessment of the risk. Using established qualitative-analysis methods and tools to evaluate the probability and consequences of the risks helps correct biases that are often present in a project plan.

In order to monitor changes in the project risks, qualitative risk analysis should be revisited during the project's life cycle. This process can result in further quantitative risk analysis or risk response planning – both of which are discussed later in this lesson

Topic 1: Structuring Risk Analysis (cont'd)



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Quantitative Risk Analysis

The aim of **quantitative risk analysis** is to analyze numerically the probability of each risk occurring and assess the consequence on project objectives. This process uses several different techniques – for example, Monte Carlo simulation and decision analysis.

The function of quantitative risk analysis is to

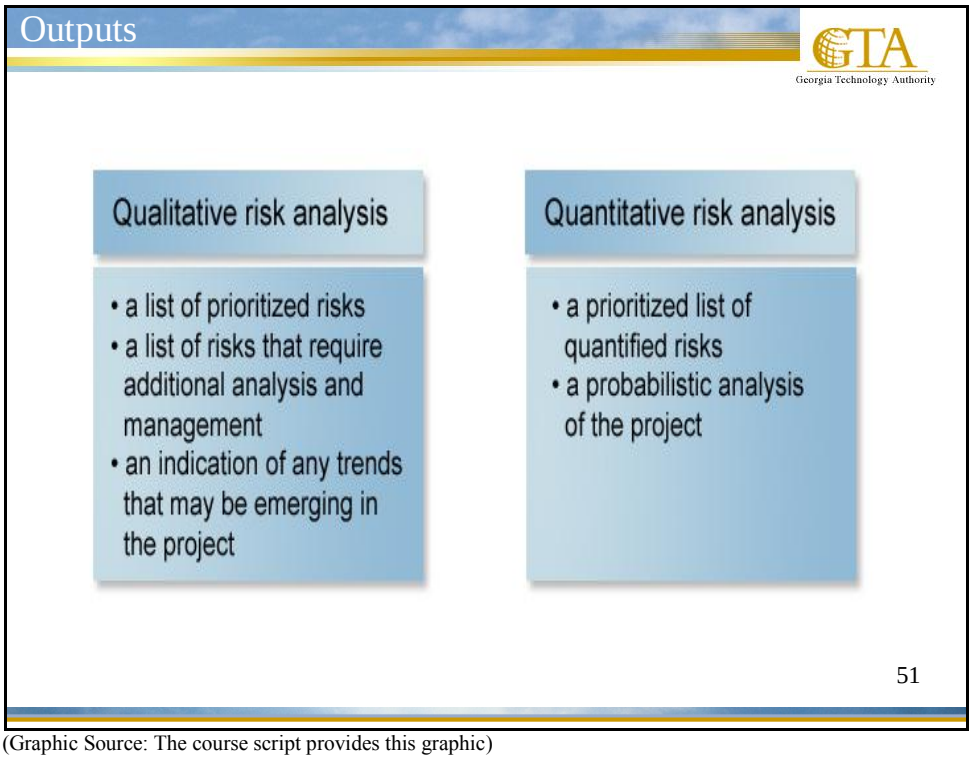
- determine the **probability of achieving each project objective**
- quantify the project's **risk exposure** and determine the size of cost and schedule **contingency reserves** that may be needed
- identify risks that require the **most attention** by quantifying their contribution to project risk
- identify **realistic and achievable targets** related to cost, schedule, or scope

This type of analysis generally follows qualitative risk analysis, but both types of analysis processes can be used separately or together.

The method of quantitative analysis used will be determined by time and budget availability considerations and the need for qualitative or quantitative statements about risk and impacts.

You can determine whether more or less risk management action is required by repeating quantitative analysis a few times during the project's life cycle and observing the trends in the results.

Topic 1: Structuring Risk Analysis (cont'd)



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Qualitative Analysis

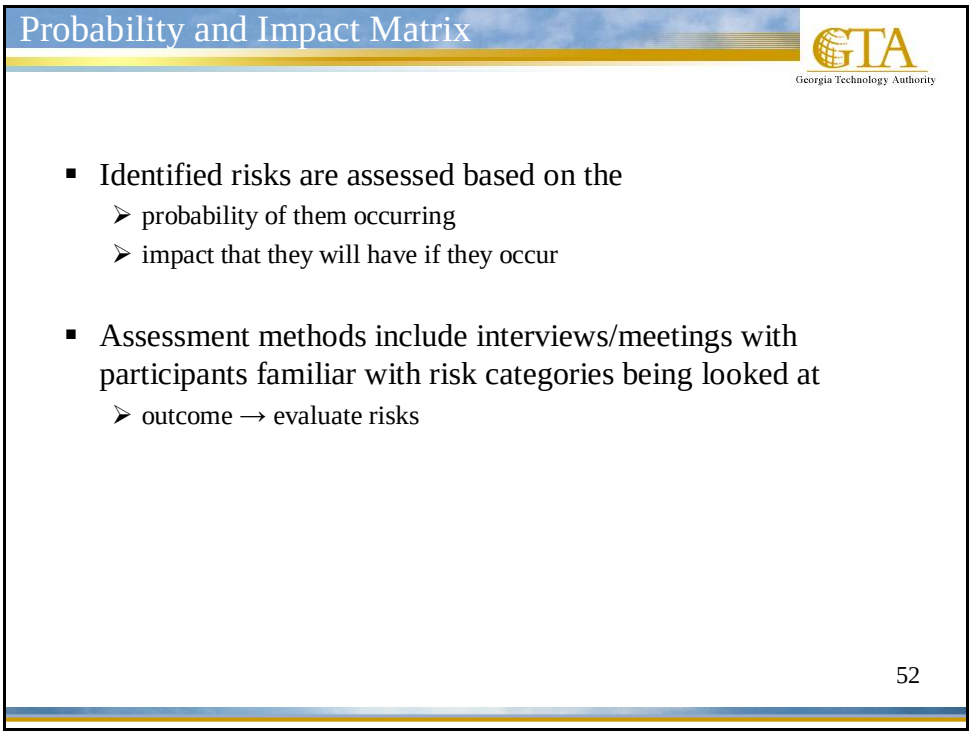
Qualitative analysis generates several outputs. These include a list of prioritized risks, a list of risks that require additional analysis and management, and an indication of any trends that may be emerging in the project. High or moderate risks may require additional analysis including quantitative risk analysis, and risk management action.

Conducting a quantitative analysis allows you to generate a prioritized list of quantified risks and a probabilistic analysis of the project. A list of quantified risks includes those that present the greatest opportunity or pose the greatest threat to the project, coupled with a measure of their impact. Probabilistic analysis yields forecasts of possible completion dates and project duration and costs, together with their associated confidence levels.

Quantitative analysis also provides an opportunity to assess the probability of achieving cost and time objectives. This is done by evaluating the current plan and the current knowledge of the risks facing the project.

As with qualitative analysis, the results of a quantitative analysis can be studied to determine if any trends – positive or negative – are emerging. Identifying trends at an early stage can help you determine what kind of analysis and risk response to perform as the project progresses.

Topic 2: Probability and Impact Assessment



Risk Probability / Impact Assessment

One of the techniques used in **qualitative risk analysis** is a **risk probability and impact assessment**. Risk probability describes the likelihood of a risk occurring, whereas risk impact describes the effect a risk will have if it occurs on a project objective – such as time, cost, scope, or quality. The impact can have negative effects (threats) or positive ones (opportunities).

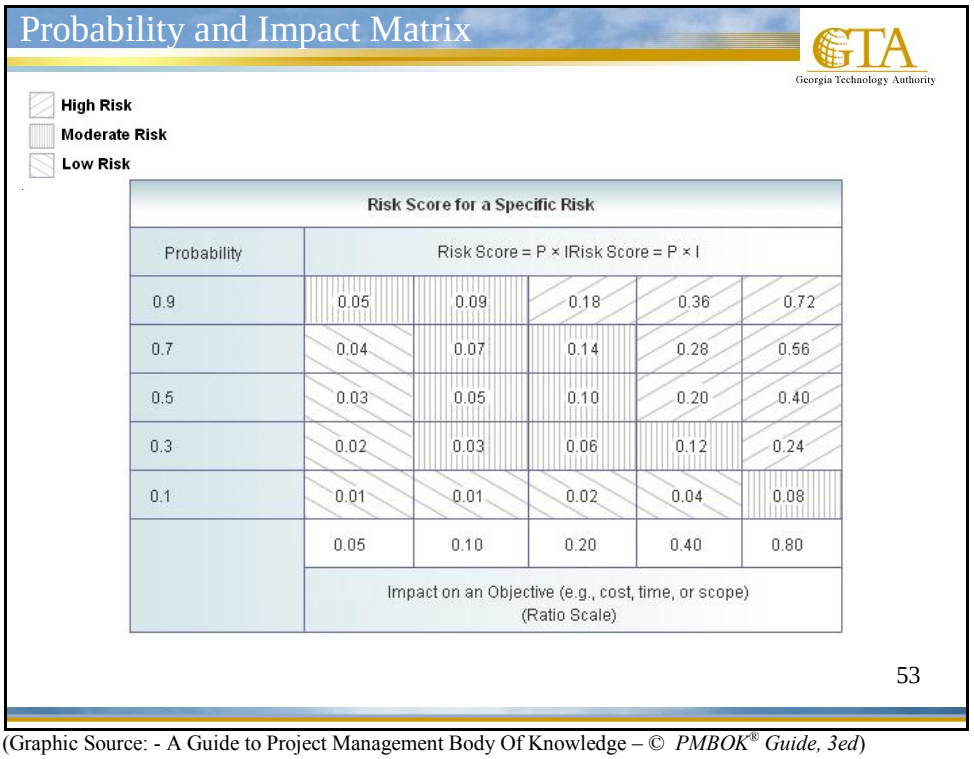
A common way of assessing risks is to conduct interviews or hold meetings with participants who are familiar with the risk categories being examined. For this reason, it's a good idea to include project team members and knowledgeable people from outside the project in any interviews or meetings. (Obtaining expert judgment is important because very little information on risks can be obtained from an organization's database of past projects.)

The discussion should be led by an experienced facilitator because participants may have little or no experience with risk assessment.

During the discussion, participants evaluate the level of probability for each risk, assess its impact on each objective, and take notes about how the decisions were made.

Some risks – for example, ones with low ratings of probability and impact – will not be rated. Although these risks are ignored, they are included on a watch list for future monitoring.

Topic 2: Probability and Impact Assessment (cont'd)



(Graphic Source: - A Guide to Project Management Body Of Knowledge – © *PMBOK® Guide, 3ed*)

Risk Event Status

A risk matrix is used to combine probability and impact to yield the **risk event status**. **Probability** is defined as the likelihood of an event occurring and is expressed as a number from 0 to 1. **Impact** is defined as the effect that a risk or opportunity will have on cost, schedule, or performance.

Each risk's importance, or priority for attention, is evaluated using a look-up table or a probability and impact matrix. This table/matrix specifies descriptive relative terms or numeric values for the probability and impact of a risk(s), as follows:

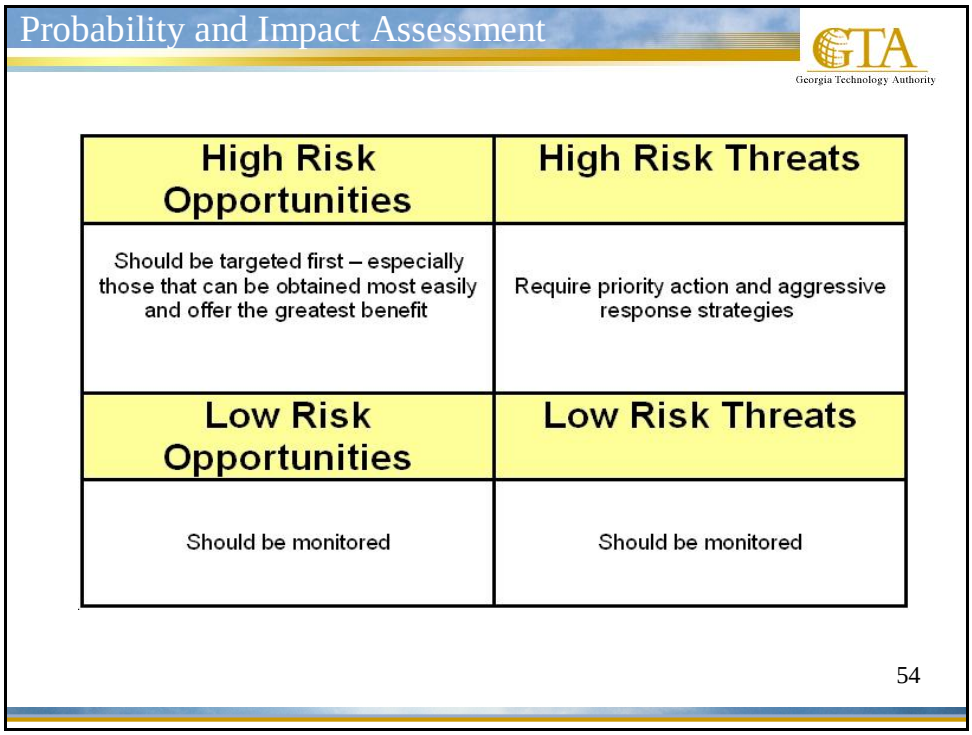
- **descriptive terms** – e.g. "very low", "low", "moderate", "high", and "very high"
- **numeric values** – e.g. 1, .3, .5, .7, .9, (1 = high chance of the risk occurring)

These terms/values determine which combinations of probability and impact result in a particular **risk event status**. In the slide shown above, a high risk is represented by the down diagonal background pattern, a moderate risk by the vertical background pattern, and a low risk by the up diagonal background pattern. (These risk event statuses can be used to prioritize a risk for further quantitative analysis and response.)

Usually, the risk event status rules are specified at the planning stage and can be tailored to the specific project being examined.

An organization can rate a risk separately for each objective, and it can develop ways to determine one overall rating for each risk – for example, a weighted average of the objective-specific scores can be used to derive a blended risk score for each risk.

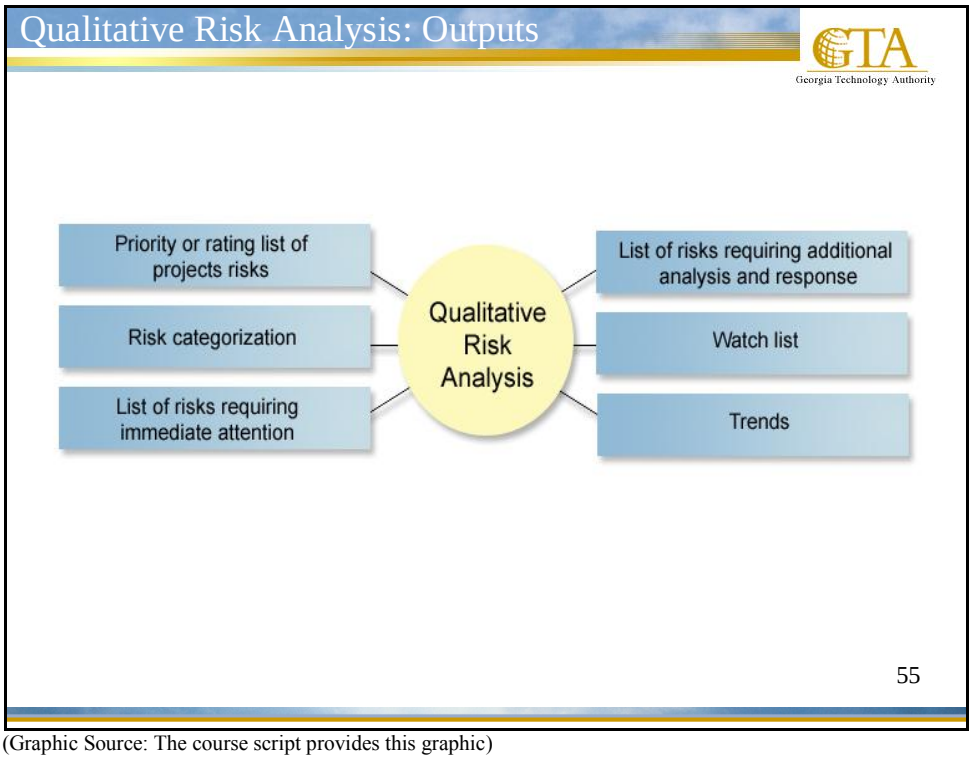
Topic 2: Probability and Impact Assessment (cont'd)



Threats and Opportunities

The same matrix can be used for both **threats and opportunities**, but a mirror double matrix is generally used to clarify which require priority attention.

Topic 2: Probability and Impact Assessment (cont'd)



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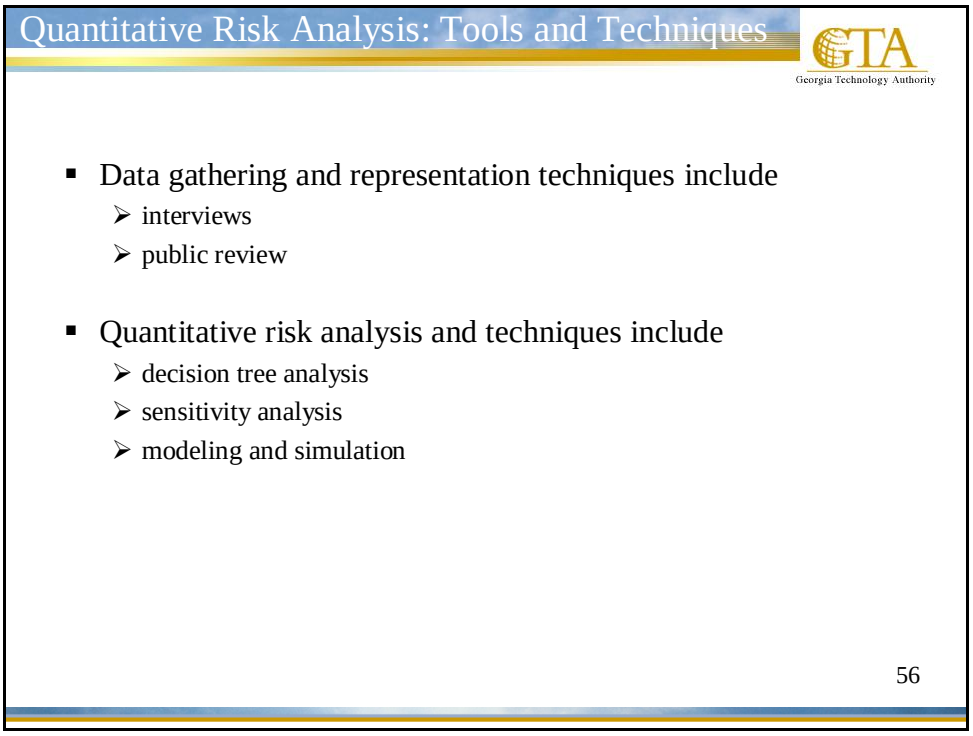
The Risk Response Plan

Information from the qualitative risk analysis is added to the risk identification template to deliver the risk response plan. The risk response plan is part of the project management plan and is used to track identified risks and the analysis. The information added to the risk response plan, in addition to the identified risks, includes

- **relative rating or priority list of project risks**, which classifies risks according to their individual significance – a separate list can be done for each objective
- **risk categorization**, which helps identify common causes of risk or areas that require attention
- **list of risks requiring an urgent response**
- **list of risks for additional analysis and response**
- **watch list** of low priority risks
- **trends** in qualitative risk analysis results

For an example of specific details, see the sample risk template later in this lesson.

Topic 3: Quantitative Risk Analysis



Conducting Quantitative Risk Analysis

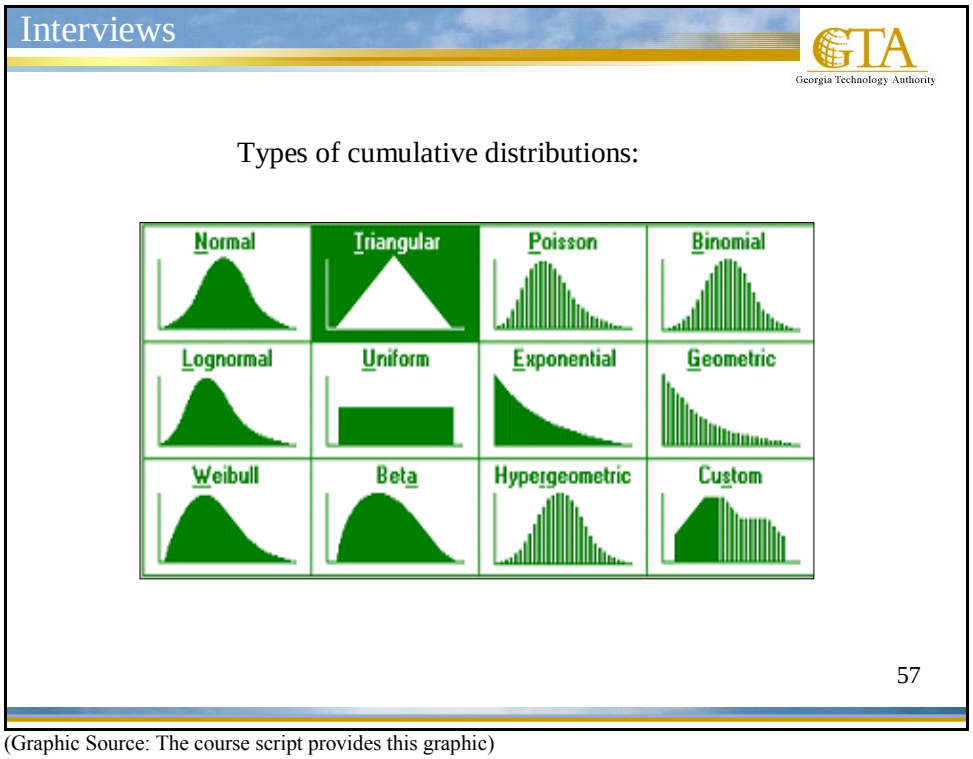
The aim of quantitative risk analysis is to analyze numerically the probability of each risk occurring and its consequence on project objectives. The method for conducting quantitative risk analysis is twofold:

Firstly, data gathering occurs. A variety of tools and techniques are used to gather information that is then processed using the quantitative risk analysis tools.

Next, quantitative risk analysis tools are used to assess risks against the project objectives. These tools include

- **interviewing**
- **public review**
- **decision tree analysis**
- **sensitivity analysis**
- **modeling and simulation**

Topic 3: Quantitative Risk Analysis (cont'd)



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Interviewing Techniques

Good **data collection** is essential for accurate risk assessment. One way of doing this is to use **interviewing techniques** to quantify the probability and consequences of risks on project objectives. For example, many organizations conduct risk interviews with project stakeholders and subject-matter experts as a first step to quantifying risks.

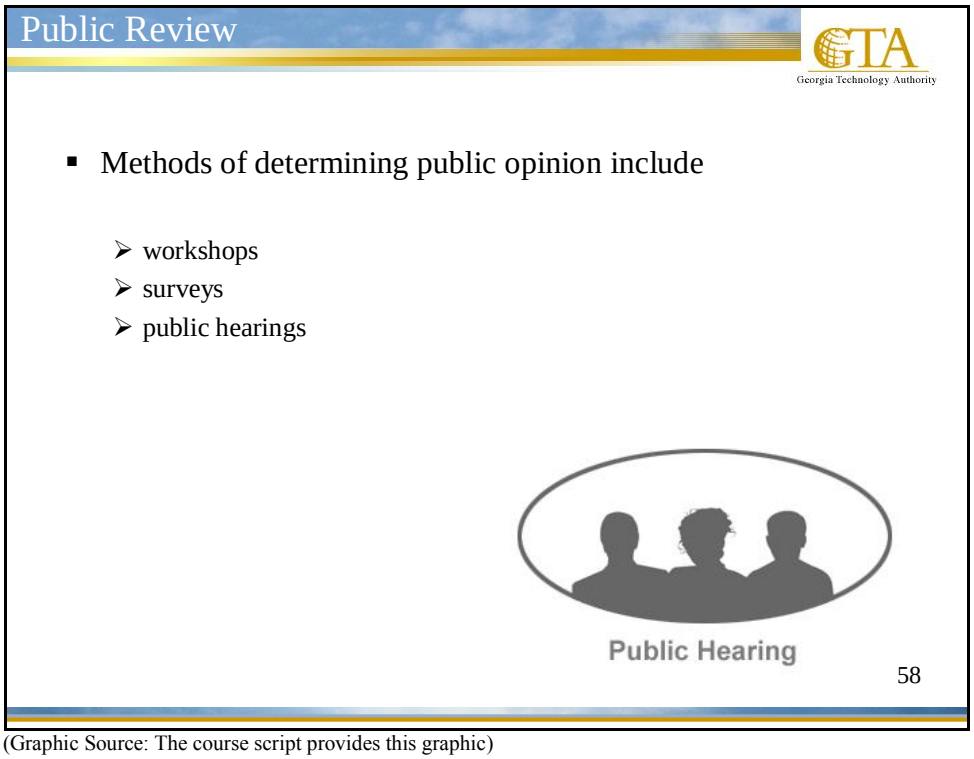
The information required depends on the type of probability distributions used. **Quantitative risk analysis normally uses continuous probability distributions, which represent both probability and consequences of the project component**. The most popular distributions are

- **binomial distribution** is a discrete distribution representing two-outcome chance events of independent trials
- **exponential distribution** is a distribution typically used for representing the time between arrivals of random events
- **triangle distribution** is a continuous distribution uniquely specified by its range (low and high) and its mode. It is the most popular distribution in Monte Carlo simulation because of its simplicity and ease of sampling.
- **normal distribution** is the frequently encountered, bell-shaped distribution.

Other common distribution types include uniform, beta, and log normal.

An important component of the risk interview is documenting the rationale of the risk ranges. By doing this, effective strategies for risk response can be defined in the risk response planning process.

Topic 3: Quantitative Risk Analysis (cont'd)



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Public Review

If there is any controversy about the government project, it should be subjected to public scrutiny. This allows the elected representatives to gauge the opinion of voters.

Every project has advantages and disadvantages. Public project reviews help opponents of the project make their case. The opponents do not have the resources or information that the supporters of the project have and generally respond on an emotional level, which does not help inform the elected representatives or search for the best solution. Project resources must, therefore, be committed to helping the opponents to articulate their case in a clear and logical manner.

There are three ways of gauging public opinion. These are to hold

- workshops
- surveys
- public hearings

The advantage of holding **workshops** and surveys is that everyone has an opportunity to participate. In a workshop, the different aspects of the project are described at information booths. Members of the public visit each booth to learn about the project and present opinions.

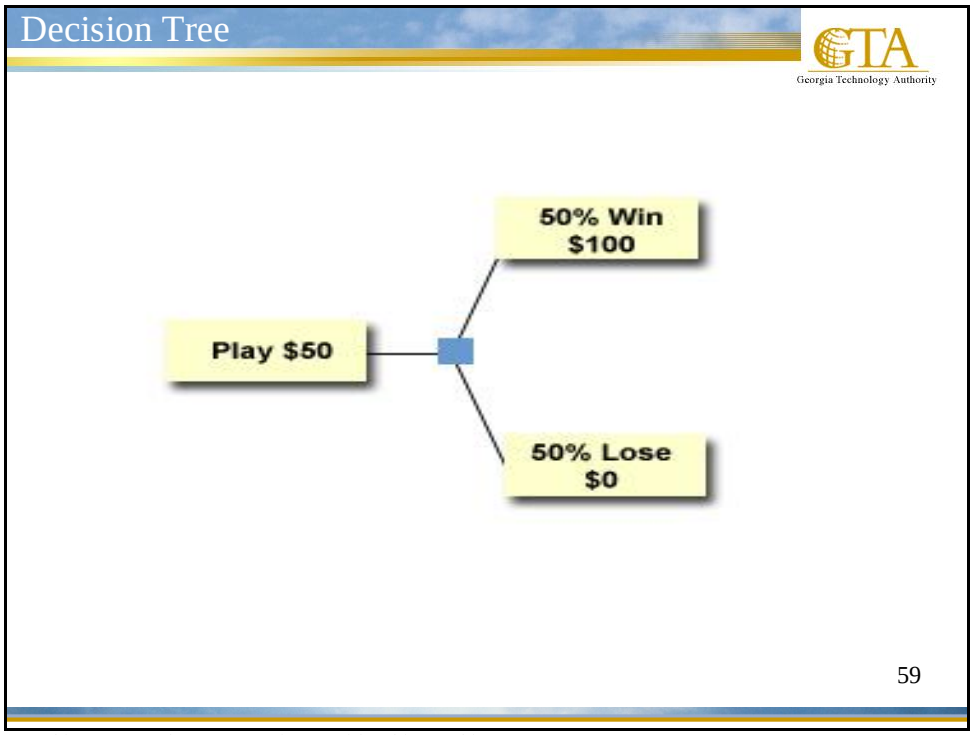
Surveys are quantitative information collection techniques used in marketing, political polling, and social science research. All surveys involve questions of some sort. When the questions are administered by a researcher, the survey is called an interview or a researcher-administered survey. When the questions are administered by the respondent, the survey is referred to as a questionnaire or a self-administered survey.

Topic 3: Quantitative Risk Analysis (cont'd)

Most people do not participate in **public hearings**. Public participation is generally limited to people who feel strongly about the project or who enjoy public speaking in which they have to address the assembly.

Workshops give a better idea of public opinion and are more helpful in developing logical arguments and alternatives.

Topic 3: Quantitative Risk Analysis (cont'd)



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Decision Trees

Decision trees are used to select the best course of action in situations where you face uncertainty. For example:

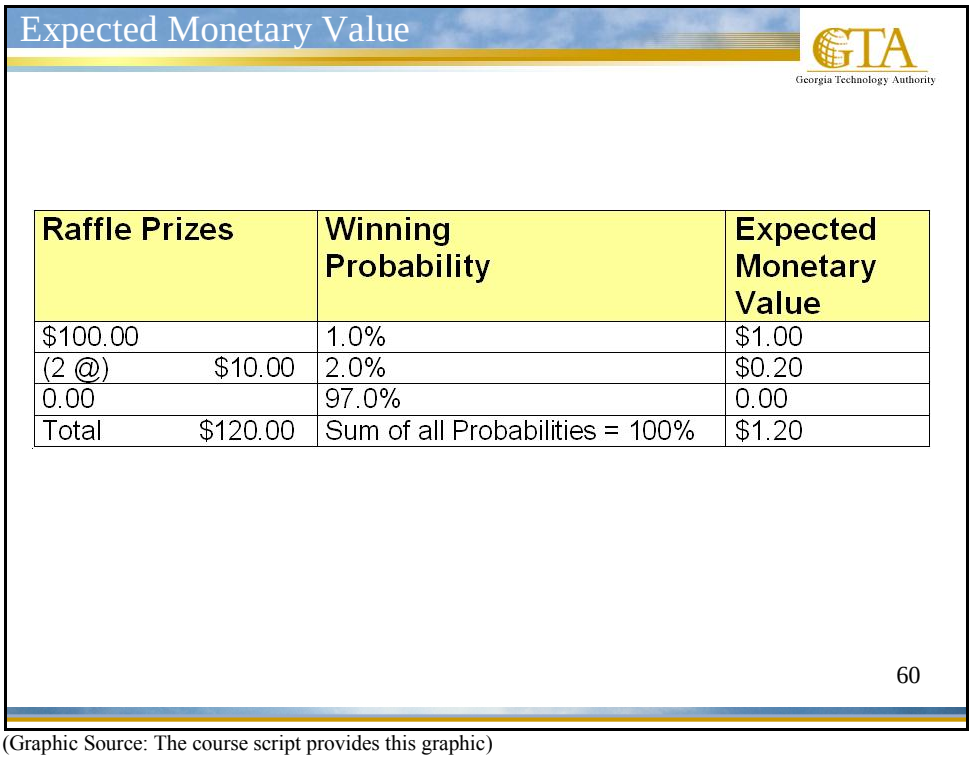
- a project manager may need to establish how much inventory is required for the Georgia rail system before knowing precisely what level of demand there will be
- a technical project may have to choose between maintaining an older technology or leasing a new system (if the project stays with the older technology, it may risk serious technical flaws)
- a speculator must decide to buy an asset before knowing if it can be sold for a profit

In all of these cases, the decision-maker faces an unknown that seems to make it difficult to choose the **right option** with any certainty.

Although the decision-maker does not know what the outcome of the unknown will be, he or she generally has some knowledge about what the possible outcomes are and how likely each is to occur.

This information can be used to select the option that is most likely to yield favorable results. **Decision trees** are the structure, using the concept of **Expected Monetary Value (EMV)** that makes this type of analysis easy to apply.

Topic 3: Quantitative Risk Analysis (cont'd)

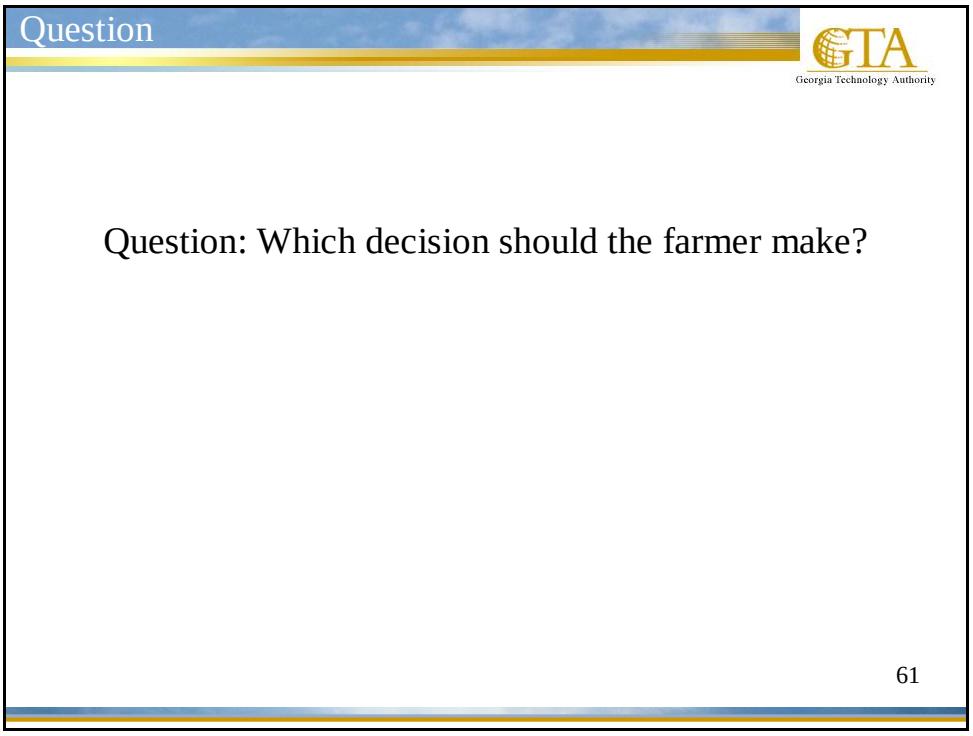


(Graphic Source: The course script provides this graphic)

Expected Monetary Value is the product of an event's probability of occurrence and the loss or gain that will result. Here is an example of a single, independent risk:

there is a 50% probability of a snow storm, and snow will result in a $10,000 loss
the expected monetary value of the snow event is $5,000 (0.5 * $10,000)

Topic 3: Exercise – Georgia Apple Orchard



A Georgia farmer needs to make a decision. His orchard is expected to produce 100,000 bushels of peaches, which he wishes to sell to a large grocery chain at $15 per bushel as 'Grade A' peaches.

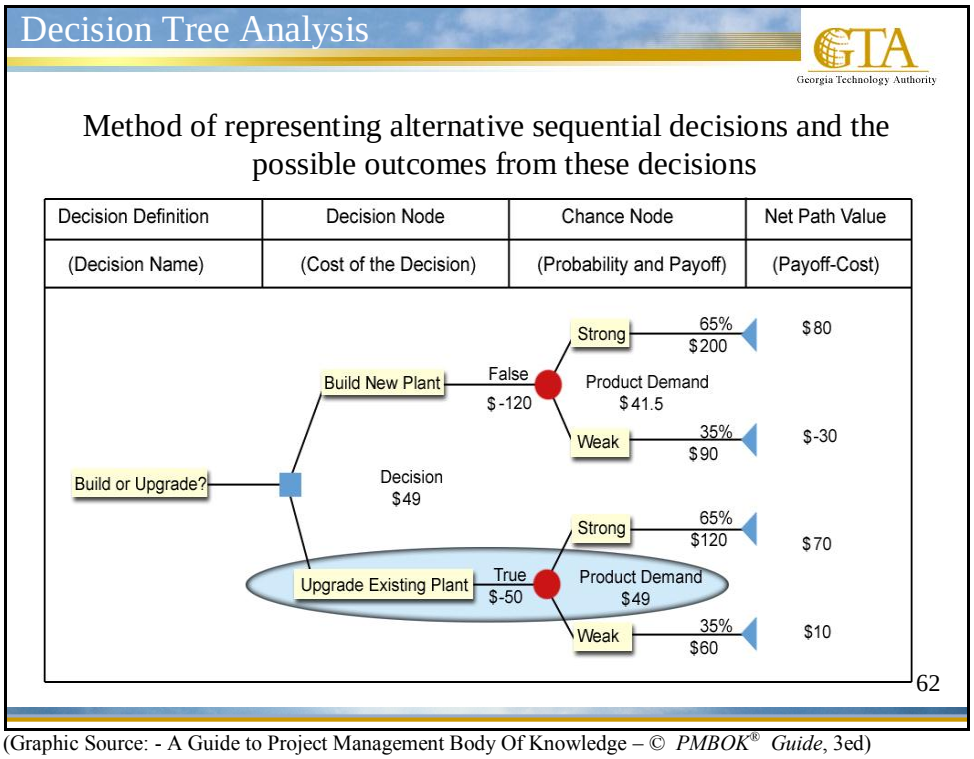
However, he has great concern about the possibility of early frost damaging his crop. For three of the past five years, the western part of the state where the farmer lives has suffered severe frost.

The Department of Agriculture's figures show that the probability of early frost in the orchard area in any given year is 20%. If his crop is damaged, it would not be marketable as fresh fruit and he would have to sell it to a cannery in Alabama for $3.00 per bushel.

He could purchase insurance which would ensure that if his peaches were damaged, he could sell the total crop (both damaged and good fruit) to the insurance company for $7.00 per bushel. The cost of the insurance would be $50,000. What are the monetary expectations of the farmer's decision to purchase or to not purchase insurance?

Exercise Worksheet

Topic 3: Quantitative Risk Analysis (cont'd)



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Decision Tree Analysis

A decision tree is a diagram that describes a decision under consideration. It is used to assess the implications of choosing one or another of the available alternatives. It incorporates probabilities or risks and the costs or rewards of each logical path of events and future decisions.

The decision tree diagram incorporates the cost of each choice, the probabilities of each possible scenario, and the rewards of each alternative logical path. It is usually drawn chronologically from left to right and branches out, like a tree lying on its side.

The decision tree diagram consists of three types of nodes:

Node type	**Indicated in diagram by**	**Represents**
Decision	Squares	Variables/actions that decision maker controls
Chance event	Circles	Variables/events that decision maker cannot control
Terminal/End	Unconnected branches	Endpoints where outcome values are attached

The decision node is called the root. The radial lines in the diagram are called the branches or twigs, and the terminal nodes are called leaves.

Topic 3: Quantitative Risk Analysis (cont'd)

Several values are reflected in the diagram. These include PV, EV, EU, and CE:

- present value (PV) is the sum of discounted cash flow values. The discount rate represents policy or attitude toward time preference of money.

- expected value (EV) is a probability weighted average of all possible outcomes. Where the outcome is measured in monetary terms, the term is usually called expected monetary value (EMV).

  An example of EMV is $49 for the product demand when the existing plant is upgrade

  In the public review example, the EMV for the upgrade option is $49 whereas the EMV for the build option is $41.5. A comparison of these two figures shows that the upgrade option is more advantageous because of the increased average of all possible outcomes

- expected utility (EU) denotes expected value utility, where utility is typically the risk-attitude-adjusted NPV (net present value), transformed with a utility function.

  Where there is a unanimous desire for one option over another, the EU for that option is 1. For example, if all stakeholders wanted to upgrade the existing plant and there is no desire for building a new plant, the upgrade has a utility of 1 and the new plant has a utility of 0.

- certainty equivalent (CE) is the amount, known with certainty, a decision maker would be just willing to exchange for an uncertain gamble. The difference between CE and EMV is the risk premium, or risk penalty.

  As an example, if the decision maker knew they were $43 from keeping the production as it is, would they be willing to gamble? The value of $43 is the certainty equivalent

There are three types of numbers used to label the diagram:

- probabilities are assigned to each outcome branch originating from chance nodes.

- outcome values represent present values (PVs) of resulting cash-flow stream, discounted to the date of the root decision. These values can be placed along the branches, or the entire outcome can be displayed at the terminal node.

- expected values (EV) are calculated during the decision process and displayed at each node. Examples of EVs include expected monetary value (EMV), expected (value) utility (EU), and certainty equivalent (CE).

Solving a decision tree involves quantifying uncertain implications, costs, rewards, and subsequent decisions. Starting at the terminal nodes, you calculate the EV of each node in the diagram and label it – for example, you can use a dollar value when calculating EMV or EV costs.

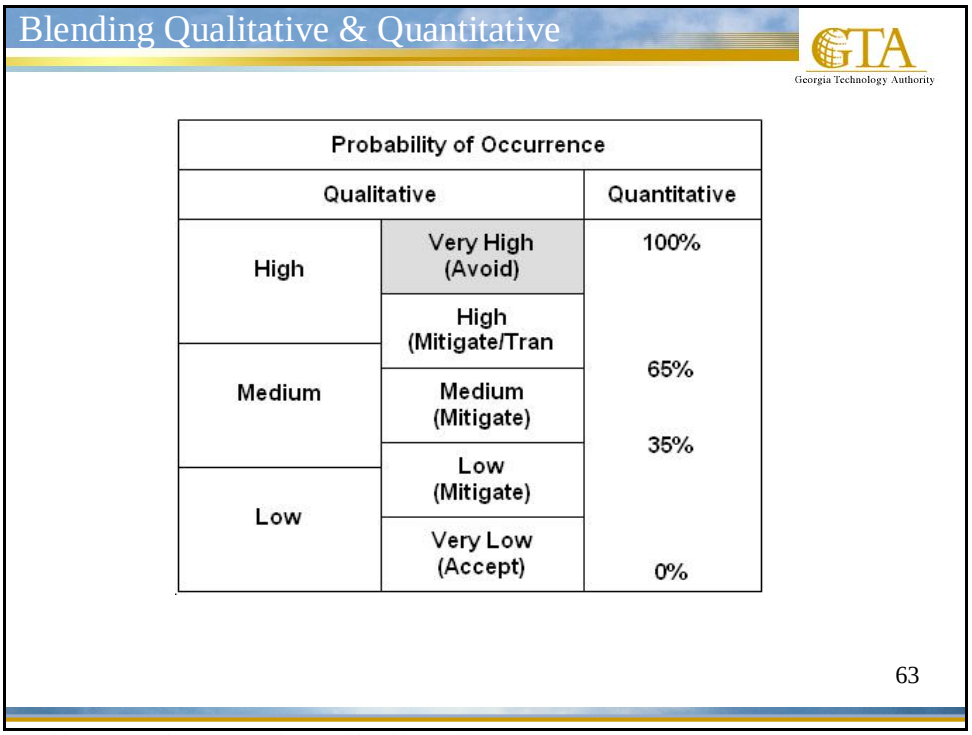
Topic 3: Quantitative Risk Analysis (cont'd)

There are three simple rules to keep in mind when solving a decision tree:

- at a chance node, calculate its EMV (or EV cost) from the probabilities and values of each alternative branch. Label the node with this value.
- at a decision node, label it with the value of its best alternative (using the EMV decision rule).
- if a cost lies along a branch, factor in the cost when passing from right to left – that is, subtract the cost to maximize EMV. (If a tree is designed to solve EV costs, then add the cost along the branch.)

Decision tree analysis is best suited for everyday problems where you want to pick the best alternative quickly.

Topic 3: Quantitative Risk Analysis (cont'd)



(Graphic Source: The course script provides this graphic)

Organizations may have several different factors to considering when deciding what makes a risk high, medium or low. Consequently they require definitions to ensure the same criteria and interpretation are applied to each analyzed risk.

Some general definitions which can be applied or modify to conduct project risk evaluation are as follows:

- **high risk** – a risk that is very likely to adversely impact the schedule, drive costs up or drive quality down. Under these conditions, close project monitoring and contractor or vendor involvement will not change the course of events.
- **medium risk** – a risk that has the potential to affect the schedule, drive project costs up or the quality of deliverable down. Under these conditions, close project monitoring and contractor or vendor involvement will overcome the difficulties.
- **low risk** – a risk with a very low potential to cause measurable effects on the schedule, costs, or the quality of deliverables. Normal project management controls and contractor or vendor involvement will probably overcome difficulties.

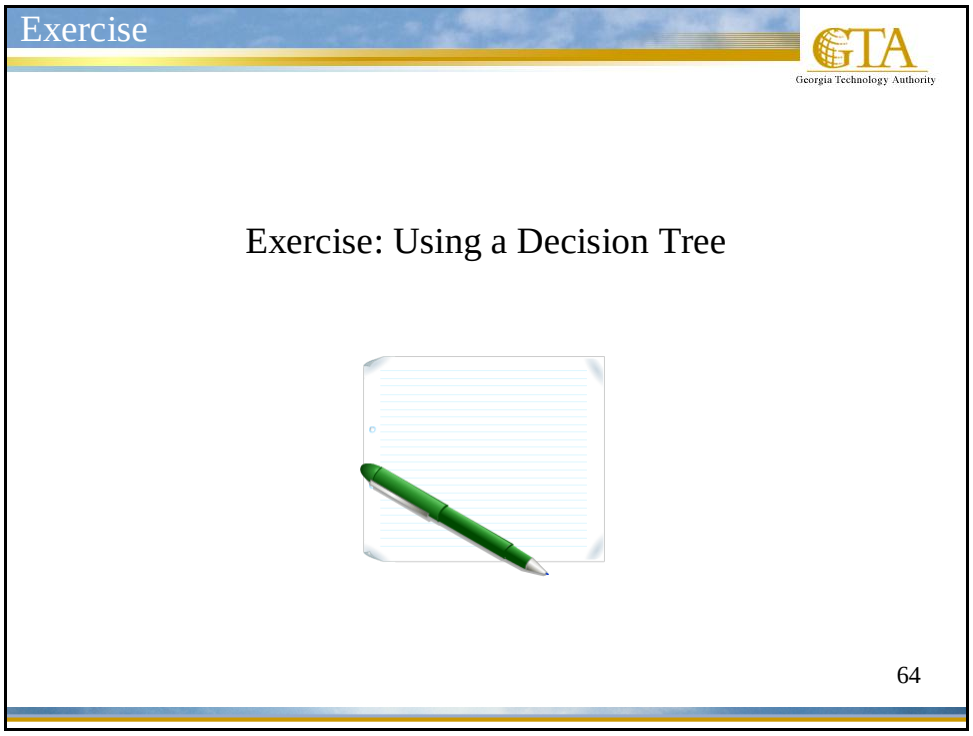
In addition to having definitions for qualitative risk evaluation, the organization needs to determine what percentage constitutes the probabilities from a **low** to a **high** risk rating. This decision is driven by risk tolerance.

Topic 3: Quantitative Risk Analysis (cont'd)

For example, an organization that is a risk taker may establish a limit of **high** probability of occurrence at 45%, while a risk adverse organization may choose to classify risks with a 25% probability of occurrence as **high.**

In other words, the blending of **qualitative** and **quantitative** risk assessment will be driven by the organizational risk tolerance.

Topic 3: Exercise: Using a Decision Tree



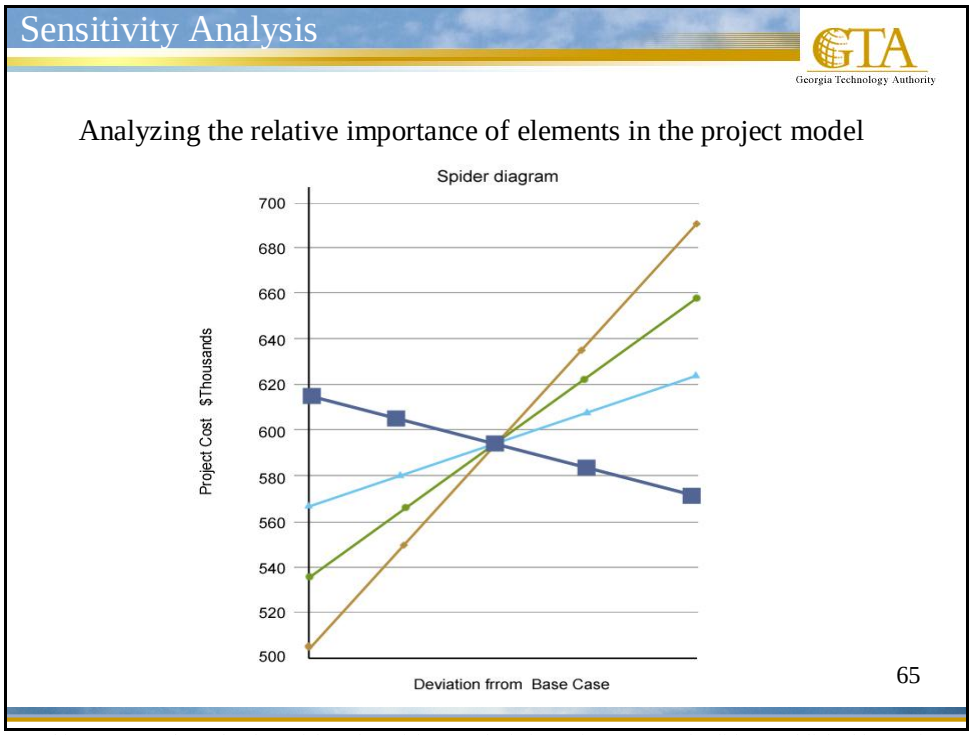
You are part of the assembled dedicated risk management team for the Georgia Light Rail system. Your team has delivered a risk management plan to the project stakeholders. The same stakeholders are looking at a particular situation and want your team to assess the alternatives.

The type of light rail carriage is being examined. One option is to go for a new toughened steel chassis with reinforced glass. The other option is to use a fiber type chassis, which will enhance the lightness of the carriages. The steel option, at a cost of $20 million, is durable but is also prone to operational damages; the probability of this occurring is 60% with estimated costs of $3 million over five years of operation. The fiber carriages, at a cost of $30 million, show a 50% probability of saving the state authority $10 million over the next five years. These savings are associated with reduced maintenance and increased durability.

Which alternative would you recommend? Use a decision tree to determine the best alternative.

Exercise Worksheet

Topic 3: Quantitative Risk Analysis (cont'd)



(Graphic Source: John Schuyler; Risk and Decision Analysis in Projects; Second Edition; Published by Project Management Institute, © 2001)

Sensitivity Analysis

Sensitivity analysis is the process of analyzing the relative importance of elements in the project model. Its function is to

- identify **key variables** that require **special attention**
- provide information to validate a presentation and **recommendation**

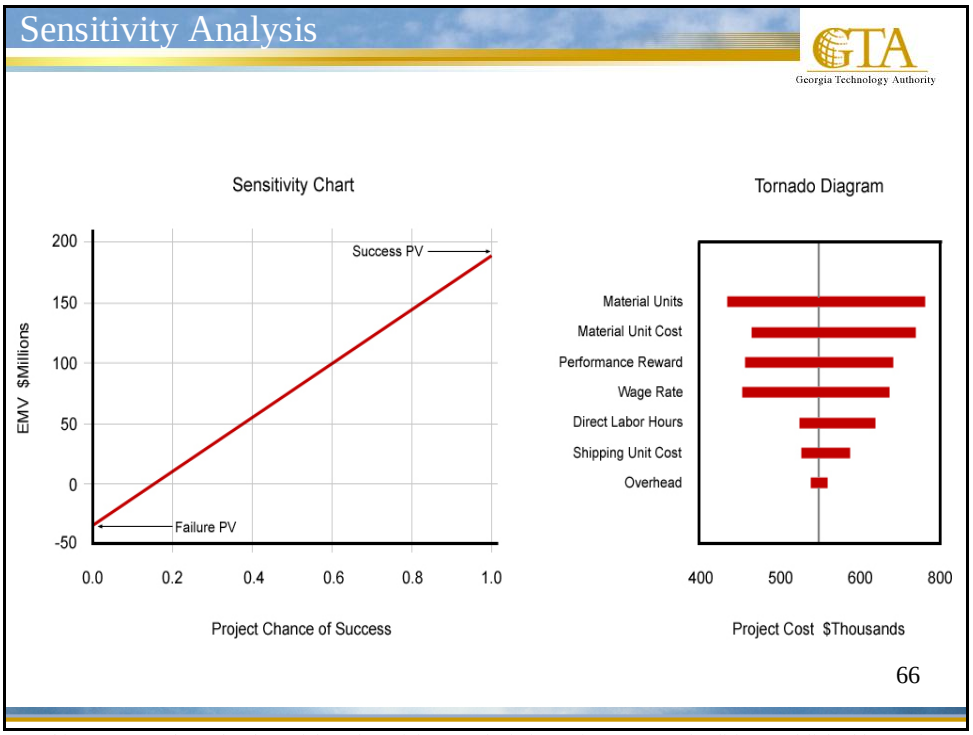
The simplest application of sensitivity analysis is to make alternative "what-if" trials of a deterministic model by making changes (in a step manner) in one or more chance or decision variables. (Typically, over 90% of uncertainty in outcome value is caused by two to five input variables.) This form of sensitivity analysis is easy to perform because only one variable is changed at a time and it does not involve probabilities. It can be represented by a

- **spider diagram**
- **sensitivity chart**
- **tornado diagram**

In a **spider diagram**, the *x*-axis is a factor deviation from the base case. The *y*-axis can be any dependent parameter, although the outcome value measure is most meaningful. In the example shown, the more sensitive the model to a variable, the steeper the slope.

Spider diagrams are a useful way to present simple sensitivity analysis. However, they do have one drawback – percent deviations do not indicate the *range* of uncertainty for each variable.

Topic 3: Quantitative Risk Analysis (cont'd)

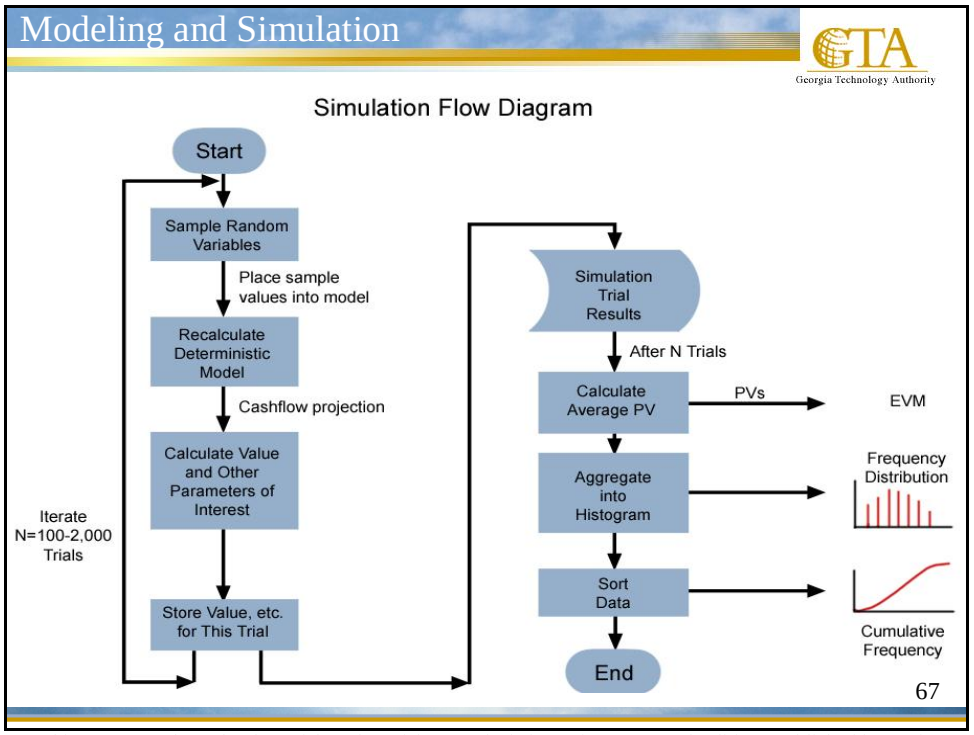


(Graphic Source: John Schuyler; Risk and Decision Analysis in Projects; Second Edition; Published by Project Management Institute, © 2001)

Sensitivity charts are used to estimate the sensitivity of single variables. Essentially, they are single-variable spider diagrams.

A **tornado diagram** is a more popular form of sensitivity graph. It expresses the combined effect of the variable range and model sensitivity to that variable. We run alternative what-if cases, changing one variable at a time to a low confidence bound (e.g. 10%) and then to a high confidence bound (e.g. 90%). The graph illustrated prioritizes variables in sequence of importance, according to the range of the resulting outcome values. When the graph is oriented in the manner shown, it resembles a tornado.

Topic 3: Quantitative Risk Analysis (cont'd)



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Modeling and Simulation

Simulation refers to any analytical method used to imitate a real-life system. It is undertaken when other analyses are too mathematically complex or too difficult to reproduce. While decision tree analysis is a simple method of predicting a scenario, often the depth of analysis required is too complex for the decision tree method, and so in its place simulation tools and techniques are employed

Simulation elements include

- a model that projects outcomes and outcome values (with the decision tree model, this outcome is termed as the EMV)
- a technique that repeatedly generates scenarios (trials) that are based on randomly sampling input probability distributions

One type of simulation is the **Monte Carlo simulation**, which randomly and repeatedly generates values for uncertain variables to simulate a model. The technique is frequently used to solve EV, the probability-weighted average of a probability distribution. A valuable side benefit of this is that we can also easily obtain approximate outcome probability distribution shapes.

Take the scenario presented in the decision tree for the Georgia Light Rail project, where the light rail carriage is being examined. One option is to go for a new toughened steel chassis with reinforced glass. The steel option, at a cost of $20 million, is durable but is also prone to operational damages. The probability of this occurring is 60%, with estimated costs of $3 million over five years of operation.

Topic 3: Quantitative Risk Analysis (cont'd)

However if the probability of damages varies from 30% to 80%; the scenario becomes complex, and difficult to present clearly in a decision tree. Instead, Monte Carlo simulation can generate random numbers between the two extremes and generate the expected probability for damages.

In the example shown in the slide, each scenario/trial is a pass through the steps at the left, and generates a possible case for the behavior of the project. A typical sequence of steps might be as follows:

- step 1: sample **probability distributions** representing the several random variables – the probability of damages from 30% to 80%
- step 2: substitute the **trial values of the random variables** into the deterministic model. Re-solve the model, obtaining project results and outcome values. Enter these values (representing the probability of damages) into the simulation model. This generates the expected probability with a request to repeat the experiment a number of times (i.e. 100 times)
- step 3: store pre-selected **outcome values**, such as time and cost to complete, in a data file
- step 4: **return to step 1** and repeat until the number of trials is sufficient to provide the required level of precision – repeat the experiment 1000 times to increase the accuracy of the result
- step 5: analyze the stored results

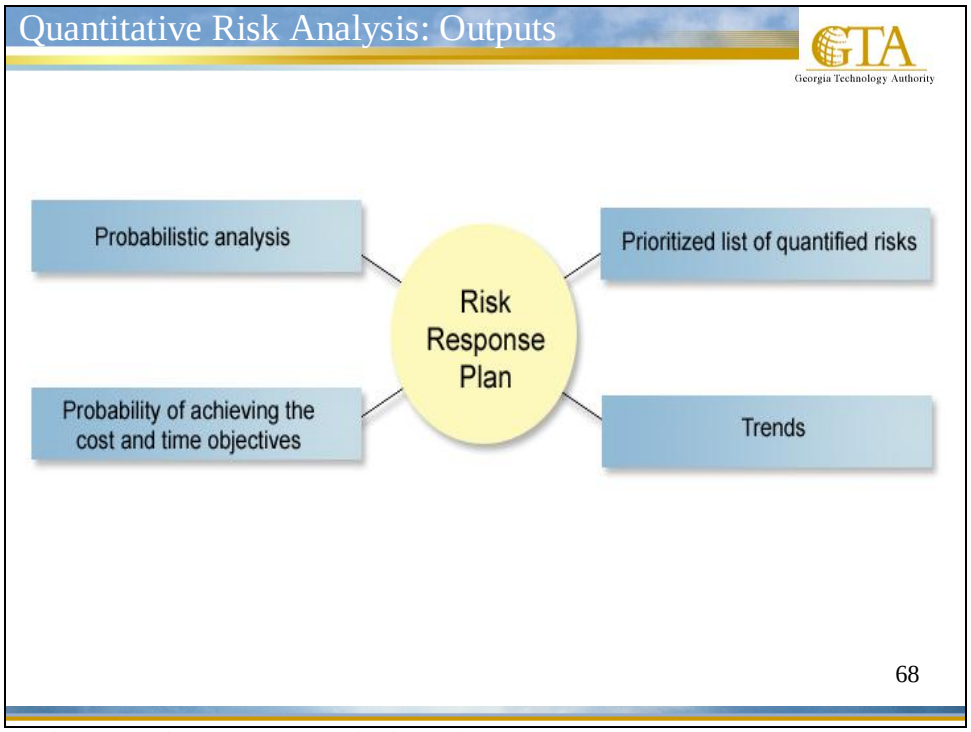
The program generates many cases, until a predetermined number of trials or a stopping rule is satisfied. Typically, several hundred trials are necessary to obtain enough data for reasonable precision in the **EV calculation.**

Although the **EMV** may be sufficient information for decision making, it is good practice to include the PV in the analysis presentation. Two distribution formats are available:

- by aggregating PVs into groups, their values can be displayed as a frequency histogram. This provides the approximate shape of the PV probability (density) function.
- by sorting PVs by magnitude, PV can be displayed as a function of rank, yielding the cumulative frequency distribution.

These frequency distributions approximate the shape of the solution probability distributions.

Topic 3: Quantitative Risk Analysis (cont'd)

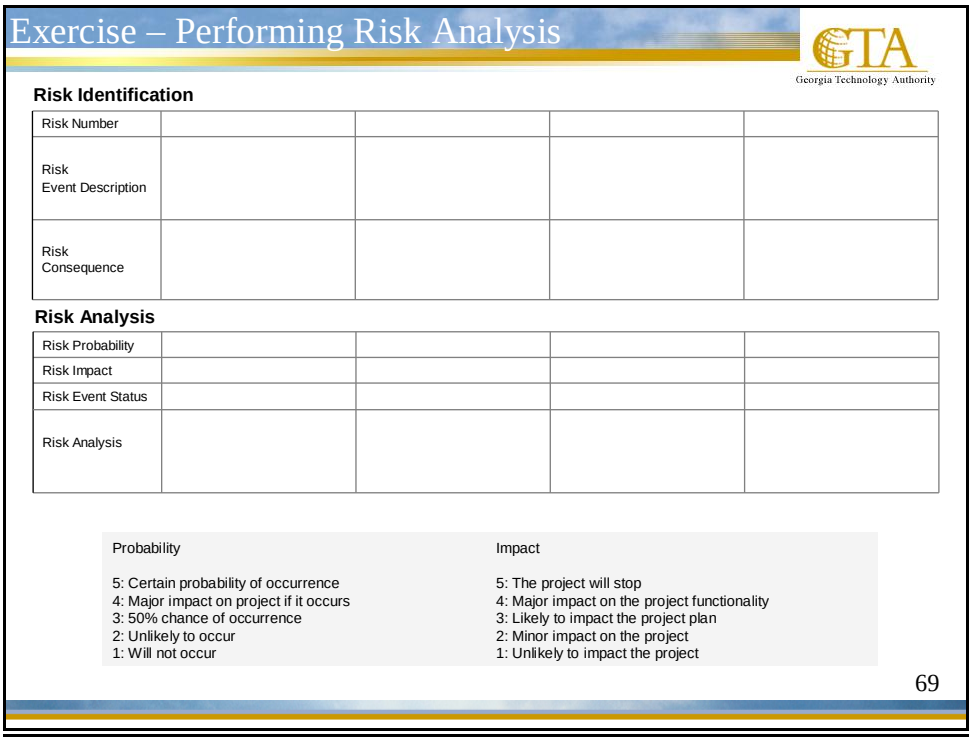


(Graphic Source: The course script provides this graphic)

In quantitative risk analysis, the risk response plan is updated with the following components:

- **probabilistic analysis** of the project, which defines estimates for potential project schedule and cost outcomes, with an associated confidence level of achieving each one
- **probability of achieving the cost and time objectives**, which is based on the current plan and the risks facing the project
- **prioritized list of quantified risks**, which indicates the greatest threats or greatest opportunities to the project
- **trends** in quantitative risk analysis results, which can affect risk responses

Topic 4: Exercise – Performing Risk Analysis



This is an example of a risk analysis template, with a risk identification template also displayed.

In this exercise, you have a list of some apparent risks that need to be logged. You are tasked with putting a risk response plan together to analyze each of the risks.

Exercise Worksheet

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects.	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail/construction projects. Furthermore, the scale of the project is bigger than any other project undertaken by the state of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. Although the current list of preferred contractors has a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the life cycle of the "full" project, it may be that officials in the state authority will change. This could impact on the level of support the project will receive.	Although the project management team is experienced in light-rail projects, the functional expertise may require a learning curve during the pilot scheme, which will result in cost and time over-runs.
Probability (P)				
Impact (I)				
Risk Event Status (P * I)				
Quantitative Analysis				

Probability	**Impact**
5: Certain probability of occurrence	5: The project will stop
4: Major impact on project if it occurs	4: Major impact on the project functionality
3: 50% chance of occurrence	3: Likely to impact the project plan
2: Unlikely to occur	2: Minor impact on the project
1: Will not occur	1: Unlikely to impact the project

Lesson 3: Summary

The lesson is now completed and the following topics have been covered:

Topic 1: Structuring Risk Analysis

- Risk analysis can be carried out using a **qualitative** or **quantitative** approach.

- **Qualitative risk analysis** prioritizes risks based on their potential effect on project objectives. It generates several outputs including a list of prioritized risks, a list of risks that require additional analysis and management, and an indication of any trends that may be emerging in the project.

- The aim of **quantitative risk analysis** is to analyze numerically the probability of each risk occurring and assess the consequence on project objectives.

From this topic you should **take away** the following:

- an ability to identify qualitative risk analysis and quantitative risk analysis
- an understanding of the differences and similarities between them

Topic 2: Probability and Impact Assessment

- The main techniques used in **qualitative risk analysis** are
  - **risk probability –** describes the likelihood of a risk occurring
  - **impact assessment –** describes the effect a risk will have if it occurs on a project objective.

- A risk matrix is used to combine probability and impact to yield the **risk event status**. The matrix specifies descriptive terms or numeric values for the probability and impact of a risk(s).

From this topic you should **take away** the following:

- an understanding of what qualitative risk analysis is
- an understanding of how risk is presented in a risk matrix

Topic 3: Quantitative Risk Analysis

- Quantitative risk analysis tools are used to assess risks against the project objectives. These tools include
  - **decision trees –** these are diagrams that describe a decision under consideration. They incorporate probabilities or risks and the costs or rewards of each logical path of events and future decisions.
  - **EMV** – the concept of **Expected Monetary Value (EMV)** makes decision tree analysis easy to apply. **Expected Monetary Value** is the product of an event's probability of occurrence and the loss or gain that will result.
  - s**ensitivity analysis** – this is the process of analyzing the relative importance of elements in the project model. It can be represented by a **spider diagram,** a **sensitivity chart** or a **tornado diagram.**
  - **simulation** – this refers to any analytical method used to imitate a real-life system. It is undertaken when other analyses are too mathematically complex or too difficult to reproduce.
  - **Monte Carlo simulation –** this is a simulation method that randomly and repeatedly generates values for uncertain variables to simulate a model.

From this topic you should **take away** the following:

- an understanding of the application of decision trees using the concept of earned monetary value (EMV)
- the ability to update the risk response plan with probabilistic analysis of the project, probability of achieving the cost and time objectives, prioritized list of quantified risks and any trends in analysis results

Topic 4: Performing Risk Analysis

- An exercise is presented to demonstrate how to present a completed risk response plan

From this topic you should **take away** the following:

- an ability to update the risk response plan with information detailing what needs to be done to respond to the risk, using qualitative and quantitative risk analysis techniques

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Lesson 4: Responding to Risk

Topic 1: Identifying Risk Response Strategies

Topic 2: Risk Simulation in Practice

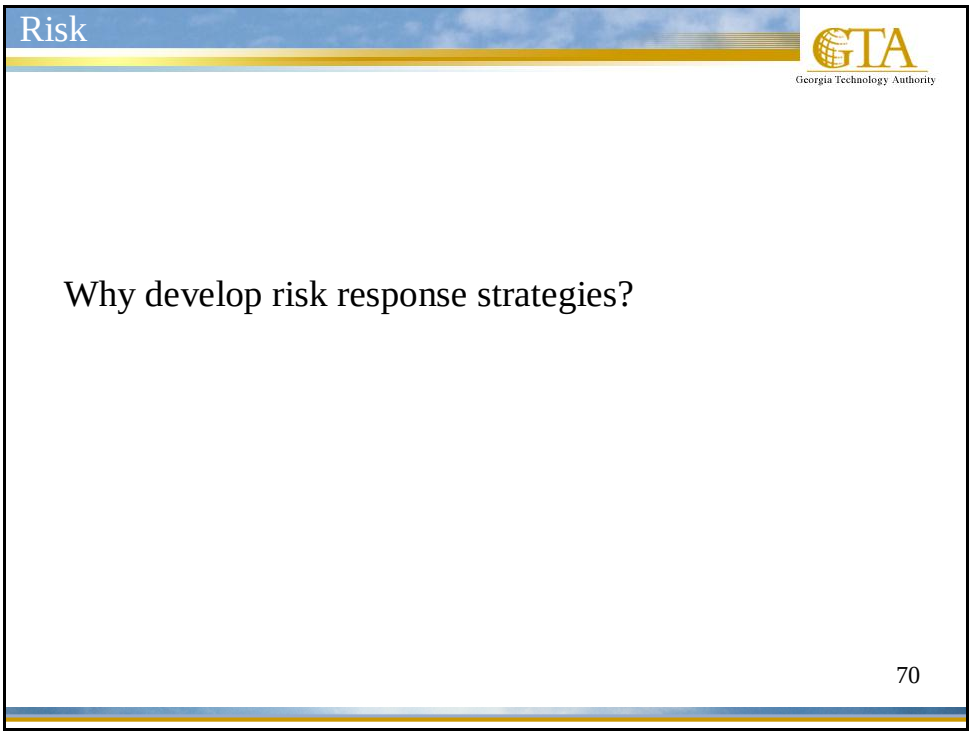
Topic 3: Responding to Analyzed Risk

Student learning objectives

After completing this lesson, you should be able to

- discuss risk response strategies
- describe the principles behind risk simulation
- identify appropriate response strategies based on analyzed risks

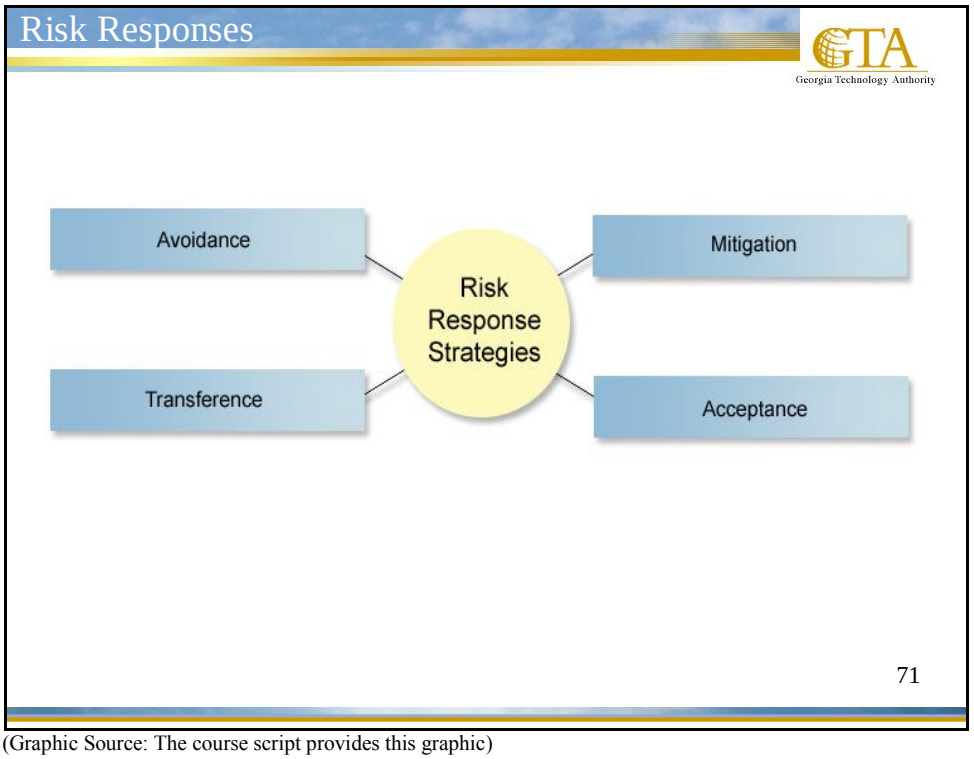
Topic 1: Identifying Risk Response Strategies



Risk response deals with identifying strategies and developing plans to address risk in the event of it occurring.

In developing risk responses, the project team should come up with as many responses as possible. Once each risk has been analyzed & responses developed, the project team may then select those responses which will offer the greatest benefit to the project.

Topic 1: Identifying Risk Response Strategies (cont'd)



(Graphic Source: The course script provides this graphic)

There are several risk response strategies available to project managers, each of which requires specific actions to be developed to implement the strategy.

Avoidance

Risk avoidance involves altering the project plan to eliminate the risk or to protect the project objectives from the risk's impact. Specific risks identified early in a project can be dealt with by clarifying requirements, obtaining information, improving communication, or acquiring expertise. Examples of risk avoidance strategies include **reducing scope to avoid high-risk activities**, adding resources, adopting a cautious rather than innovative approach, or avoiding an unfamiliar subcontractor.

Transference

Risk transfer is attempting to **shift risk impact and risk response ownership to a third party** – without eliminating the risk. Risk transfer is generally most effective when dealing with financial risk exposure and involves the payment of a risk premium to the party taking on the risk. Examples of risk transfer include the use of insurance, performance bonds, warranties, and guarantees.

Mitigation

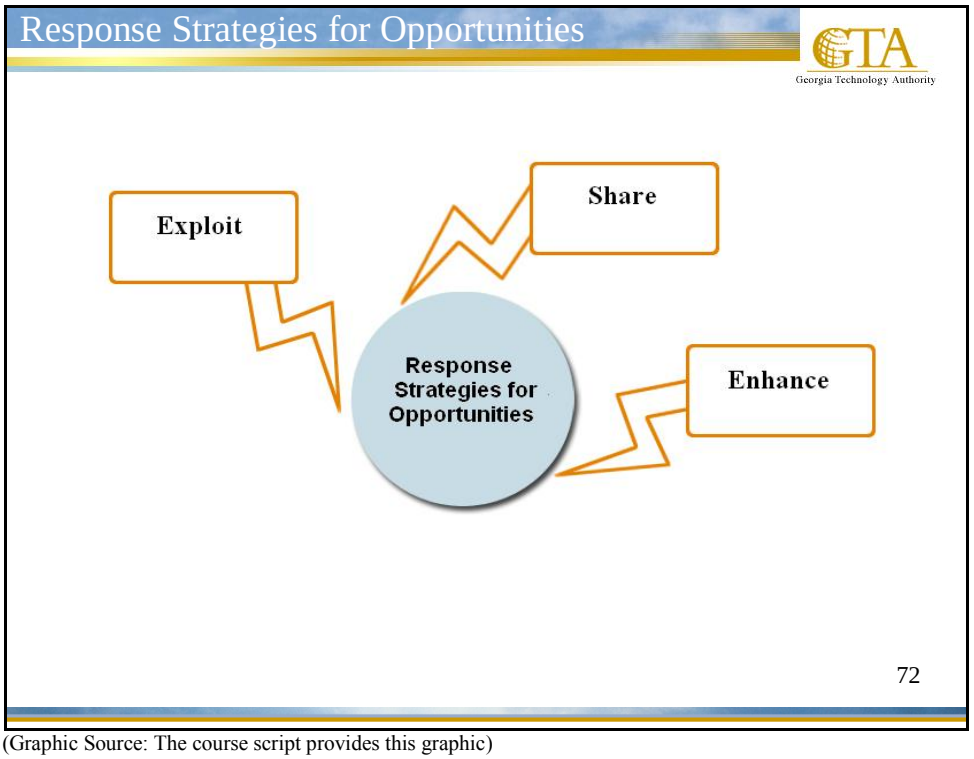
Risk mitigation involves attempting to **reduce the probability and/or impact of an adverse risk event to an acceptable threshold**. Taking early action to reduce the probability of a risk occurring is more effective than trying to repair any damage after it has occurred. Examples of risk mitigation include changing conditions to reduce risk by adding resources or time to a schedule or, where it isn't possible to reduce risk probability, targeting factors that determine the severity of risk impact.

Topic 1: Identifying Risk Response Strategies (cont'd)

Acceptance

Risk acceptance occurs when the project team decides not to change the project plan to deal with a risk, or when the team is unable to identify any other suitable response strategy. Active **acceptance involves developing a contingency plan that can be executed if a risk does occur**. In contrast, passive acceptance doesn't require any action, leaving the project team to deal with the risks as they occur. The most common risk acceptance response is to establish a contingency allowance that includes amounts of time, money, or resources to account for known risks.

Topic 1: Identifying Risk Response Strategies (cont'd)



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Project managers also need to consider the correct response strategy for dealing with positive risks (opportunities).

Exploit

Project managers use the **exploit strategy to eliminate the uncertainty** associated with a particular upside risk by making the opportunity definitely happen. An example of an exploiting response is assigning better resources to a project to reduce the time to completion or to provide better quality than originally planned.

Share

Sharing a positive risk means **sharing risk ownership** with a third party who is better placed to capture the opportunity for the benefit of the project. An example of a sharing action is forming a joint venture with a company that has the specialized skills to exploit a particular opportunity.

Enhance

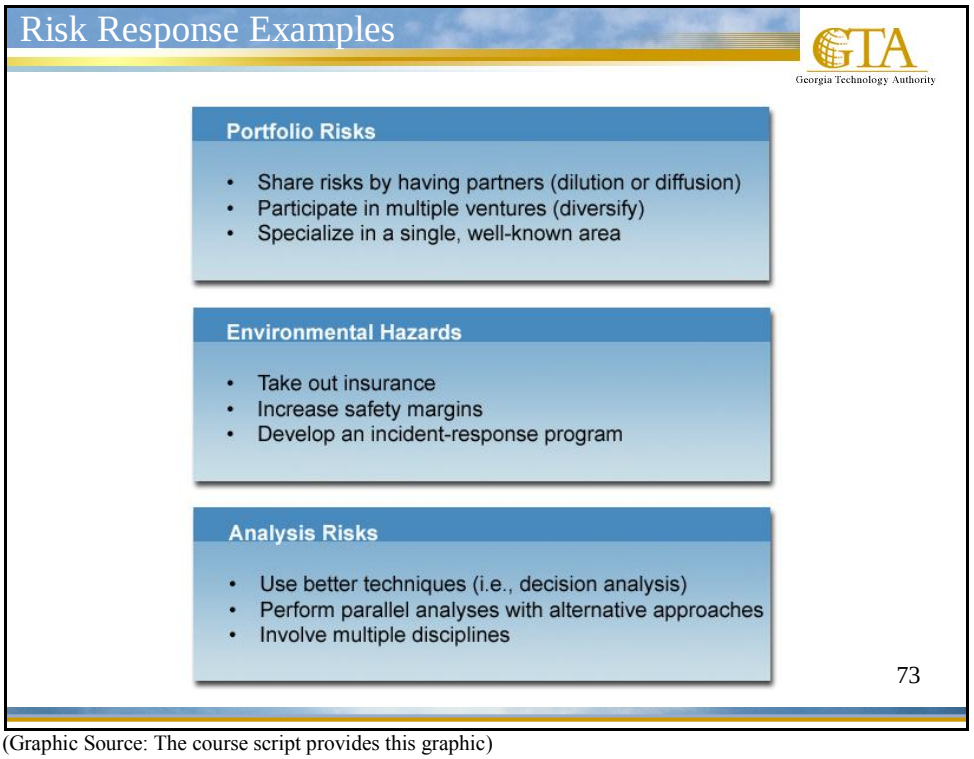
A risk enhancing strategy entails **modifying the "size" of an opportunity by increasing probability** and positive impacts, and by identifying and maximizing key drivers of these positive-impact risks.

An example of a risk enhancing strategy is a government IT project where the opportunity could be increased by using enhanced test procedures and equipment to validate new software. The opportunity is enhanced and the budget is increased.

Topic 1: Identifying Risk Response Strategies (cont'd)

Acceptance is represented as both positive and negative. Typically, a further strategy of acceptance can be adopted because it is usually impossible to remove all risk from a project. This strategy indicates that the project team has opted not to alter the project plan to deal with a risk or is unable to identify any other suitable response strategy. It may be adopted for either threats or opportunities. The most common risk acceptance response is to establish a contingency reserve that includes amounts of time, money and resources.

Topic 1: Identifying Risk Response Strategies (cont'd)



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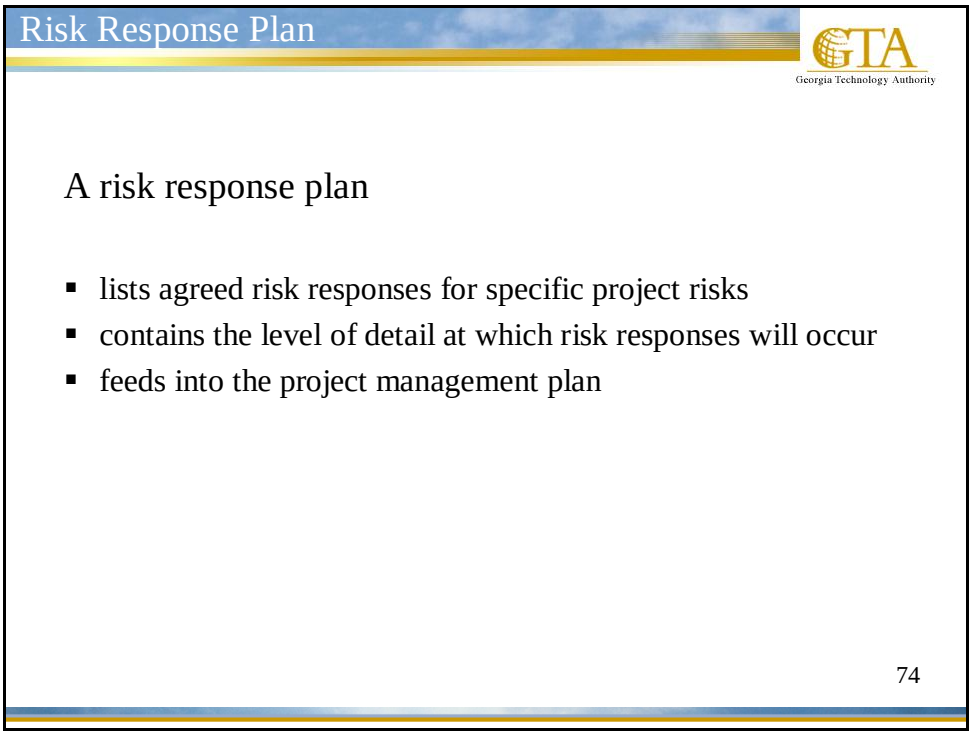
The slide lists sample strategies for avoiding, transferring, or mitigating risks for certain types of risks.

Topic 1: Identifying Risk Response Strategies (cont'd)



Risk Response Plan

A risk response plan lists agreed risk responses for specific project risks. Risk response plan updates become updates to the project management plan, which ensures that agreed actions are implemented and monitored as part of the ongoing project.

The **risk response plan** should contain the level detail at which risk response actions will be taken. The high and moderate risks are generally included in detail, whereas risks considered to be of low priority are included in a "watch list" for periodic monitoring.

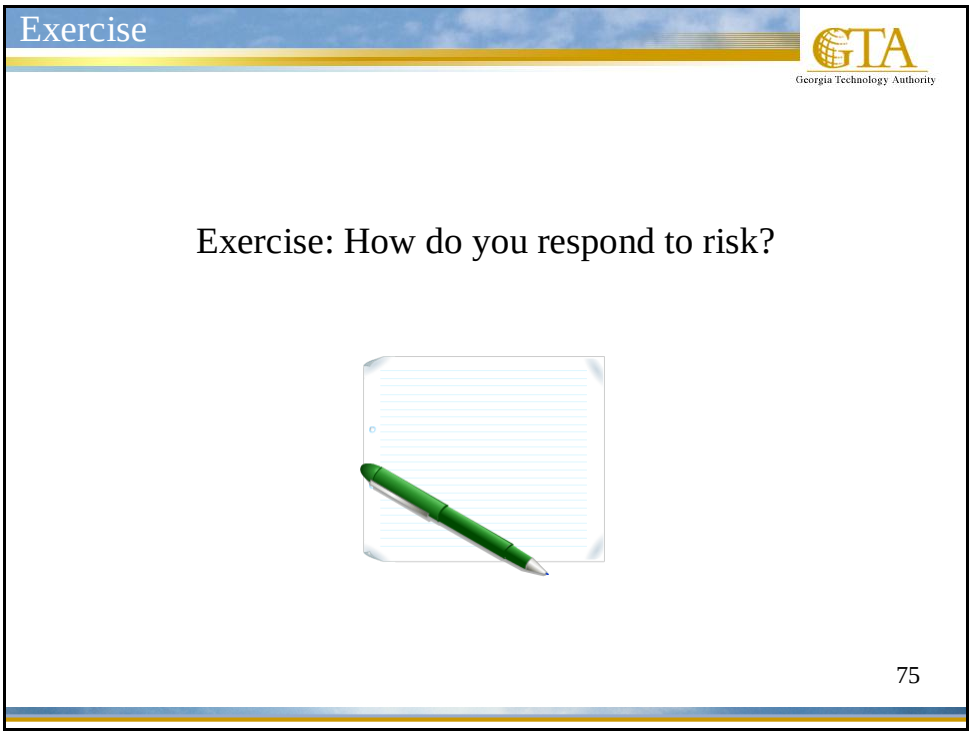
Components of the risk response plan include

- **identified risks**, their descriptions, the area(s) of the project affected, the cause of the risks, and how they may affect project objectives
- **risk owners** and assigned responsibilities
- **results** from the qualitative and quantitative risk analysis processes
- agreed **response strategies**
- **specific actions** to implement the response strategy
- level of **risk expected** to be remaining after the actions are implemented
- **budget and schedule activities** required to implement the chosen responses
- **contingency reverses** of time and cost designed to provide for stakeholders' risk tolerances
- contingency plans and **triggers** that call for their execution
- **fallback plans** for use as a reaction to a risk that has occurred. These are plans with specific actions that will be taken if the contingency plan is not effective.
- **residual risks** that may remain after planned responses have been taken
- **secondary risks** that arise as a direct result of implementing a risk response

Topic 1: Identifying Risk Response Strategies (cont'd)

Responses are developed for both threats and opportunities. The Risk Response Plan relies on the analysis and prioritization of identified risks. The project team as a whole should participate in developing response strategies, to ensure a common understanding of the responses and to attain buy-in from the participants.

Topic 1: Exercise – How Do You Respond To Risk?



The following is a list of risks. You are requested to identify an appropriate risk response strategy. It can be one for the following:

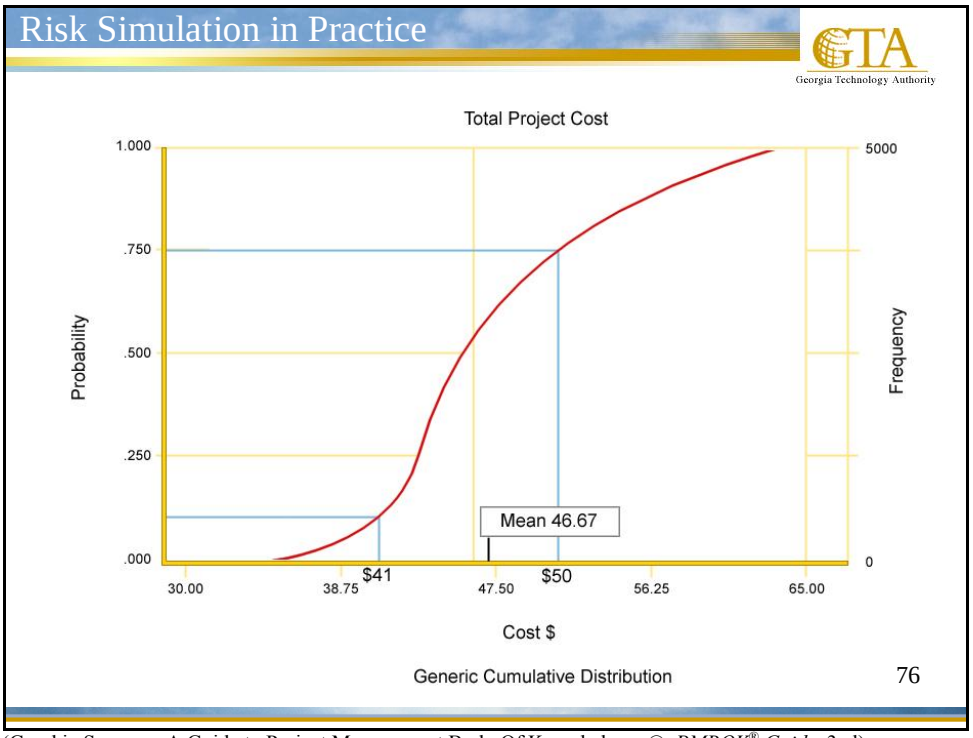
- avoidance
- mitigation
- transference
- acceptance

How would you respond to these risks? What is the specific response strategy in each case?

Exercise Worksheet

Types of Risks	Risk Responses	Response Strategy
Project risks associated with investment opportunities	• Share risks by having partners • Spread risks over time • Participate in many ventures • Seek lower risk ventures	
Risk associated with material prices	• Hedge or fix prices in the future markets • Use long-term and short-term sales contracts • Tailor contracts for appropriate risk sharing	
Environmental hazards	• Buy insurance • Increase safety margins • Develop and test an incident-response program	
Operational risks	• Hire contractors under turnkey project contracts • Tailor contracts for appropriate risk sharing • Acquire additional inventory and spares • Conduct tests, pilot programs, and trials • Increase training	

Topic 2: Risk Simulation in Practice



(Graphic Source: - A Guide to Project Management Body Of Knowledge – © *PMBOK® Guide*, 3ed)

Risk Simulation

Risk simulation uses a model to translate uncertainties identified at a detailed level into their potential impact on objectives expressed at the level of the total project. Simulations are generally performed using the **Monte Carlo technique**. Simulations often use the traditional project WBS as a model when conducting a cost risk analysis.

The slide illustrates a cost risk simulation result as a generic cumulative distribution that uses distribution curves. Simulation is an efficient way of calculating distribution curves for various outcome parameters of interest. Cumulative curves are generally used for comparing the risk-versus-value profiles of the different alternatives.

Monte Carlo simulation provides an alternative calculation method to decision tree analysis when there are

- many significant uncertainties and contingencies
- strategic decisions that involve a portfolio of projects
- outcome probability distributions are required to compare risk-versus-value profiles
- complex decision policies

However, decision tree analysis is better in situations that involve a sequence of decisions or low-probability events, or where a simple decision model is sufficient.

Topic 2: Risk Simulation in Practice (cont'd)

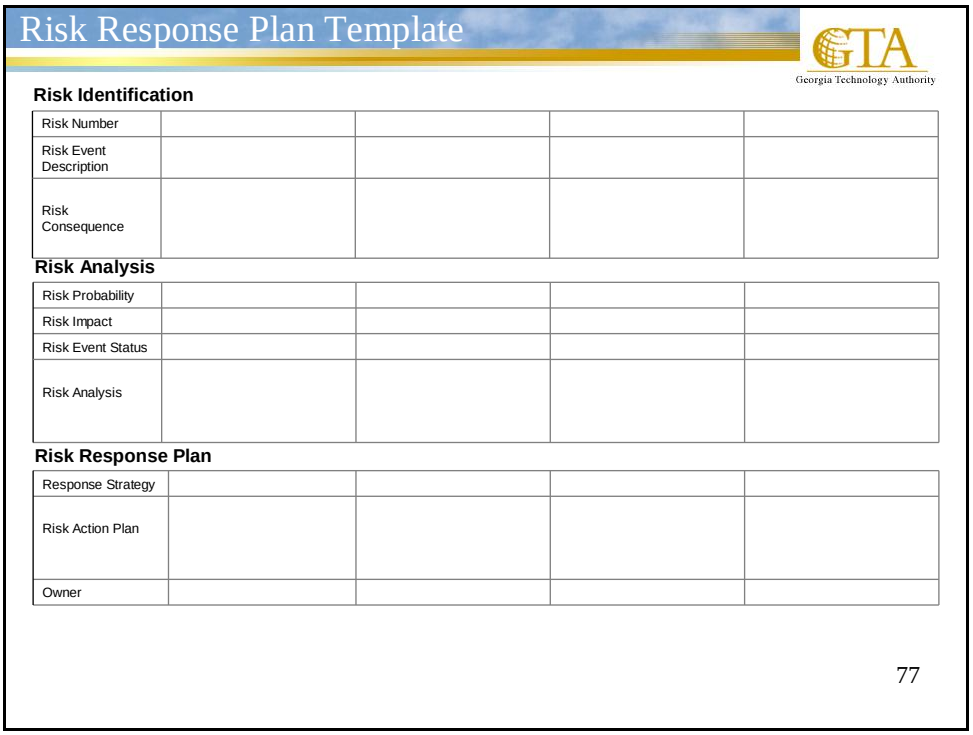
Simulation software tools include

- **Microsoft Excel** – the leading spreadsheet modeling platform
- **@RISK® by Palisade Corporation** – a Monte Carlo spreadsheet simulation add-in
- **Crystal Ball® by Decisioneering, Inc**. – a Monte Carlo spreadsheet simulation add-in

The Monte Carlo spreadsheet add-ins augment Excel capabilities by providing the following: sampling functions for popular and custom distribution shapes, correlation, control of the simulation run process, monitoring of convergence, and analysis of simulation results.

The decision tree analysis software tool **PrecisionTree by Palisade Corporation** builds the tree inside an Excel worksheet. The product is part of Palisade's DecisionTools Suite that includes **@RISK®**, and is ideal when project managers want to link simulation and decision tree analysis.

Topic 3: Exercise – Responding to Analyzed Risk



Based on the Georgia Rail Project case study, you need to put a risk response plan together that includes an analysis and response strategy for each risk.

Exercise Worksheet

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects.	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time.	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail/construction projects. Furthermore, the scale of the project is bigger than any other project undertaken by the state of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. Although the current list of preferred contractors has a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the life cycle of the "full" project, officials in the state authority may change. This could impact on the level of support the project will receive.	Although the project management team is experienced in light-rail projects, the functional expertise may require a learning curve during the pilot scheme, which will result in cost and time over-runs.
Probability (P)	5: There is a 100% chance of occurrence.	3: There is a 50% chance of occurrence.	3: There is a 50% chance of occurrence.	5: There is a 100% chance of occurrence.
Impact (I)	3: There is a 50% chance it will impact the project.	4: There is a major impact on the project if it occurs	2: The impact on the project is minor.	4: There is a major impact on the project if it occurs.
Risk Event Status (P * I)	15	12	6	20
Quantitative Analysis	The response is well understood in this case (i.e. training/involvement), so there may be no place for further analysis.	The response may be to look at other contractors, and these should be evaluated using sensitivity analysis.	This is a risk that may be accepted by the project, and no further analysis is required	Alternatives schemes/deployment could be investigated (use of decision trees/brainstorming to investigate).

Probability

5: Certain probability of occurrence
4: Major impact on project if it occurs
3: 50% chance of occurrence
2: Unlikely to occur
1: Will not occur

Impact

5: The project will stop
4: Major impact on the project functionality
3: Likely to impact the project plan
2: Minor impact on the project
1: Unlikely to impact the project

Exercise Worksheet

Response Strategy

Action Plan

Owner

Lesson 4: Summary

The lesson is now completed and the following topics have been covered:

Topic 1: Identifying Risk Response Strategies

- There are several risk response strategies available to project managers, each of which requires specific actions to be developed to implement the strategy. They include r**isk avoidance, transference, mitigation** and **acceptance.**

- When faced with positive risks (opportunities), project managers need to consider the correct response strategy – whether to exploit, share, or enhance the positive risk.

- A **risk response plan** lists agreed risk responses for specific project risks. The risk response plan should contain the level detail at which risk response actions will be taken. Responses are developed for both threats and opportunities

From this topic you should **take away** the following:

- an understanding of the various strategies that can be used when responding to risk
- an ability to apply a suitable response strategy given various scenarios

Topic 2: Risk Simulation in Practice

- **Risk simulations** are generally performed using the **Monte Carlo technique**. Several simulation software tools are available that will automatically perform the Monte Carlo technique.

From this topic you should **take away** the following:

- an understanding that simulation is computer based with some of the following packages being particularly useful; Microsoft Excel; @RISK® by Palisade Corporation or Crystal Ball® by Decisioneering, Inc.

Topic 3: Responding to Analyzed Risk

- An exercise is presented to demonstrate how to complete a risk response plan that includes an analysis and response strategy for each risk.

From this topic you should **take away** the following:

- an ability to update the risk response plan with information detailing what needs to be done to ensure a suitable response to specific risks

•

Lesson 5: Monitoring Risk

Topic 1: Monitoring and Controlling Risk

Topic 2: Risk Ownership and Action

Topic 3: Tracking the Action Plan

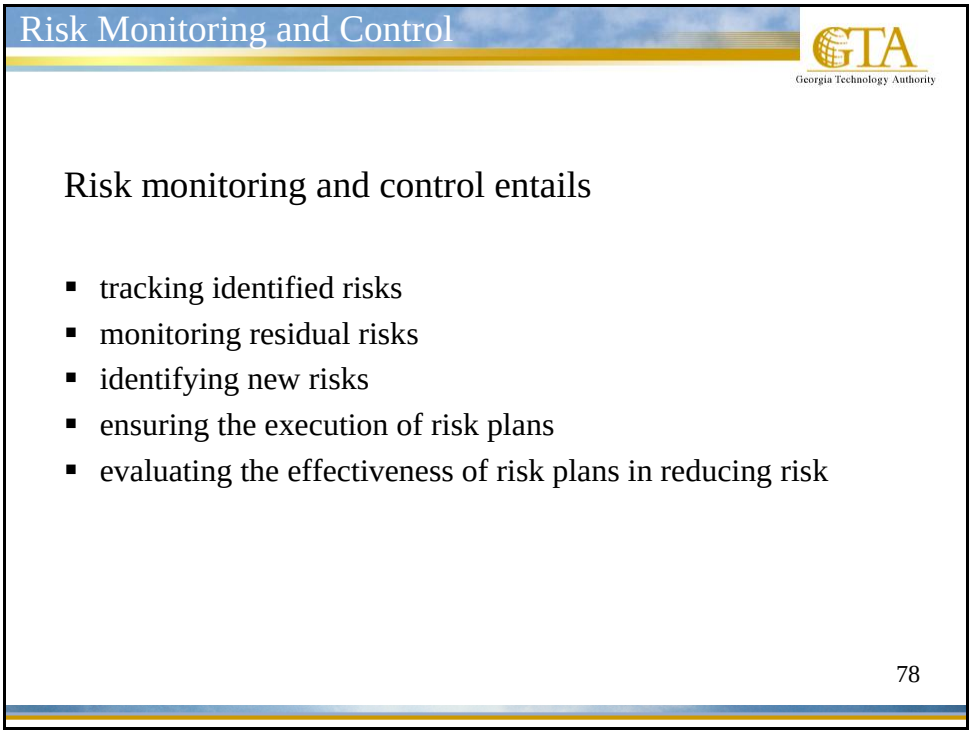
Topic 4: Presenting a Risk Response Plan

Student learning objectives

After completing this lesson, you should be able to

- recognize where and why risk monitoring is used
- explain the relevance of action plans as part of the risk management process
- identify the different tools and techniques that can be used to track a risk action plan
- identify appropriate actions for each risk presented in a case study and determine suitable ways of tracking those risks

Topic 1: Monitoring and Controlling Risk



Risk Monitoring and Control

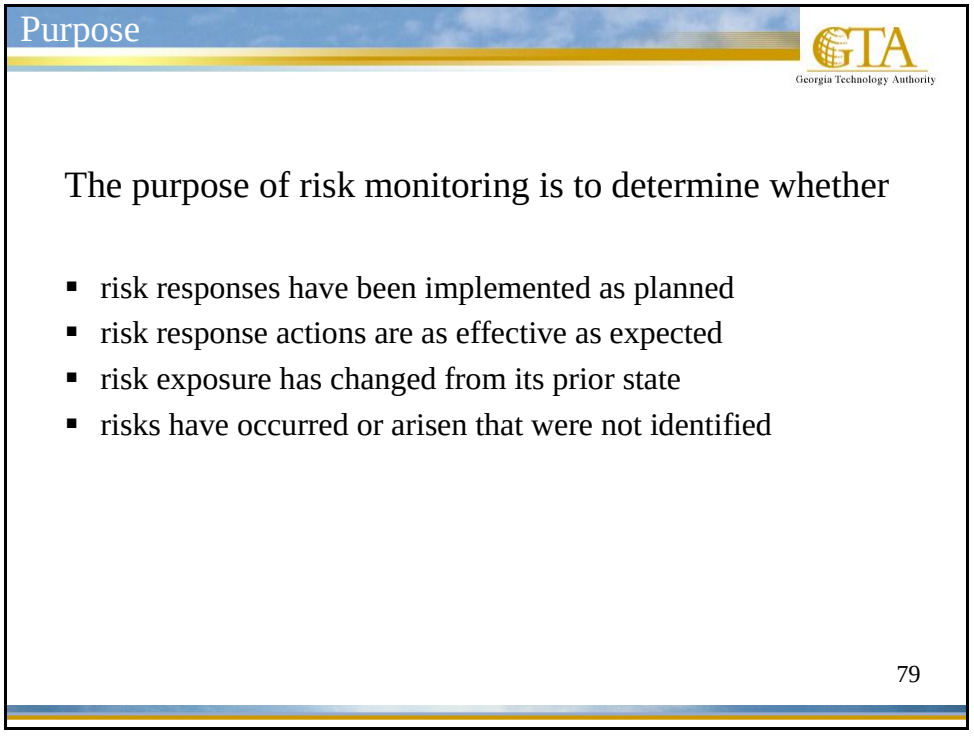
The process of risk monitoring and control involves

- **tracking identified risks**
- **monitoring residual risks** (risks that remain after risk responses have been implemented)
- **identifying new risks**
- ensuring the execution of **risk plans**
- evaluating the **effectiveness of risk plans** in reducing risk

This process records risk metrics associated with implementing contingency plans. It is an ongoing process for the life of the project. As the project progresses, the risks change, new risks develop, or expected risks do not appear.

Good risk monitoring and control processes provide information that enable effective decisions to be made before the risk occurs.

Topic 1: Monitoring and Controlling Risk (cont'd)



Risk Monitoring and Control - Purpose

All project stakeholders need to be involved periodically in risk monitoring, in order to assess the acceptability of the level of risk on the project. The purpose of risk monitoring is to ascertain whether

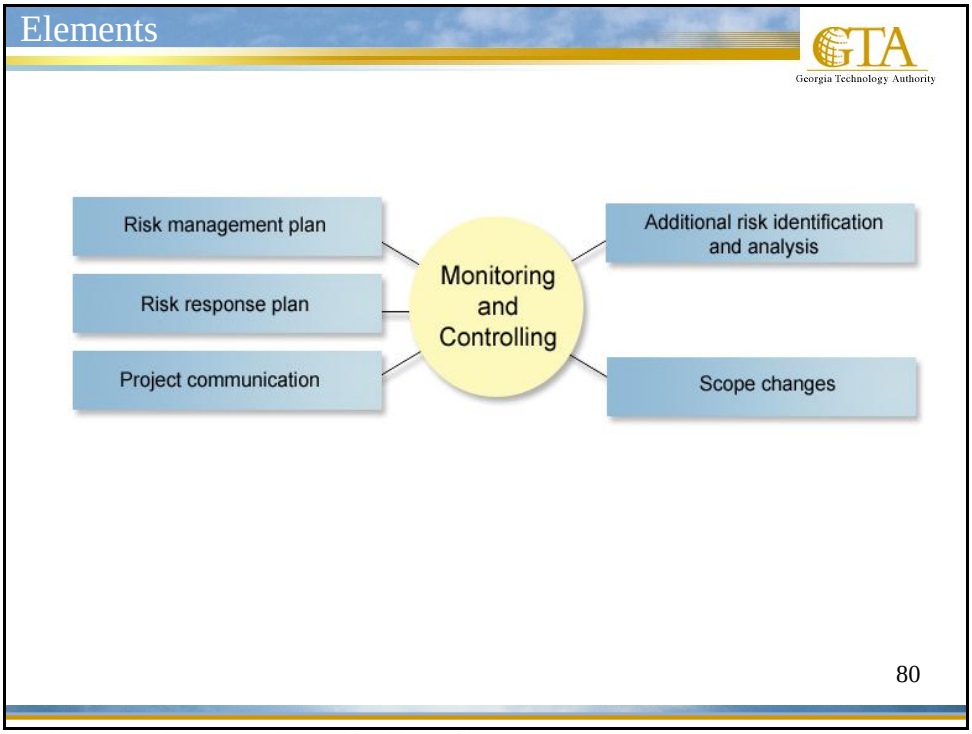
- **risk responses** have been implemented as planned
- risk response actions are as **effective** as expected (if not, new responses should be developed)
- project **assumptions are still valid**
- **risk exposure** has changed from its prior state with the analysis of trends
- a **risk trigger** has occurred
- proper **policies and procedures** are followed
- risks have occurred or arisen that were not previously **identified**

Risk control may entail

- choosing alternative strategies
- implementing a contingency plan
- taking corrective action
- replanning the project

The risk response owner should report periodically to the project manager and the risk team leader on the effectiveness of the plan, any unanticipated effects, and any mid-course corrections needed to offset the risk.

Topic 1: Monitoring and Controlling Risk (cont'd)



(Graphic Source: The course script provides this graphic)

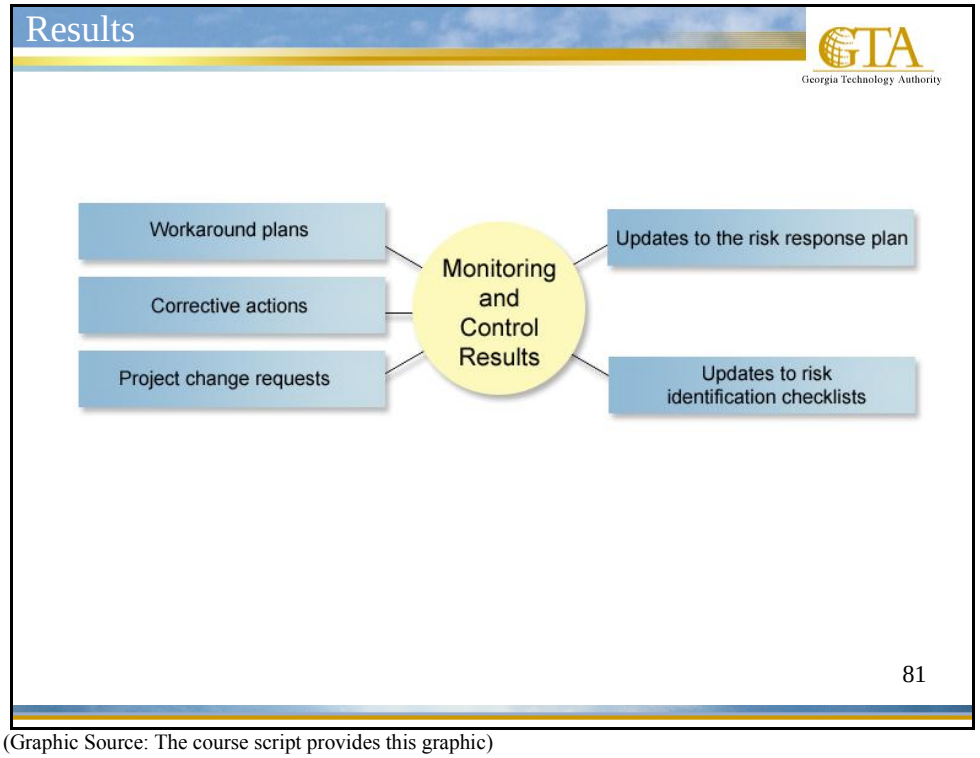
Risk Monitoring and Control - Elements

The main elements of risk monitoring and control are

- **risk management plan**
  - describes how **risk management** – which entails identification, qualitative and quantitative analysis, response planning, monitoring, and control – is structured and performed on a project
- **risk response plan**
  - lists agreed risk responses for **specific project risks** and should contain the level of detail for risk response actions
- **project communication**
  - **work results** and other project records, providing information on project performance and risks
  - **reports** used to monitor and control risks, such as issues logs, action-item lists, jeopardy warnings, or escalation notices
- **additional risk identification of potential risks** not previously identified. These may arise as the performance of the project is measured and reported
  - **implement the cycle of risk processes** – identification, qualitative analysis, quantitative analysis, and response – for these risks
- **scope changes**
  - require **new risk analysis** and response plans

Of particular importance are the elements of project communication and scope changes.

Topic 1: Monitoring and Controlling Risk (cont'd)



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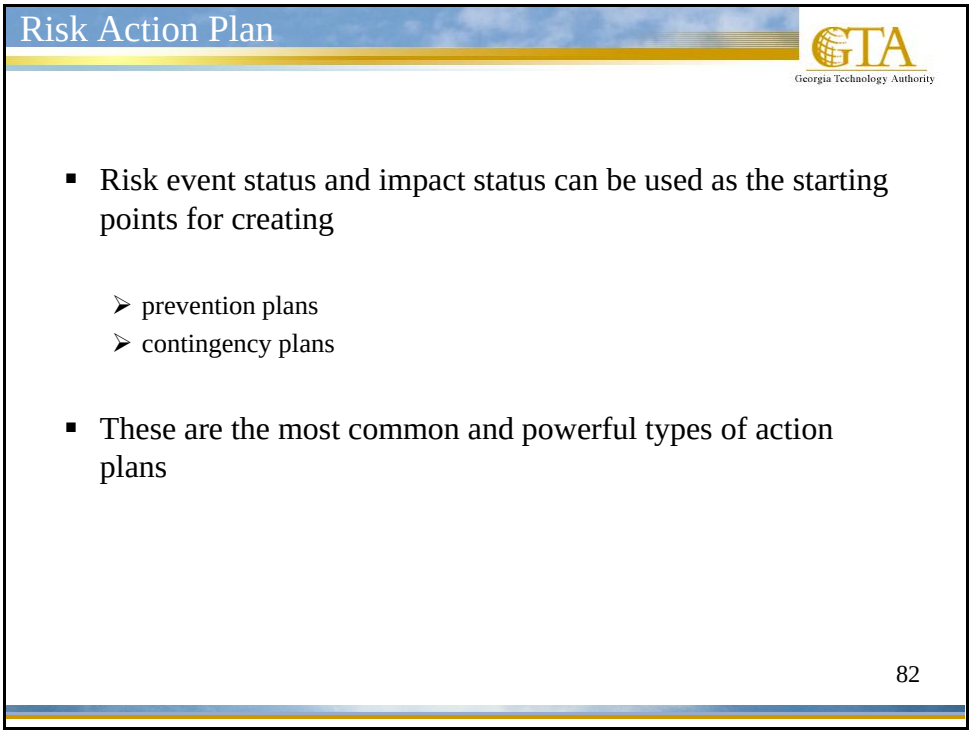
Risk Monitoring and Control - Results

The results from risk monitoring and control are

- **workaround plans**
  - workarounds are unplanned responses to emerging risks
  - workarounds must be properly documented and incorporated into the project plan and risk response plan
- **corrective action**
  - corrective action involves performing the contingency plan or workaround
- **project change requests**
  - implementing contingency plans or workarounds often requires changing the project plan to respond to risks
  - project change requests result in issuance of a change request that is managed by integrated change control
- **updates to the risk response plan**
  - risks that occur should be documented and evaluated
  - implementation of risk controls may reduce the impact or probability of identified risks
  - risk rankings must be reassessed so that new, important risks may be properly controlled
  - risks that do not occur should be documented and closed in the risk response plan
- **updates to risk identification checklists**
  - updated checklists will help risk management in future projects

Topic 2: Risk Ownership and Action



Risk Action Plan

The risk action plan is a subset of the risk response plan. A **risk response plan** is the documentation of identified risk, analysis information, and response strategies. The **risk action plan** is a series of steps used to realize the desired response strategy.

Risk event status and impact status can be used as the starting points for creating the most common and powerful types of action plans: prevention plans and contingency plans.

Usually, each risk event status suggests a **prevention plan**, which is an action plan that keeps the risk event from occurring. A **contingency plan** is an action plan that minimizes the actual loss should the risk event occur despite your prevention plans. These plans also depend on the type of response strategy identified.

Sometimes, one status suggests multiple action plans, whereas others do not lead to an action plan by themselves. An effective action plan must designate a responsible individual, a due date, a means of measuring progress, and resources to execute the plan.

The model facilitates the formulation of actionable plans in two ways:

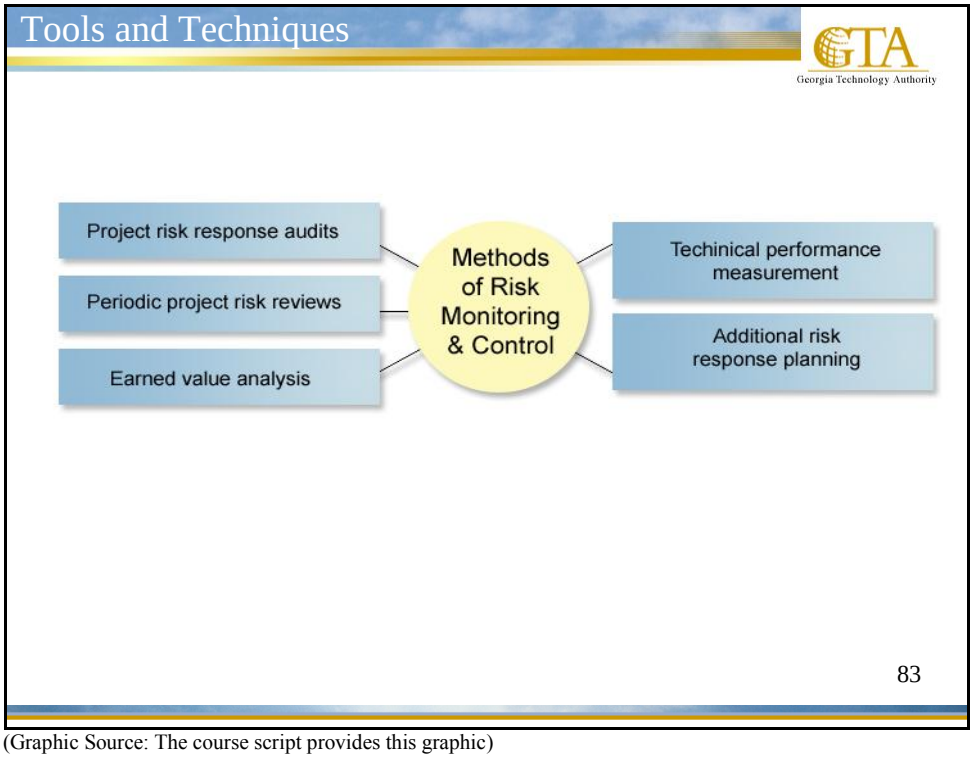
- The status often may point toward an **effective action plan** targeting root causes.
- If an **action plan isn't apparent**, it may be necessary to check that the status for the risk is listed in full.

Topic 2: Risk Ownership and Action (cont'd)

The risk model points to other types of action plans, such as avoidance, transference, and acceptance (which are covered in lesson 4 as part of risk response strategies).

If the risk event and impact status are not defined clearly, it cannot be assumed that a clear picture of the risk has been obtained. A lack of clarity in wording the risk event and impact status will become apparent when you are attempting to convert risk events into action plans.

Topic 3: Tracking the Action Plan



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Methods of Monitoring and Controlling Risk

Different methods of monitoring and controlling risk can be used, depending on the risk response. Furthermore, a combination of the following set of tools can be effective in managing risk responses:

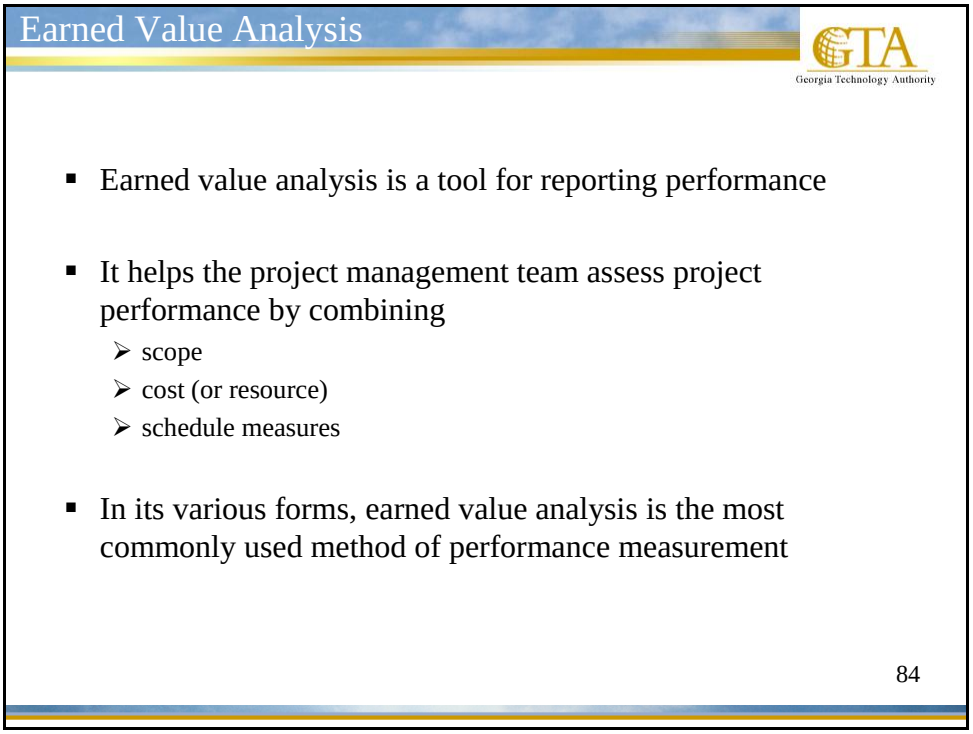
- **project risk response audits**
  - Risk auditors examine and document the effectiveness of the risk response in avoiding, transferring, or mitigating risk occurrence.
  - These audits also evaluate the effectiveness of the risk owner.
  - Risk audits are carried out during the project life cycle to control risk.
- **periodic project risk reviews**
  - **Risk ratings** and prioritization may change during the project life cycle.
  - Any changes arising from **project risk reviews** may require additional qualitative or quantitative analysis.
  - **Reviews** should be scheduled regularly and appear as an agenda item at all team meetings.
- **earned value analysis**
  - Earned value analysis is used for monitoring overall project performance against a baseline plan.
  - The results from an earned value analysis may indicate potential deviation of the project at completion from cost and schedule targets.
  - When a project deviates significantly from the baseline, updated risk identification and analysis should be performed.

Topic 3: Tracking the Action Plan (cont'd)

- **technical performance measurement**
  - Technical performance measurement compares technical accomplishments during project execution to the project plan's schedule of technical achievement.
  - Any deviation from the project plan's schedule, such as not demonstrating functionality as planned at a milestone, can indicate a risk to achieving the project's scope.
- **additional risk response planning**
  - If there is an emerging risk not previously anticipated in the risk response plan, the planned response may not be adequate.
  - If a risk has a greater than anticipated impact on the objectives, the planned response may not be adequate.
  - In these cases, it will be necessary to perform additional response planning to control the risk.

This course looks at earned value in detail because it is the commonly recommended control tool for all types of project and risk plans.

Topic 3: Tracking the Action Plan (cont'd)



Earned Value Analysis

Of the tools for monitoring and controlling risk, earned value analysis is perhaps the most important.

Earned value analysis is a tool for reporting performance. In its various forms, earned value analysis is the most commonly used method of performance measurement. It combines scope, cost (or resource), and schedule measures to help the project management team assess project performance.

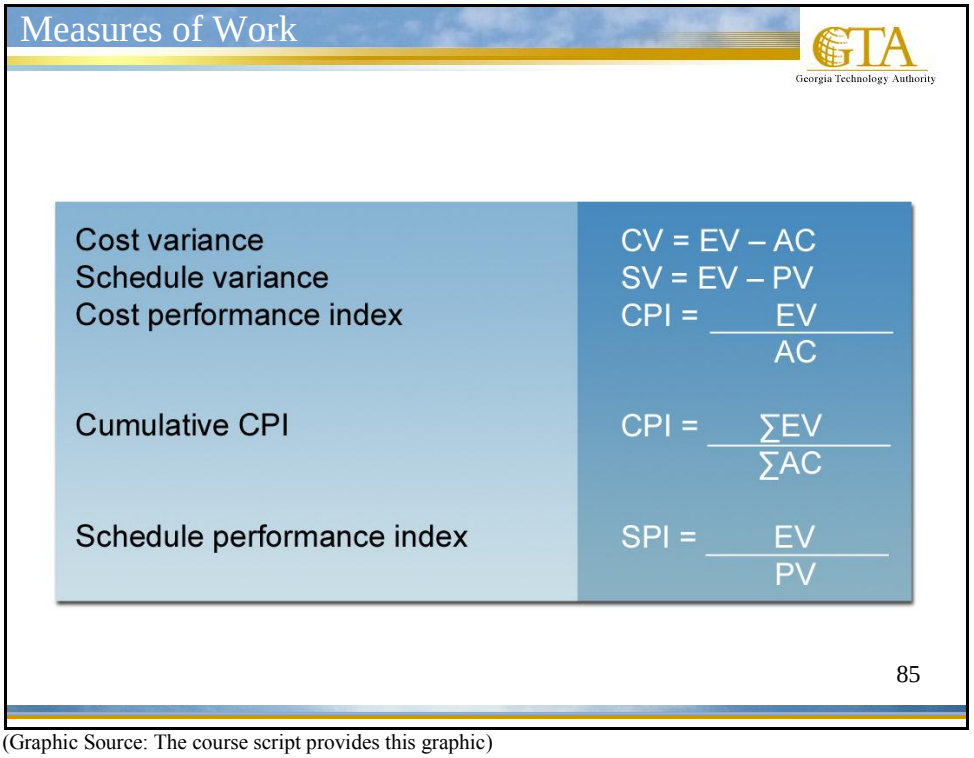
There are three key values that must be calculated for each activity in earned value analysis.

These are

- **planned value (PV)**, previously called the budgeted cost of work scheduled (BCWS) – this is the portion of the approved cost estimate planned to be spent on the activity during a given period
- **earned value (EV)**, previously called the budgeted cost of work performed (BCWP) – this is the value of the work actually completed

- **actual cost (AC)**, previously called the actual cost of work performed (ACWP) – this is the total of all costs incurred in accomplishing work on the activity during a given period, and it must correspond to whatever was budgeted for the PV and the EV

Topic 3: Tracking the Action Plan (cont'd)



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Planned value, earned value, and actual cost can be combined in various ways to provide measures of whether work is being accomplished as planned.

The most commonly used measures are the **cost variance (CV)** and the **schedule variance (SV)**:

CV = EV – AC
SV = EV – PV

These two values can be converted to efficiency indicators to reflect the cost and schedule performance of any project.

The **cost performance index (CPI)** is the most commonly used cost-efficiency indicator:

CPI = EV/AC

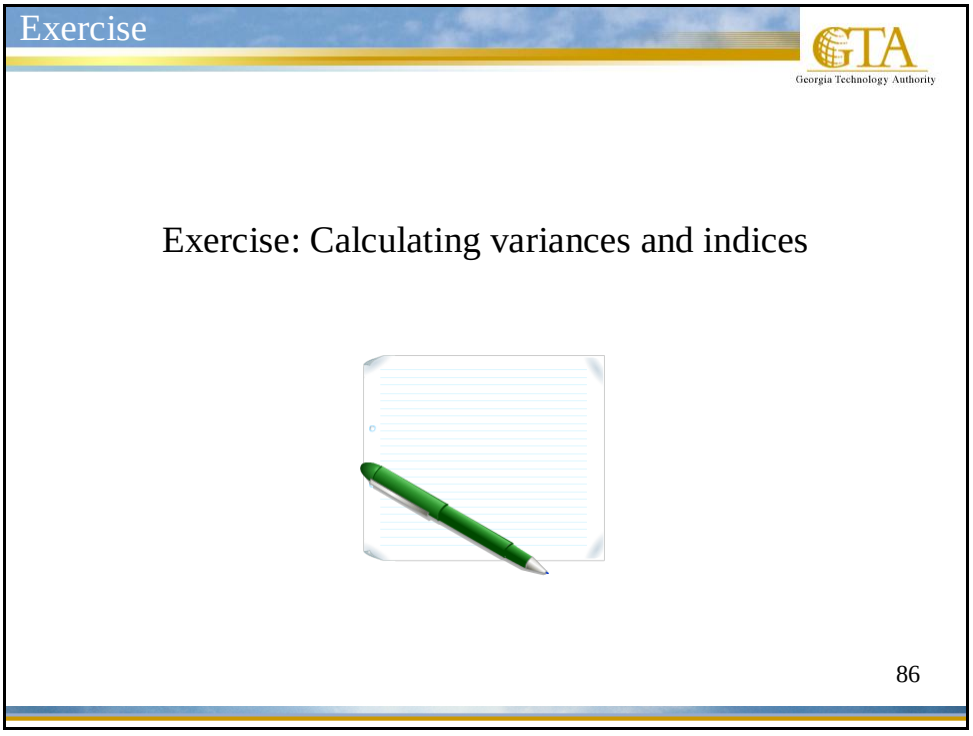
The cumulative CPI is widely used to forecast project costs at completion:

Cumulative CPI = ∑ EV / ∑AC

The **schedule performance index (SPI)** is sometimes used in conjunction with the CPI to forecast the project completion estimates:

SPI = EV/PV

Topic 3: Exercise – Calculating Variances and Indices



Due to the "new" nature of the Georgia Light Rail project for all stakeholders, the associated learning curve may result in cost and time over-runs.

While the project management team is experienced in light-rail projects, the functional expertise may undergo a learning curve during the pilot scheme which will result in cost and time over-runs.

The response to this risk is to put training plans in place and monitor progress to see if the risk event status is reduced. The Training Manager owns this risk and is indicating that such training will take 6 months to complete at a cost of $180,000, which will be prorated evenly per month. There are ninety people who need to be trained, with 15 people receiving the training per month. At the end of the second month, at a risk review meeting, the training manager indicates that they have spent $40,000 and 20 people have completed the training program.

You are requested to represent this data using cost variances, schedule variances, cost performance index and schedule performance index, and comment on the overall position of the training program.

Topic 3: Tracking the Action Plan (cont'd)

Answer

It costs $2,000 to train one person (Total Cost / Number of people trained = $180,000 / 90 = $2,000)
PV @ 2 months = 30 people trained at a cost of $60,000.
EV @ 2 months = 20 people trained = $40,000
AC @ 2 months = $40,000

CV = EV – AC
= $40,000 - $40,000
= 0

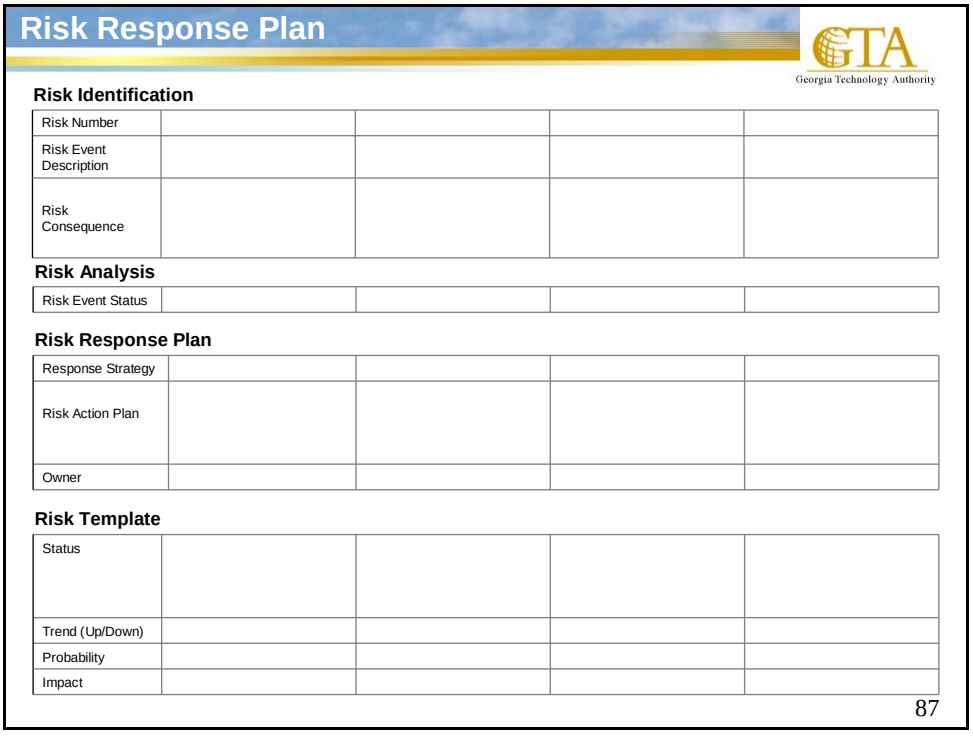
SV = EV – PV
= $40,000 - $60,000
= -$20,000

CPI = EV / AC
= $40,000 / $40,000
= 1

SPI = EV / PV
= $40,000 / $60,000
= 0.67 or 67%

The training manager should be pleased with the cost performance, but he / she is not meeting the schedule and has completed 67% of the planned training program, which is a cause for concern

Topic 4: Exercise – Presenting a Risk Response Plan



Topic 4: Exercise – Presenting a Risk Response Plan (cont'd)

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time.	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail / construction projects. Furthermore the scale of the project is bigger than any other project undertaken by the State of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. While the current list of preferred contractors have a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the lifecycle of the 'full' project, it may be that officials in the state authority will change. This could impact on the level of support the project will receive.	While the project management team are experienced in light-rail projects, the functional expertise may undergo a learning curve during the pilot scheme which will result in cost and time over-runs.
Risk Event Status (P * I)	15	12	6	20
Response Strategy	Mitigation	Transference	Acceptance	Mitigation
Risk Action Plan				
Risk Owner				

Exercise Worksheet

Lesson 5: Summary

The lesson is now completed and the following topics have been covered:

Topic 1: Monitoring and Controlling Risk

- The process of risk monitoring and control involves **tracking identified risks, monitoring residual risks**, **identifying new risks,** ensuring the execution of **risk plans,** and evaluating the **effectiveness of risk plans** in reducing risk.

- The main elements of risk monitoring and control are the **risk management plan,** the **risk response plan, project communication, additional risk identification of potential risks** and **scope changes.**

- The results from risk monitoring and control are **workaround plans, corrective action, project change requests, updates to the risk response plan** and **updates to risk identification checklists.**

From this topic you should **take away** the following:

- an understanding that controlling risk response is critical to ensuring risks are brought under control
- an understanding that monitoring new risks is a continual process throughout the lifecycle of a project

Topic 2: Risk Ownership and Action

- **Risk event status** and impact status can be used as the starting points for creating prevention plans and contingency plans:
  - a **prevention plan** is an action plan that keeps the risk event from occurring and
  - a **contingency plan** is an action plan that minimizes the actual loss should the risk event occur

- The status often may point toward an **effective action plan** targeting root causes. An effective action plan must designate a responsible individual, a due date, a means of measuring progress, and resources to execute the plan.

From this topic you should **take away** the following:

- an understanding that action is required to ensure the response plan is adhered to, and therefore risk responses will only be worthwhile if there is a feasible action plan
- an ability to identify an action plan and an action owner

Lesson 5: Summary (cont'd)

Topic 3: Tracking the Action Plan

- Earned value analysis is a tool for reporting performance. The three key values that must be calculated for each activity in earned value analysis are
  - **planned value (PV)**,
  - **earned value (EV)**
  - **actual cost (AC).**

- The most commonly used cost-efficiency indicator is the **cost performance index (CPI)**:
  - **CPI = EV/AC**

- The **schedule performance index (SPI)** is sometimes used in conjunction with the CPI to forecast the project completion estimates:
  - **SPI = EV/PV**

From this topic you should **take away** the following:

- an understanding of the function of earned value as a tracking and control tool
- an ability to apply the earned value variances and indices to report on the progress of the risk response plan

Topic 4: Presenting a Risk Response Plan

- An exercise is presented to demonstrate how to put a risk response plan together with an action plan, owners, trends and control tools identified.

From this topic you should **take away** the following:

- an understanding of the need to take action to ensure that risk trends are downwards

Sample Answers

Lesson 1, Topic 2: Exercise – Are you a Risk Seeker or Risk Averse?

Lesson 1, Topic 5: Exercise – Preparing a Risk Management Plan

Lesson 2, Topic 2: Exercise – Using Risk Gathering Techniques

Lesson 2, Topic 4: Exercise – Using Risk Identification Tools and Techniques

Lesson 3, Topic 4: Exercise – Performing Risk Analysis

Lesson 4, Topic 1: Exercise – How do you respond to risk?

Lesson 4, Topic 3: Exercise – Responding to Analyzed Risk

Lesson 5, Topic 4: Exercise ─ Presenting a Risk Response Plan

Lesson 1, Topic 2: Exercise – Are you a Risk Seeker or Risk Averse?

Question

Read the excerpts that follow and decide which option you would choose.

A project manager is sourcing equipment for a new IT project. The project has to choose between two vendors, Best Retailer IT and New Retailer IT. To simplify the problem, the project manager decides to estimate the potential profit of these vendors on the basis of product reliability.

- Through research and talking to other project managers, the manager finds that Best Retailer IT has a 60% chance of providing reliable equipment, and its parts cost $300,000 (this includes costs of installations and maintenance).
- There is, however, a 40% chance that the equipment will fail – in which case, costs can increase to $850,000.
- On the other hand, if New Retailer IT is chosen, there is an 80% chance of high reliability at a cost of $750,000 and a 20% chance of failure.
- New Retailer IT provides lifelong guarantees and maintenance services.

Would you choose Best Retailer IT or New Retailer IT?

Sample answer

Sample answer & guidelines

If you choose Best Retailer IT, you can consider yourself to be a risk seeker, and if you chose New Retailer IT, you could be considered averse to risk.

- **Risk seekers** will choose the option with the most at stake (40% chance that costs can increase to $850,000) but the most favorable outcome ($300,000 cost).

- **Risk averse** individuals will choose the safest option (80% chance of high reliability at a cost of $750,000) with a life-long guarantee. However, this is the costly option.

As a risk seeker would the following scenario change your mind?

Given the competition from New Retailer IT, Best Retailer IT has proposed the following incentive: a 70% guarantee of providing reliable equipment and parts at a cost of $300,000. There is still however a 30% chance that the equipment will fail – in which case, the costs can increase to $850,000.

Would this change your choice of retailer?

As Best Retailer IT's guarantees increase, its offer becomes attractive to even the most risk-averse individuals because of the massive savings it offers compared with New Retailer IT.

Lesson 1, Topic 6: Exercise – Preparing a Risk Management Plan

Question

Assume that the state authority has sanctioned the rail project. You are part of the assembled dedicated risk management team. The first set of tasks entails identifying a risk management plan, including key aspects for consideration by the project sponsors.

A risk management template is provided for guidance.

Sample answer

Step 1: Identify the structure of the risk management plan.

The following is an example of the structure:

- methodology – defines the approaches, tools, and data sources used to perform risk management
- risk categories – provide a structure for identifying a consistent level of risk detail that contributes to the effectiveness and quality of risk identification
- roles and responsibilities – defines the lead, support, and risk management team membership for each type of action in the risk management plan
- budgeting – determines a risk management budget for the project and assigns resources as required
- timing – establishes how frequently the risk management process will be performed throughout the project life cycle
- reporting formats – describe the content and format of the risk response plan, as well as determine how the results of the risk management processes are documented, analyzed, and communicated to the project team
- tracking – documents how all risk activities are recorded so that information can be used for the benefit of the current project and to inform future needs
- thresholds – establish risk criteria that will be acted upon, by whom, and in what manner
- scoring and interpretation – determines the most appropriate methods (determined in advance to ensure consistency) for the type and timing of the qualitative and quantitative risk analysis being performed

Step 2: Satisfy each of the above criteria.

The following are examples:

Methodology includes

- risk identification with explanation on how it will be completed
- risk analysis (qualitative and quantitative analysis) with explanation on how it will be completed
- risk response development with explanation on how it will be completed
- risk response monitoring and control with explanation on how it will be completed

Lesson 1, Topic 6: Exercise – Preparing a Risk Management Plan (cont'd)

Risk categories include

- political – the risk that parts of the project implementation are rejected by the state on the basis of non-technical or non-operational grounds (e.g. the product does not comply with government standards)
- safety and security – risks associated with the safety of persons and property during project
- organizational – risks concerning the interactions of the project team and constraints with other project deliverables within the organization
- contractor specific – all risks concerning possible lapses by the contractor, including late delivery, poor supplies, etc.

Roles and responsibilities include

- risk identification (e.g. all stakeholders)
- risk analysis (e.g. project team and decision makers)
- risk response development, which is dependent on the status of the risk
- risk response monitoring and control, including the project team members who own risks

Budgeting and timing determine a risk management budget and how frequently the risk management process will be performed.
Scoring and interpretation determine the most appropriate methods (determined in advance to ensure consistency) for the type and timing of the qualitative and quantitative risk analysis being performed.

Lesson 1, Topic 6: Exercise – Preparing a Risk Management Plan (cont'd)

Risk Score for a Specific Risk					
Probability	Risk Score = P × IRisk Score = P × I				
0.9	0.05	0.09	0.18	0.36	0.72
0.7	0.04	0.07	0.14	0.28	0.56
0.5	0.03	0.05	0.10	0.20	0.40
0.3	0.02	0.03	0.06	0.12	0.24
0.1	0.01	0.01	0.02	0.04	0.08
	0.05	0.10	0.20	0.40	0.80
	Impact on an Objective (e.g., cost, time, or scope) (Ratio Scale)				

A sample risk matrix

Reporting formats and tracking and thresholds establish risk criteria that will be acted upon, by whom, and in what manner

Step 3: Highlight areas that you feel, as a risk manager, are critical to the success of the project.

Key areas for project stakeholders and team members include an understanding of how risk is to be measured and who is responsible for risk.

Lesson 2, Topic 2: Exercise – Using Risk Gathering Techniques

Question

Having read The Georgia Rail Project case study, the state authority has sanctioned the project. As part of the assembled dedicated risk management team, you have delivered a risk management plan to the project stakeholders. The stakeholders have requested that a SWOT analysis be performed to highlight project strengths and opportunities.

Sample answer

Strengths	Weaknesses
1. The light-rail system is a state-of-the-art project, which will give the state authority a "flagship" transport system. 2. The Arizona project is a suitable benchmark. 3. The system will enhance future traffic flow. 4. Businesses near the new system will benefit from an increased flow of people.	1. The state authority has no previous experience of light-rail projects. 2. The contractors may not have the required level of expertise for the project.
Opportunities	**Threats**
1. The light-rail system will promote the state of Georgia. 2. The rail system will be continually expanded throughout the state of Georgia.	1. The public may be alienated due to the restrictions on traffic management during construction. 2. Government changes may impact on project support over time. 3. Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.

Lesson 2, Topic 4: Exercise – Using Risk Identification Tools and Techniques

Question

The state authority has sanctioned the light-rail project. You have completed the SWOT analysis and there are some apparent risks that need to be logged. You are tasked with putting a risk response plan together that will present

- risk event
- risk consequence

Once completed, you want to identify potential risk responses.

Sample answer

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects.	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time.	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail / construction projects. Furthermore, the scale of the project is bigger than any other project undertaken by the State of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. While the current list of preferred contractors have a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the lifecycle of the 'full' project, it may be that officials in the state authority will change. This could impact on the level of support the project will receive.	While the project management team are experienced in light-rail projects, the functional expertise may require a learning curve during the pilot scheme which will result in cost and time over-runs.

Lesson 2, Topic 4: Exercise – Using Risk Identification Tools and Techniques (cont'd)

The following responses are based on identifying the consequence/cause of the risk. No detailed analysis has being performed as this stage.

Risk Response	Provide training to the state authority. Involve the state authority in all aspects of the project. Introduce buffers to allow for project learning.	Bring in contractors from proven sources (e.g. Arizona project).	Accept this risk. Ensure that the project team works with current and prospective authority individuals.	Hire experienced professionals with suitable track records. Accept the cost/time over-runs.

Lesson 3, Topic 3: Exercise – Georgia Apple Orchard

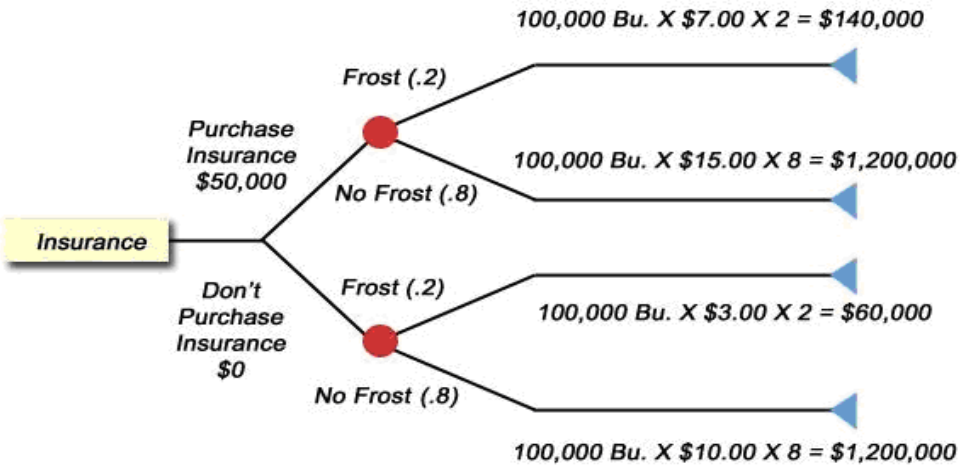
Question
A Georgia farmer needs to make a decision. His orchard is expected to produce 100,000 bushels of peaches, which he wishes to sell to a large grocery chain at $15 per bushel as 'Grade A' peaches.

However, he has great concern about the possibility of early frost damaging his crop. For three of the past five years, the western part of the state where the farmer lives has suffered severe frost.

The Department of Agriculture's figures show that the probability of early frost in the orchard area in any given year is 20%. If his crop is damaged, it would not be marketable as fresh fruit and he would have to sell it to a cannery in Alabama for $3.00 per bushel.

He could purchase insurance which would ensure that if his peaches were damaged, he could sell the total crop (both damaged and good fruit) to the insurance company for $7.00 per bushel. The cost of the insurance would be $50,000. What are the monetary expectations of the farmer's decision to purchase or to not purchase insurance?

Sample answer



Expected Monetary Value:
A.) Purchase Insurance = $140,000 + $1,200,000 - $50,000 = $1,290,000
B.) Don't Purchase Ins. = $60,000 + $1,200,000 - $0 = $1,260,000

Lesson 3, Topic 3: Exercise: Using a Decision Tree

Question

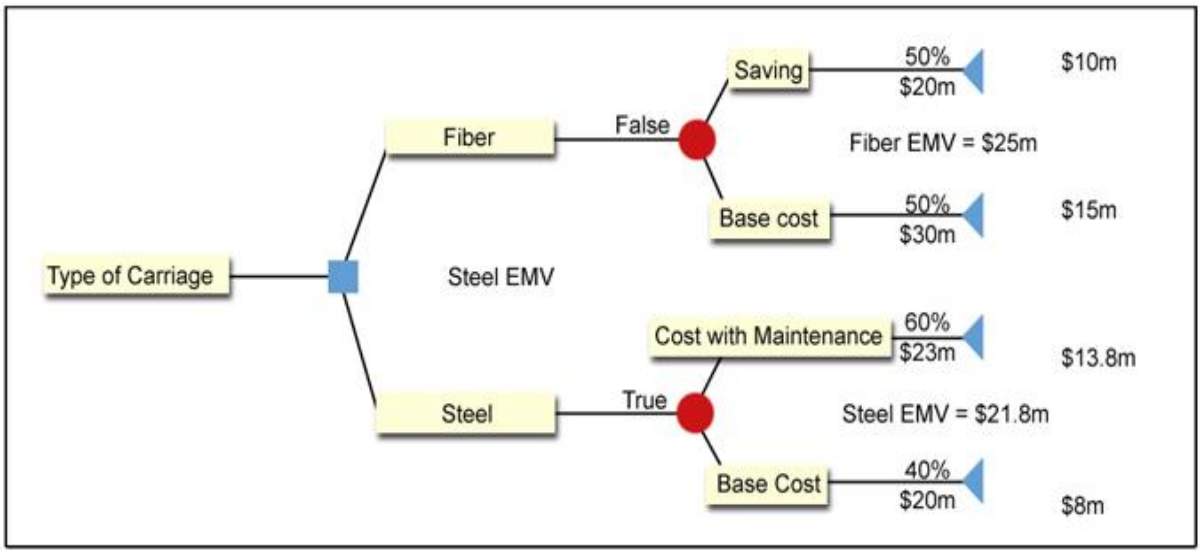
You are part of the assembled dedicated risk management team for the Georgia Light Rail system. Your team has delivered a risk management plan to the project stakeholders. The same stakeholders are looking at a particular situation and want your team to assess the alternatives.

The type of light rail carriage is being examined. One option is to go for a new toughened steel chassis with reinforced glass. The other option is to use a fiber type chassis, which will enhance the lightness of the carriages. The steel option, at a cost of $20 million, is durable but is also prone to operational damages; the probability of this occurring is 60% with estimated costs of $3 million over five years of operation. The fiber carriages, at a cost of $30 million, show a 50% probability of saving the state authority $10 million over the next five years. These savings are associated with reduced maintenance and increased durability.

Which alternative would you recommend? Use a decision tree to determine the best alternative.

Sample answer

Make the point that the decision is at the discretion of the stakeholders, but a decision tree shows that the steel is the more cost-effective option over the next five years.



Lesson 3, Topic 4: Exercise – Performing Risk Analysis

Question

In this exercise, you have a list of some apparent risks that need to be logged. You are tasked with putting a risk response plan together to analyze each of the risks.

Sample answer

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects.	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail/construction projects. Furthermore, the scale of the project is bigger than any other project undertaken by the state of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. Although the current list of preferred contractors has a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the life cycle of the "full" project, it may be that officials in the state authority will change. This could impact on the level of support the project will receive.	Although the project management team is experienced in light-rail projects, the functional expertise may require a learning curve during the pilot scheme, which will result in cost and time over-runs.
Probability (P)	5: Certain probability of occurrence	3: 50% chance of occurrence	3: 50% chance of occurrence	5 : Certain probability of occurrence
Impact (I)	3: 50% chance it will impact the project	4: Major impact on project if it occurs	2: Minor impact	4: Major impact on project if it occurs
Risk Event Status (P * I)	15	12	6	20

Lesson 3, Topic 4: Exercise – Performing Risk Analysis (cont'd)

Quantitative Analysis	The response is well understood in this case (i.e. training / involvement), so there may be no place for further analysis.	The response may be to look at other contractors, which should be evaluated using sensitivity analysis.	This is a risk that may be accepted by the project and so no further analysis required.	Alternatives schemes / deployment could be investigated (use of decision trees/brainstorming to investigate).

Probability	**Impact**
5: Certain probability of occurrence	5: The project will stop
4: Major impact on project if it occurs	4: Major impact on the project functionality
3: 50% chance of occurrence	3: Likely to impact the project plan
2: Unlikely to occur	2: Minor impact on the project
1: Will not occur	1: Unlikely to impact the project

Lesson 4, Topic 1: Exercise – How do you respond to Risk?

Question

The following is a list of risks. You are requested to identify an appropriate risk response strategy. It can be one for the following:

- avoidance
- mitigation
- transference
- acceptance

How would you respond to these risks? What is the specific response strategy in each case?

Sample answer

Types of Risks	Risk Responses	Response Strategy
Project risks associated with investment opportunities	• Share risks by having partners • Spread risks over time • Participate in many ventures • Seek lower risk ventures	Mitigation
Risk associated with material prices	• Hedge or fix prices in the future markets • Use long-term and short-term sales contracts • Tailor contracts for appropriate risk sharing	Transference
Environmental hazards	• Buy insurance • Increase safety margins • Develop and test an incident-response program	Transference

Lesson 4, Topic 1: Exercise – How do you respond to Risk?

Operational risks	• Hire contractors under turnkey project contracts • Tailor contracts for appropriate risk sharing • Acquire additional inventory and spares • Conduct tests, pilot programs, and trials • Increase training	Mitigation

Lesson 4, Topic 3: Exercise – Responding to Analyzed Risk

Question
Based on the Georgia Rail Project case study, you need to put a risk response plan together that includes an analysis and response strategy for each risk.

Sample answer

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects.	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time.	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail/construction projects. Furthermore, the scale of the project is bigger than any other project undertaken by the state of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. Although the current list of preferred contractors has a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the life cycle of the "full" project, officials in the state authority may change. This could impact on the level of support the project will receive.	Although the project management team is experienced in light-rail projects, the functional expertise may require a learning curve during the pilot scheme, which will result in cost and time over-runs.
Probability (P)	5: There is a 100% chance of occurrence.	3: There is a 50% chance of occurrence.	3: There is a 50% chance of occurrence.	5: There is a 100% chance of occurrence.
Impact (I)	3: There is a 50% chance it will impact the project.	4: There is a major impact on the project if it occurs	2: The impact on the project is minor.	4: There is a major impact on the project if it occurs.
Risk Event Status (P * I)	15	12	6	20
Quantitative Analysis	The response is well understood in this case (i.e. training/involvement), so there may be no place for further analysis.	The response may be to look at other contractors, and these should be evaluated using sensitivity analysis.	This is a risk that may be accepted by the project, and no further analysis is required	Alternatives schemes/deployment could be investigated (use of decision trees/brainstorming to investigate).

Lesson 4, Topic 3: Exercise – Responding to Analyzed Risk (cont'd)

Probability	**Impact**
5: Certain probability of occurrence	5: The project will stop
4: Major impact on project if it occurs	4: Major impact on the project functionality
3: 50% chance of occurrence	3: Likely to impact the project plan
2: Unlikely to occur	2: Minor impact on the project
1: Will not occur	1: Unlikely to impact the project

Response Strategy	Mitigation	Transference	Acceptance	Mitigation
Action Plan	Provide training for all stakeholders	Look for other contractor, and shape the contract in a way that will transfer the risk of non-performance to the contractor	Monitor risk	Put training plans in place as a first step and monitor progress to see whether the risk event status is reduced

Lesson 5, Topic 3: Exercise – Calculating Variances and Indices

Question

Due to the "new" nature of the Georgia Light Rail project for all stakeholders, the associated learning curve may result in cost and time over-runs.

While the project management team is experienced in light-rail projects, the functional expertise may undergo a learning curve during the pilot scheme which will result in cost and time over-runs.

The response to this risk is to put training plans in place and monitor progress to see if the risk event status is reduced. The Training Manager owns this risk and is indicating that such training will take 6 months to complete at a cost of $180,000, which will be prorated evenly per month. There are ninety people who need to be trained, with 15 people receiving the training per month. At the end of the second month, at a risk review meeting, the training manager indicates that they have spent $40,000 and 20 people have completed the training program.

You are requested to represent this data using cost variances, schedule variances, cost performance index and schedule performance index, and comment on the overall position of the training program.

Answer

It costs $2,000 to train one person (Total Cost / Number of people trained = $180,000 / 90 = $2,000)
PV @ 2 months = 30 people trained at a cost of $60,000.
EV @ 2 months = 20 people trained = $40,000
AC @ 2 months = $40,000

CV = EV – AC
= $40,000 - $40,000
= 0

SV = EV – PV
= $40,000 - $60,000
= -$20,000

CPI = EV / AC
= $40,000 / $40,000
= 1

SPI = EV / PV
= $40,000 / $60,000
= 0.67 or 67%

The training manager should be pleased with the cost performance, but he / she is not meeting the schedule and has completed 67% of the planned training program, which is a cause for concern

Lesson 5, Topic 4: Exercise – Presenting a Risk Response Plan

Question

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time.	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail / construction projects. Furthermore the scale of the project is bigger than any other project undertaken by the State of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. While the current list of preferred contractors have a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the lifecycle of the 'full' project, it may be that officials in the state authority will change. This could impact on the level of support the project will receive.	While the project management team are experienced in light-rail projects, the functional expertise may undergo a learning curve during the pilot scheme which will result in cost and time over-runs.
Risk Event Status (P * I)	15	12	6	20
Response Strategy	Mitigation	Transference	Acceptance	Mitigation
Risk Action Plan				
Risk Owner				

Lesson 5, Topic 4: Exercise – Presenting a Risk Response Plan (cont'd)

Sample answer

Here, we present the full version of the risk response template.

Risk Number	Risk_1	Risk_2	Risk_3	Risk_4
Risk Event Description	The state authority has no previous experience of light-rail projects	The contractors may not have the required level of expertise for the project.	Government changes may impact on project support over time.	Due to the "new" nature of the project for all stakeholders, the associated learning curve may result in cost and time over-runs.
Risk Consequence	The state authority has not been involved in previous rail / construction projects. Furthermore the scale of the project is bigger than any other project undertaken by the State of Georgia.	The preferred state authority contractors have not worked on projects of the size of the light-rail system. While the current list of preferred contractors have a base skill set, it may not be sufficient for the light-rail project.	As elections will be run during the lifecycle of the 'full' project, it may be that officials in the state authority will change. This could impact on the level of support the project will receive.	While the project management team are experienced in light-rail projects, the functional expertise may undergo a learning curve during the pilot scheme which will result in cost and time over-runs.
Risk Event Status (P * I)	15	12	6	20
Response Strategy	Mitigation	Transference	Acceptance	Mitigation
Risk Action Plan	Provide training for all stakeholders.	Look for other contractors and shape the contract in a way that will transfer the risk of non-performance to the contractor.	Monitor risk.	Put training plans in place as a first step and monitor progress to see if the risk event status is reduced.
Risk Owner	State Authority	Contract Manager	Project Manager	Training Manager
Status / Control	Risk Review Meetings	Contract Earned Value	Risk Review Meetings	Risk Review Meetings
Trend (Up / Down	Down	Down	No-Change	Down

Lesson 5, Topic 4: Exercise – Presenting a Risk Response Plan (cont'd)

Updated Probability	4: It is with almost certain probability of occurrence	1: There is no chance of occurrence	3: There is a 50% chance of occurrence	4: It is with almost certain probability of occurrence
Updated Impact	3: There is a 50% chance it will impact the project	4: Major impact on the project if it occurs	2: Minor impact	4: Major impact on the project if it occurs

Probability	**Impact**
5: Certain probability of occurrence	5: The project will stop
4: Major impact on project if it occurs	4: Major impact on the project functionality
3: 50% chance of occurrence	3: Likely to impact the project plan
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