CRM | ANALYSIS OF RISK

LEARNING GUIDE

RISK & INSURANCE
EDUCATION ALLIANCE

Analysis of Risk

THE CERTIFIED RISK MANAGER PROGRAM

Analysis of Risk

Control of Risk

Financing of Risk

Practice of Risk Management

Principles of Risk Management

Risk & Insurance Education Alliance

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Contents

A Letter from William J. Hold, President/CEO

We know that choosing the right professional development programs to strengthen your career can be challenging. There are many options for you to choose from; so how can you be sure that your time, efforts, and money are being invested and not wasted?

By partnering with Risk & Insurance Education Alliance, you can rest assured that you are also making the best educational choice for your career—no matter what step of your learning path you are on.

For the last 50 years, our designations have been regarded throughout the industry as symbols of quality and trust. Our practical insurance and risk management courses are taught by active insurance practitioners, include policies and forms currently used in the field, and guide you through real-world scenarios to give you a deeper understanding of what your clients are facing today. The knowledge and skills you develop in any one of our courses (or designation programs) can be put to use immediately.

You will build long-lasting relationships with your clients and stay ahead of industry trends, emerging risks, and products that are constantly evolving in our dynamic market. You will have access to the industry's latest learning materials and be the first to hear about new courses. With a learning path customized to fit your needs, you will be better equipped to protect your clients.

Have no doubt that your success is our priority. Whether you are new to your career or a seasoned professional, you are about to embark on a wonderful professional development journey. Thank you for choosing Risk & Insurance Education Alliance as your guide toward a thriving career.

Let's take the first step.

William J. Hold, M.B.A., CRM, CISR

President/CEO

To the Participant

Welcome to Analysis of Risk, part of the Certified Risk Manager designation program. This program will provide you with the core knowledge and tools you need to support your clients with analysis of their business risks and forecasting future losses. A Certified Risk Manager (CRM) is recognized as someone capable of analyzing risks, policies, forms, and claims data and communicating that understanding clearly to clients, carriers, and colleagues. As a participant in Risk & Insurance Education Alliance (RIEA) program of study, it is expected that you will not only gain knowledge that will give you greater success in your work, but that you will be challenged to make Risk & Insurance Education Alliance's core values of integrity, innovation, and imagination part of your daily practice. As experts in their fields, RIEA faculty, consultants, and academic directors—each with a commitment to assisting you in your efforts to achieve standards of excellence—have contributed to the content of this course. In this course, you can expect:

- engagement in the learning process
- clear learning objectives supported by essential content
- activities designed to strengthen understanding
- exposure to real-world examples and contexts

As representatives of Risk & Insurance Education Alliance (RIEA), we take great pleasure in welcoming you to this program and to our organization. We are committed to helping you become a successful Certified Risk Manager.

Program Overview

This program overview provides an at-a-glance view of the contents of this Learning Guide. Here you will find section goals as well as specific learning objectives for every section.

Section 1: Introduction to Risk Analysisin the Risk Management Process

Section Goal

In this section, you will become familiar with the definition of risk analysis, the types of risk analysis, and their key uses.

Learning Objectives

1. *Describe the key uses of risk analysis.*
2. *Discuss the purposes of qualitative and quantitative analysis and characteristics of each.*

Section 2: Qualitative Analysis

Section Goal

In this section, you will gain an understanding of the types and uses of qualitative analysis tools to help the organization set risk management priorities.

Learning Objectives

1. *Discuss the assessment of broad loss exposures that may have a financial impact on the organization but may be difficult to quantify.*
2. *Identify the characteristics of quality loss data and describe how those characteristics impact analysis.*
3. *Differentiate between the different data measurement tools and explain how they can be used in risk analysis.*
4. *Summarize the methods and purpose of root cause analysis and explain how risk managers use it to avoid recurrence of losses.*
5. *Distinguish between predictive analytics and catastrophe modeling and identify their uses.*

Section 3: Quantitative Analysis Tools

Section Goal

In this section, you will acquire a fundamental understanding of data-related statistics that will enable you to make statistical calculations and general observations on data sets.

Learning Objectives

1. *Understand how to calculate three measures of central tendency and interpret the effect of extreme values on each measure.*
2. *Understand how to calculate two measures of dispersion and explain how these measures are used by risk managers.*
3. *Describe the role of the standard deviation in a normal distribution and explain the differences between a normal and skewed distribution.*
4. *Be able to draw a simple histogram showing individual losses versus annual totals.*
5. *Forecast future losses by describing and calculating confidence intervals and simple linear regression.*

Section 4: Loss Forecasting

Section Goal

In this section, you will learn how to make predictions of frequency and severity by adjusting loss data to reflect current experience and future loss trends.

Learning Objectives

1. *Explain the different types of claim reserves and summarize why reserves are important to a risk manager.*
2. *Calculate ultimate losses for an organization.*
3. *Explain the necessary data requiring adjustment prior to loss forecasting and calculate a loss projection.*
4. *Summarize the different resources available to obtain loss development factors.*

Section 5: Time Value of Money Concepts

Section Goal

The goal of this section is to understand the time value of money concept, calculate values, and make decisions according to results.

Learning Objectives

1. *Utilizing proper terminology, explain the purpose of adjusting for the time value of money.*
2. *Compare inflows and outflows by calculating present and future values.*
3. *Using time value of money calculations, make determinations on capital investment projects.*

Section 6: Risk Analysis Applications

Section Goal

In this section, we will examine real-world applications of risk analysis, with a focus on net present value cost-benefit analysis.

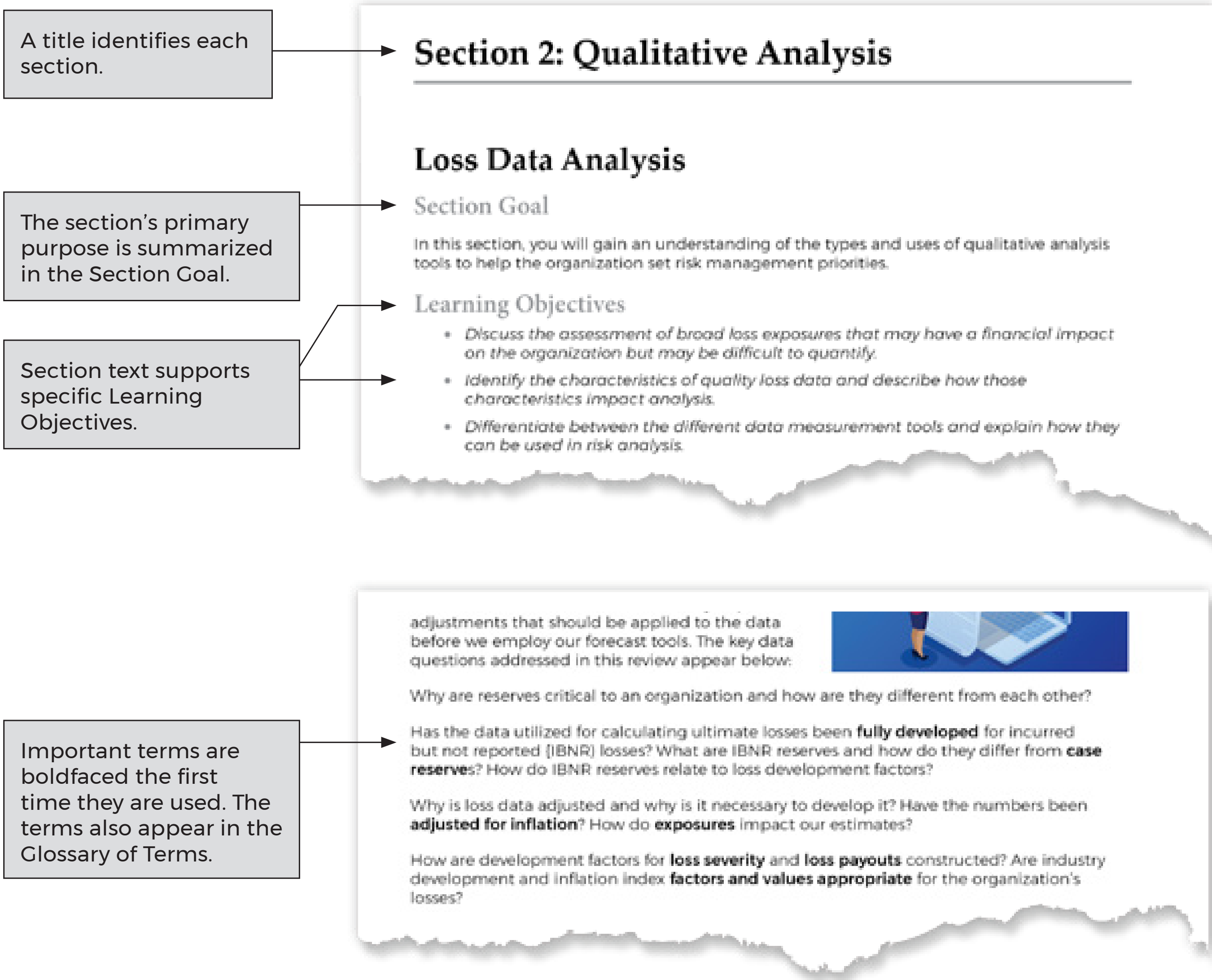
Learning Objectives

1. *Explain the importance and purpose of a net present value cost-benefit analysis to a risk management program.*
2. *Understand the steps required to calculate a net present value cost-benefit analysis when making investments in equipment and training.*
3. *Understand how to calculate a net present value cost-benefit analysis for decisions related to risk financing options.*
4. *Understand the issues related to quantitative and qualitative analyses.*

How to Use This Learning Guide

The Learning Guide you are using in this course is like all the learning materials published by Risk & Insurance Education Alliance; it has been written and authenticated by industry experts.

Each section in this learning guide shares the same features.



Section 2: Qualitative Analysis

Loss Data Analysis

Section Goal

In this section, you will gain an understanding of the types and uses of qualitative analysis tools to help the organization set risk management priorities.

Learning Objectives

- *Discuss the assessment of broad loss exposures that may have a financial impact on the organization but may be difficult to quantify.*
- *Identify the characteristics of quality loss data and describe how those characteristics impact analysis.*
- *Differentiate between the different data measurement tools and explain how they can be used in risk analysis.*

adjustments that should be applied to the data before we employ our forecast tools. The key data questions addressed in this review appear below:

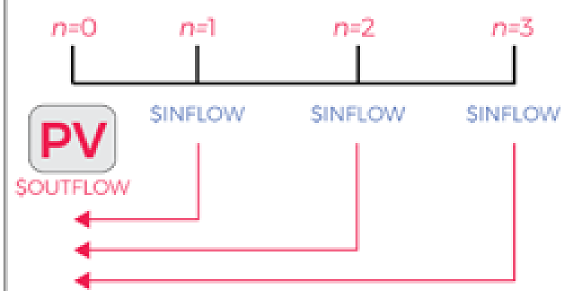
Why are reserves critical to an organization and how are they different from each other?

Has the data utilized for calculating ultimate losses been **fully developed** for incurred but not reported (IBNR) losses? What are IBNR reserves and how do they differ from **case reserves**? How do IBNR reserves relate to loss development factors?

Why is loss data adjusted and why is it necessary to develop it? Have the numbers been **adjusted for inflation**? How do **exposures** impact our estimates?

How are development factors for **loss severity** and **loss payouts** constructed? Are industry development and inflation index **factors and values appropriate** for the organization's losses?

Visuals such as diagrams, graphs, and tables support the text.

Characteristics	Considers TVOM
	Present Value  Assumptions of value of cash flows, discount rate, and time periods

Each section opens with an introduction and concludes with a summary.

Introduction to Quantitative Analysis Tools

In the previous section, we discussed the use of qualitative assessment in risk management. Equally as important is quantitative assessment, or the use of traditional, acceptable methods of assigning numerical value to risk exposures. Where qualitative analysis answers the question, "What?", quantitative analysis answers the question, "How much?"

Risk managers use statistics—the mathematical body of science that pertains to the collection, analysis, interpretation or explanation, and presentation of data—as part of the quantitative risk analysis process needed to properly control and finance risk. Since the volume of

Summary

Risk analysis is a critical component of the risk management process. There are many uses for risk analysis, including validation and refinement of loss data, prioritization of risk factors, and financial assessment, to name a few.

There are two types of risk analysis: qualitative and quantitative. Qualitative analysis asks the question "What?" and seeks to determine the impact that risks might have on an organization, while quantitative analysis seeks to use traditional, accepted methodology to answer the question, "How much?" Qualitative risk analysis techniques should be used in conjunction with quantitative risk analysis techniques. Both types of analysis are critical to making the right business decision or recommendation. A few key takeaways regarding qualitative and quantitative analyses include:

- Non-quantifiable risks are subject to identification and analysis.
- Qualitative risks that are not analyzed can cause significant

Examples describe real-world-style scenarios to enhance your understanding of the concepts presented.

Below are examples of the types of questions that can be answered through risk analysis. Throughout this course, we will walk through the steps of calculating the solutions to questions such as these.

1. *Jumping Jacks, Ltd., a manufacturer of jump ropes, has a five-year frequency of losses as follows:*

Year	Numbers of Losses
X1	120
X2	383
X3	247
X4	301
X5	199

a. *What will predicted losses be in Year X6?*

b. *What is the range of losses that might be expected to occur in Year X6?*

c. *What is the degree of certainty of these predictions?*

Check-Ins and Knowledge Checks help you test your understanding before moving forward.

Check-In

Directions: State whether each scenario is an outcome of under-reserving or over-reserving.

1. A company overstates their income, making their financial health look better than it really is.

   Under-reserving   Over-reserving

2. A company is unable to invest in a new project because they have allocated too much of their capital to reserves.

   Under-reserving   Over-reserving

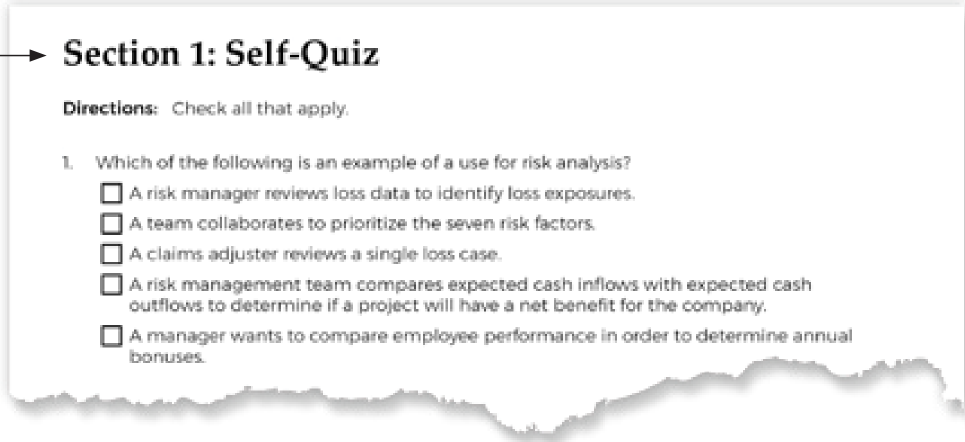
3. An accounting consultant reviews a company's books and notices a large redundancy in reserves.

   Under-reserving   Over-reserving

Knowledge Check

1. Describe a risk map and its uses.

Each section closes with a quiz to help you assess your learning.

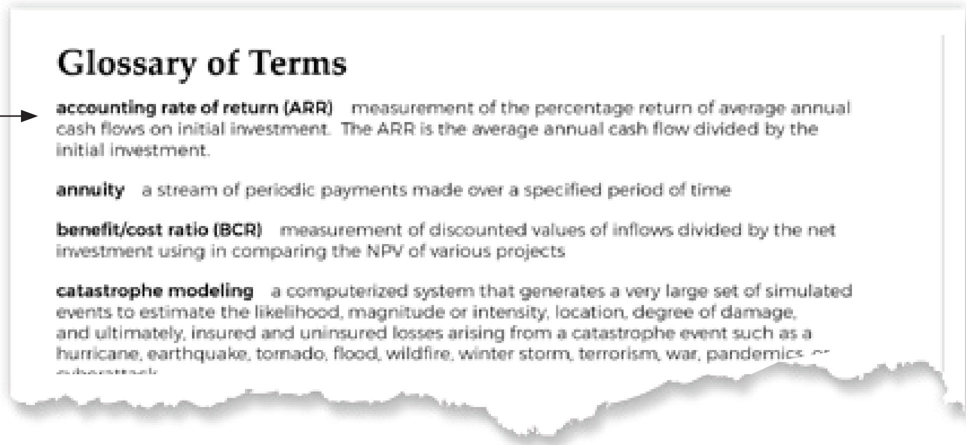


Section 1: Self-Quiz

Directions: Check all that apply.

1. Which of the following is an example of a use for risk analysis?
   - ☐ A risk manager reviews loss data to identify loss exposures.
   - ☐ A team collaborates to prioritize the seven risk factors.
   - ☐ A claims adjuster reviews a single loss case.
   - ☐ A risk management team compares expected cash inflows with expected cash outflows to determine if a project will have a net benefit for the company.
   - ☐ A manager wants to compare employee performance in order to determine annual bonuses.

A Glossary of Terms puts the Learning Guide's special vocabulary in one, easy-to-use location.



Glossary of Terms

accounting rate of return (ARR) measurement of the percentage return of average annual cash flows on initial investment. The ARR is the average annual cash flow divided by the initial investment.

annuity a stream of periodic payments made over a specified period of time

benefit/cost ratio (BCR) measurement of discounted values of inflows divided by the net investment using in comparing the NPV of various projects

catastrophe modeling a computerized system that generates a very large set of simulated events to estimate the likelihood, magnitude or intensity, location, degree of damage, and ultimately, insured and uninsured losses arising from a catastrophe event such as a hurricane, earthquake, tornado, flood, wildfire, winter storm, terrorism, war, pandemics

Section 1: Introduction to Risk Analysis in the Risk Management Process

Section Goal

In this section, you will become familiar with the definition of risk analysis, the types of risk analysis, and their key uses.

Risk analysis is the assessment of the potential impact that various exposures can have on the organization. It is a critical part of the risk management process, as once risks have been identified, they must then be analyzed before decisions can be made regarding the proper method to effectively control or finance them.

There are often scenarios where a risk manager can be asked to simply identify the pros and cons of a particular course of action. Analysis provides a risk professional with the foundation to build information to find the answers and make decisions within the risk management function. The challenge presented is there is no clear cut "right" answer. The course of action taken often depends on many variables: the appetite of the organization, the financial capability of the organization, the credibility and quality of the data utilized, the social responsibility of the company, and insurance market trends with regards to purchasing options, to name a few.

The process starts with the universally accepted first step in risk management analysis: identification of risks. For effective risk identification, we should have credible data for the quantitative analysis, with qualitative considerations to craft an answer to the question, "Should we take this action even if the numbers show that we can do this?" Alternatively, "Should we take this action even if the numbers show that we *can't* do this?"

You will begin the journey into risk analysis by reviewing and discussing the uses, types, and tools of risk analysis in the risk management process.

Learning Objectives

1. *Describe the key uses of risk analysis.*
2. *Discuss the purposes of qualitative and quantitative analysis and characteristics of each.*

Key Uses of Risk Analysis

Learning Objective

1. *Describe the key uses of risk analysis.*

1. Validation and Refinement of Loss Data

The risk manager can use the review of loss data as a loss exposure identification method in a variety of ways. To ensure the quality of loss data, the risk manager must be able to ensure statistical credibility and completeness and to identify changes in loss environment, as well as consider other variables.

To make proper risk analysis decisions, many factors must be considered prior to using data as a decision tool. For example:

- **A substantial time period and sample size:** A small number of highly variable losses over a short period of time have limited predictive value. To be statistically credible, there should be a substantial number of losses extended over a sufficient period of time.
- **Stability:** There should also be minimum variability in frequency and severity of losses and stable operations over time (consistent size and makeup of exposure base).
- **Consistency and validity:** Comparisons of data are only valid if made on an “apples-to-apples” basis. To ensure completeness, validity, and consistency of data, the data must have the same reporting format, the criteria for reporting data should be consistent and well understood, and the same definitions should be used for hazards, cause, and injury type. There should be a system in place for validity checks to limit duplicate reporting and incorrect coding. The loss runs should have consistent policy years, deductibles, and valuation dates. If they do not, you will need to adjust the data to make them consistent.
- **Accounting for changes:** The quality of loss data can be affected by changes in the loss environment that may have influenced past losses and the predictability of future losses. This would include:
  - Introducing a new product or service
  - Any changes in equipment, materials, or work process
  - Any acquisitions, divestitures, or restructuring
  - Legal and regulatory changes
  - Changes in social and economic environment
  - Any additional or resolved labor and management issues
  - Changes in statutory benefits, inflation, or any other changes in wages
  - Changes in incentive or safety awards programs

- Changes in deductible
- Changes in insurance carriers or third-party administrators
- Changes in claim handling procedures
- Changes in insurance coverage that may affect loss reporting (exclusions or broadenings)

2. Prioritization of Risk Factors

The seven main areas of qualitative risk assessment are:

a. Management's appetite for risk

b. Innovation, product development, and marketing

c. Contractual analysis

d. Compliance and regulatory analysis

e. Human resources and employee safety issues

f. Social responsibility and citizenship analysis

g. Technology and internal policies

Individually or in combination, these organizational directives can and will have an impact on the risk management department's priorities and decisions.

3. Financial Assessment

The purpose of a financial assessment is to identify and evaluate those broad loss exposures that may have a financial impact on the organization and are difficult to quantify. These broad loss exposures include profitability, revenue growth, earnings per share, and financial capacity.

The risk manager should consider how risk management activities, initiatives, and decisions affect these broad loss exposures. If available, an excellent source for this information is a company's annual report and quarterly filings.

4. Insurance Market Analysis

Insurance market analysis is concerned with the overview of the market, maximum probable loss versus maximum possible loss, insurance pricing, and loss costs. These factors will affect the decision of how much insurance to purchase and the amount of retention.

5. Classification of Loss Data

Identification methods allow us to analyze those qualitative risks that could have a potentially harmful impact on the organization, even though they are not subject to financial measurements.

Classification scales depict relative values that are not always quantified—specifically, the impact of frequency and/or the severity of losses. **Frequency** is the number of times a loss occurs and is normally categorized as almost unlikely, possible, or probable. **Severity** is the dollar amount of each loss and is normally categorized as high, medium, or low.

However, there is no objective level for unlikely, possible, or probable, or for high, medium, or low. These are descriptive labels on a continuum and can be quite subjective.

6. Projection of Losses and Ranges of Losses

The risk manager will utilize loss projections to assist in negotiation of insurance renewals, establish limits and deductible amounts on those renewals, and establish and implement self-insurance programs or captives. Pricing of renewals is directly tied to ultimate loss calculations and will impact the department's total cost of risk. Deductible-paid retrospective programs, captives, and self-insured programs all require collateral, which is directly tied to ultimate losses.

7. Net Present Value (NPV) Analysis

Financial decisions, including most risk management decisions, involve cash inflows and cash outflows. Because cash inflow and cash outflow often occur in different time periods, the only way to correctly compare the benefits to the costs is to use **time value of money (TVOM)** concepts to determine the **present value (PV)** of the benefits and costs. When making financial decisions, managers expect the present value of the benefits to exceed the present value of the costs. These concepts will be discussed at greater length in Section 4 of this Learning Guide.

Opportunities for risk managers to apply NPV analyses include decisions related to increasing or decreasing retention levels, the potential investment for risk control programs, liability claim settlements, and the potential formation of a captive.

8. Cost-Benefit Decision Making

Internal projects often are competing for the same source of limited funds. The risk manager may be faced with capital rationing when deciding on projects. We can employ tools that allow us to make decisions as to which project options represent the greatest return for the investment. One such tool is a cost-benefit analysis (CBA), which is used to measure the benefits of a project minus the costs associated with taking that action. The CBA can also include intangible benefits and costs, as well as the impact on employees or customers.

9. Review of Insurance Program Structure (Retentions, Coverages, Limits)

The risk manager must be able to satisfy insurance underwriting requirements when insurance is selected as a risk financing option. Working with an agent/broker or carrier, the risk manager will use loss data to negotiate premiums and coverage restrictions, set equitable premiums for retrospectively rated programs, and establish the dollar amounts of letters of credit or other required collateral.

Deductible limits are often established by the predictability of losses under specified limits for an organization. Risk analysis allows us to apply tools to determine the variability of data exceeding differing retentions supporting the deductible selection process.

10. Establishing a Basis for Allocating Premiums and Loss Costs (Cost Allocation Programs)

When establishing a basis for allocating premiums and loss costs, the risk manager can create incentives or disincentives to help reduce and control losses by charging back losses to the departmental level. Typically, the only lines of insurance that should be allocated are those for which the cost center manager can impact premiums and losses. These include workers' compensation, auto liability, general liability, and employment practices liability, but not fiduciary liability or directors and officers liability.

The risk manager should use an objective basis for allocating the total cost of risk. Considerations often include a blend of exposure base and experience base, assigning cost of insurance and cost of losses to the cost center responsible. Key to allocation is to develop a program whereby the allocation of one loss does not erase the positive operations results of a location/division. To address this challenge, many risk managers use a "minimum/maximum" model to prevent a single shock loss or one bad year from overly penalizing a cost center. Frequently, the risk manager will consult with the finance department (the treasurer or comptroller) on these cost allocations.

11. Evaluate Cost Effectiveness of Alternative Methods for Financing Losses

When evaluating potential costs/benefits of loss control alternatives, the risk manager can use loss data to assist in deciding which risks to avoid, which to control, which to transfer, and which to finance. The risk manager can analyze loss data to assist in the risk financing decision between retention and insurance (internal versus external financing), and whether a loss-sensitive or cash flow financing plan is appropriate.

12. Benchmarking Opportunities

Benchmarking is continually *comparing* an organization's performance against that of the *best in industry* (competitors) or *best in class* (those recognized in performing certain functions) to determine what should be *improved*. As we track all operations, we often benchmark those operations to an expected baseline to measure performance. There are tremendous benefits to comparing performance to both external competitors and internal operations; both internal and external benchmarking can be a key indicator of the risk management department's progress.

Senior management will often request data that demonstrates how the company compares with others in the industry, and how the performance of the organization compares from one year to the next, or from one period to the next.

Internal benchmarking includes gathering and analyzing loss data, which can also be used as a method for evaluating performance between operating units, vendors, and in-house adjusters, as well as benchmarking loss experience. By comparing the performance of similar divisions internally, best practices can be implemented across all the company's operations.

External benchmarking can highlight trends within the industry and opportunities for improvement where results do not measure up to those with similar industry operations. Key challenges face the risk manager since no two companies have identical operations, locations, activities, and/or risks. As mentioned previously, there must be systems in place to ensure consistency and validity when making comparisons.

The benefits of benchmarking include the ability to track continued improvement, enhance creative thinking and innovation, and prioritize opportunities for growth.

13. Risk Management Performance

The risk manager can also use loss data to identify the causes of the most frequent and serious losses and to recognize trends quickly and easily in loss experience. Analysis and reporting of loss data help management focus on the organization's overall total cost of risk, gain support for loss control efforts, and evaluate potential costs/benefits of loss control alternatives. Only by lowering the total cost of risk (TCOR) can a program view its actions as supportive to the organization.

With so many varied uses, it is not difficult to see why risk analysis is a key step in the risk management process, and why it is essential to effectively carry out business operations. Now that we have a better understanding of the ways in which risk analysis can be used, we will examine the two types of risk analysis, and how they can work together to provide a complete picture of the exposures facing an organization.

Knowledge Check

Peter is preparing a presentation for the board on his analysis of current exposures. He will use classification scales to present his data. Explain how classification scales are used in data analysis and provide the scales for severity.

Peter will also show how financial assessment is used as a risk analysis tool. Explain the use of financial assessment in risk analysis.

Types of Risk Analysis
(Purpose, Characteristics, Methods)

Learning Objective

2. *Discuss the purposes of qualitative and quantitative analysis and characteristics of each.*

There are two types of risk analysis: qualitative and quantitative. **Qualitative analysis** focuses on loss exposures that cannot be measured precisely, including non-monetary considerations such as the organization's reputation and brand image. **Quantitative analysis** uses widely accepted methods to calculate numerical values for risks and loss exposures. As we will see, it is important for risk managers to employ both qualitative and quantitative methods of analysis to gain a full understanding of an organization's potential loss exposures.

Qualitative Risk Analysis

The "What" Analysis: "Should We Do This?"

The purpose of qualitative risk assessment is to identify those loss exposures that cannot be easily measured by traditional statistical or financial methods and to understand their impact on the organization's ultimate risks and performance. Qualitative analysis attempts to assign relative values to determine the implications and scope of effects risks have on the organization. They do not try to assign hard financial values to either the assets, expected losses, or cost of controls, but support management in understanding the potential impact of the organization's ultimate risks on performance.

Qualitative analyses are often conducted using questionnaires, surveys, task forces, workshops, and collaboration with a variety of internal and external groups knowledgeable about the organization. Qualitative interpretation of data importantly addresses the critical questions facing the risk manager: should we implement the proposed project, and what potential impact will it have on the organization's reputation or morale.

Methods of Qualitative Analyses

Assessment Methods

1. **Risk Assessment –** used to identify and assess those loss exposures that cannot be easily measured by traditional statistical or financial methods and to understand their impact on the organization's ultimate risks and performance
2. **Financial Assessment –** used to identify and assess those broad loss exposures that have a financial impact on the organization but may be difficult to quantify
3. **Loss Data Assessment –** used to identify and apply various methods of assessing loss data, and to analyze the impact those losses may have on the organization's risk management policy and the ultimate total cost of risk.

Examples of specific tools used in qualitative assessment are described later in this section.

Quantitative Risk Analysis

The "How Much" Analysis

Quantitative analyses attempt to accurately measure risks by using acceptable traditional methodologies to calculate relative numerical values. For example, how many losses are expected to occur next year? Is the NPV positive for the proposed loss control project to be implemented next year? What is the present value of the proposed deductible losses for next years' proposed program? What is the present value of a settlement on a liability claim with a long payout period? Examples of tools used in quantitative assessment are included later in this section.

Reasons to Use Both Qualitative and Quantitative Analyses

There is a difference between qualitative analysis and quantitative analysis. Qualitative analysis cannot be precisely measured and asks the question: "What?" With qualitative analysis, we want to determine the implications and scope of the effect that risks have on an organization, without assigning hard financial values to assets, expected losses, and cost of controls. Quantitative analysis asks the question "How much?" and is precisely measured by acceptable traditional methodology.

As an illustration of qualitative versus quantitative risk analysis, consider the plight of the snail darter.

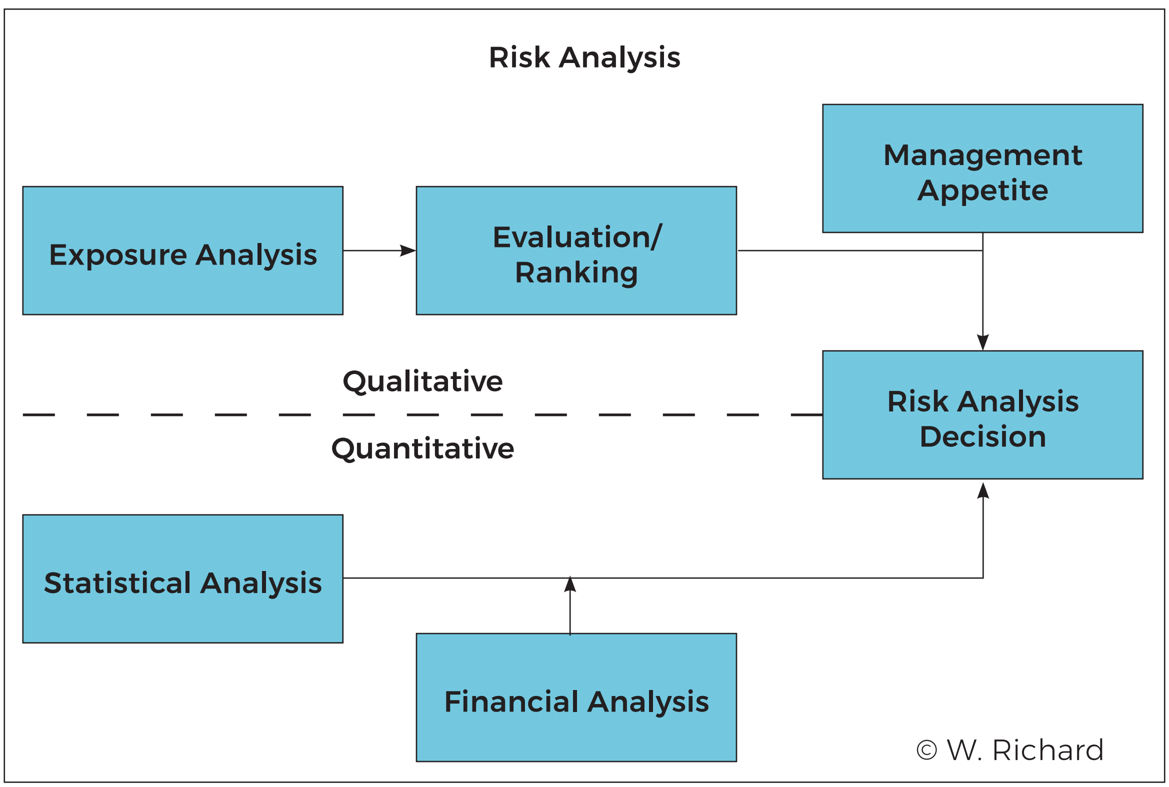
In 1973, construction on the Tellico Dam on the Little Tennessee River was stopped because the snail darter, a tiny fish, would be adversely affected by the change the dam would cause in its habitat.

Clearly, the quantitative aspects of the case (the engineering technology and Congressional approval of the funding) suggested the project should be undertaken. However, the qualitative aspects of the case (the endangerment of the snail darter, a fish roughly the length of three paperclips that is found only in the lower part of the Little Tennessee River and has no obvious commercial value) raised the question of whether the project should be undertaken. This led to a Supreme Court interpretation of the Endangered Species Act that completely stopped the project which was well underway until revisions of the Act were passed and a plan for transplanting the species to alternative, but similar, rivers was developed.

Key Reasons to Use Both Qualitative and Quantitative Analyses:

1. Valid answers are required in the analysis, e.g., predicted losses, value of claims, present value calculations. (Qualitative and Quantitative)
2. Costs and benefits are the primary factors of decision making. (Quantitative)
3. Non-monetary considerations are part of the decision-making process, e.g., reputation, morale, and citizenship. (Qualitative)

We can make a qualitative assessment when we look at corporate objectives and risk management policy and ask: Are they in conflict with each other, or are they consistent? Does risk management policy support the overall achievement of corporate objectives? Some ways the risk management program can help senior management stay on track with objectives are by providing a means of handling unexpected drains in capital or interruption of operations and by providing management with loss data that may affect the operations' objectives.



We need both qualitative and quantitative analyses when making analytical decisions because each provides different and important information about losses. We use qualitative analysis to know what losses are occurring. We use quantitative analysis to know how much those losses cost. Next, we will explore some of the tools that can be used to assess risk both qualitatively and quantitatively.

Knowledge Check

1. Distinguish between the two types of risk analysis.

2. Explain how qualitative factors and consideration can affect risk management decisions.

3. The risk management team at your organization presents you with a risk analysis for a new project. After creating in-depth loss projections and a thorough cost-benefit analysis, they feel that your organization should take on the project. Has the team conducted a complete risk analysis? Explain why or why not.

Risk Analysis Tools

Tools and models support the risk manager's ability to quantify both the likelihood events will occur and the impact they will have on the organization. Many of these tools that will be covered throughout this course are listed below.

Table: 1.1

Risk Analysis Toolbox		
Tool	**Definition**	**Qualitative or Quantitative?**
Tools Used to Assess the Likelihood an Event Will Occur		
Loss Analysis	Application of various methods of analyzing loss data to identify and understand the potential impact those losses may have on the organization's risk management program and the total cost of risk	Qualitative
Risk Mapping	A visual analytical tool utilized to communicate key risks; it presents the risks with the highest impact and probability; can range from simple to complex depending upon the organization's needs and capabilities *Note: Risk mapping also measures potential impact.*	Qualitative
Heat Mapping	A visual representation of complex data sets that uses colors to concisely indicate patterns or groupings, thus making data more actionable	Qualitative
Root Cause Analysis (RCA)	A systematic method to drill down to the root cause of an incident	Qualitative
Risk Factor Analysis	Analyzes characteristics of a risk or exposure, condition, or behavior that increases the potential for loss	Qualitative
Probability Analysis	Determines the chance of something (predicted data) occurring within a stated time, ranging from 0 (impossibility) to 1 (certainty)	Quantitative
Linear Regression (Regression model used as a predictor)	A statistical technique of modeling the relationship between variables by fitting the "best" line to the data; there are different types of linear regression—in this course we will review simple linear regression	Quantitative

Table: 1.1

Risk Analysis Toolbox		
Tool	**Definition**	**Qualitative or Quantitative?**
Tools Used to Assess the Impact of an Event Should It Occur		
Risk Register	A method that prioritizes risks based on a scale of anticipated potential impact	Qualitative
Delphi Method	A series of surveys/questionnaires used to form a consensus opinion on the anticipated impact of a risk	Qualitative
5-Whys Analysis	Five Whys is an iterative technique to explore the cause and effect relationships underlying a particular problem. The primary goal of the technique is to determine the root cause of a defect or problem by repeating the question, "Why?" Each answer forms the basis of the next question.	Qualitative
Payback Analysis	The measurement of the length of time needed to recoup the cost of a capital investment; it looks at how long it will take to pay off the investment with the non-discounted cash flow derived from the asset or project	Quantitative
Accounting Rate of Return	The measurement of the percentage rate of return of average annual cash flows on initial investment; the percentage of return does not consider the time value of money or cash flows	Quantitative
Cost-Benefit Analysis	The evaluation of a project or option by determining if the PV of expected inflows exceeds the PV of expected outflows	Quantitative
NPV Analysis	The measurement of the PV of future cash inflows compared to the net investment of a project; the first step in conducting cost-benefit analysis	Quantitative
Internal Rate of Return (IRR Method)	The calculation of an "unknown" discount rate that makes the PV of future cash inflows exactly equal to the net investment at time zero; only the project with the highest rate of return is acceptable; the IRR must exceed the cost of capital to the organization	Quantitative
Loss Projections or Forecasts	Predicting future losses through an analysis of past losses	Quantitative

Table: 1.1

Risk Analysis Toolbox		
Tool	**Definition**	**Qualitative or Quantitative?**
Tools Used to Assess the Likelihood an Event Will Occur		
TCOR Calculations and Analysis	Evaluating the impact of risk management decisions on the sum of all quantified costs and expenses associated with the risk management function of an organization; TCOR includes insurance costs, retained losses, risk management department costs, outside service fees, and quantified indirect costs	Quantitative

As you can see, risk managers have a wide variety of both qualitative and quantitative tools at their disposal when analyzing risks.

Summary

Risk analysis is a critical component of the risk management process. There are many uses for risk analysis, including validation and refinement of loss data, prioritization of risk factors, and financial assessment, to name a few.

There are two types of risk analysis: qualitative and quantitative. Qualitative analysis asks the question "What?" and seeks to determine the impact that risks might have on an organization, while quantitative analysis seeks to use traditional, accepted methodology to answer the question, "How much?" Qualitative risk analysis techniques should be used in conjunction with quantitative risk analysis techniques. Both types of analysis are critical to making the right business decision or recommendation. A few key takeaways regarding qualitative and quantitative analyses include:

- Non-quantifiable risks are subject to identification and analysis.
- Qualitative risks that are not analyzed can cause significant damage to the organization.
- Qualitative risk analysis requires a different thought process from that of quantitative analysis.

There are a number of qualitative and quantitative risk analysis tools that can be used to measure the likelihood an event will occur and the potential impact of that event occurring. These tools will be discussed at greater length in subsequent sections.

Questions that Risk Analysis Answers

Below are examples of the types of questions that can be answered through risk analysis. Throughout this course, we will walk through the steps of calculating the solutions to questions such as these.

1. *Jumping Jacks, Ltd., a manufacturer of jump ropes, has a five-year frequency of losses as follows:*

Year	Numbers of Losses
X1	120
X2	383
X3	247
X4	301
X5	199

a. *What will predicted losses be in Year X6?*

b. *What is the range of losses that might be expected to occur in Year X6?*

c. *What is the degree of certainty of these predictions?*

2. *Robert is a regional distributor of Jumping Jacks products. He stores his inventory in a warehouse his organization owns. Robert is considering either installing smoke detectors to reduce the impact of fire losses at a cost of $50,000, or renting additional space at another location to separate his inventory at an additional cost of $60,000.*

   Which should he do?

3. *A safety consultant suggests Robert also consider a sprinkler system that will cost $16,000 to install. Its installation will reduce Robert's property insurance premiums by $2,000, annually. The expected life of the sprinkler system is 15 years. Robert's CFO states the company should earn 16% on its investment.*

   Should Robert install the sprinkler system?

4. *Jumping Jacks, Ltd., has just hired you as its first risk manager. During your first week, the CFO has presented you with a list of losses that occurred over the last five years. He states that he believes Jumping Jacks, Ltd., would save money by reducing controllable losses and retaining the remainder, instead of buying very expensive insurance.*

   a. *How would you verify the loss data?*
   b. *How would you classify the loss data?*
   c. *How would you determine the viability of a retention program?*
   d. *How much should you retain?*
   e. *Would you continue to buy insurance, and if so, how much would you buy?*
   f. *What level of deductible would you buy?*

Review of Learning Objectives

- *Describe the key uses of risk analysis.*
- *Discuss the purposes of qualitative and quantitative analysis and characteristics of each.*

Resources

Important concepts related to the Learning Objectives in this chapter are summarized in separate videos. Online participants can use the links to access the videos. Classroom learners can access the videos at RiskEducation.org/RAresources.

Introduction to Analysis in Risk Management

Section 1: Self-Quiz

Directions: Check all that apply.

1. Which of the following is an example of a use for risk analysis?
   - ☐ A risk manager reviews loss data to identify loss exposures.
   - ☐ A team collaborates to prioritize the seven risk factors.
   - ☐ A claims adjuster reviews a single loss case.
   - ☐ A risk management team compares expected cash inflows with expected cash outflows to determine if a project will have a net benefit for the company.
   - ☐ A manager wants to compare employee performance in order to determine annual bonuses.
   - ☐ A risk manager uses loss projections to negotiate policy renewals.

Directions: State whether each tool/method shows qualitative or quantitative analysis.

1. Loss projections ____
2. Risk mapping ____
3. Cost-Benefit Analysis ___________________________________
4. Delphi Method ____
5. Loss Data Assessment __________________________________
6. Cash Discounting Calculations ___________________________
7. Root Cause Analysis ___________________________________
8. TCOR Calculations ____________________________________
9. Financial Assessment ___________________________________
10. NPV Calculations and Analysis ___________________________

Section 2: Qualitative Analysis

Loss Data Analysis

Section Goal

In this section, you will gain an understanding of the types and uses of qualitative analysis tools to help the organization set risk management priorities.

Learning Objectives

1. *Discuss the assessment of broad loss exposures that may have a financial impact on the organization but may be difficult to quantify.*
2. *Identify the characteristics of quality loss data and describe how those characteristics impact analysis.*
3. *Differentiate between the different data measurement tools and explain how they can be used in risk analysis.*
4. *Summarize the methods and purpose of root cause analysis and explain how risk managers use it to avoid recurrence of losses.*
5. *Distinguish between predictive analytics and catastrophe modeling and identify their uses.*

Introduction to Qualitative Risk Assessment

In Section 1, we introduced the concepts of qualitative and quantitative risk assessment, both of which are essential to conducting a thorough risk analysis. As you may recall, the purpose of qualitative risk assessment is to identify those loss exposures that cannot be easily measured by traditional statistical or financial methods and to understand their impact on the organization's ultimate risks and performance.

There is a difference between qualitative analysis and quantitative analysis. Qualitative analysis cannot be precisely measured and asks the question, "What?" With qualitative analysis, we want to determine the implications and scope of the effect that risks have on an organization without assigning hard financial values to assets, expected losses, and cost of controls.

Quantitative analysis asks the question, "How much?" and is precisely measured by acceptable traditional methodology. We need both quantitative and qualitative analysis because each provides different, important information about losses. We use qualitative analysis to know what losses are occurring. We use quantitative analysis to know how much those losses cost.

We can make a qualitative assessment when we look at corporate objectives and risk management policy and ask: Are they in conflict with each other, or are they consistent? Does risk management policy support the overall achievement of corporate objectives? The risk management program can help senior management stay on track with objectives by providing a means of handling unexpected drains in capital or interruption of operations, and by providing management with loss data that may affect the operations' objectives.

Qualitative Risk Assessment Areas

Learning Objective

1. *Discuss the assessment of broad loss exposures that may have a financial impact on the organization but may be difficult to quantify.*

As discussed in Section 1, the seven main areas of qualitative risk assessment are:

1. Management's appetite for risk
2. Innovation, product development, and marketing
3. Contractual analysis
4. Compliance and regulatory analysis
5. Human resources and employee safety issues
6. Social responsibility and citizenship analysis
7. Internal policies

Now, we will take a deeper look into how these areas can be assessed to effectively prioritize risks.

In determining management's **appetite for risk**, review the company's history, long-term objectives, and its growth mode or location in the growth cycle. Does the organization have a history of taking risks? Has it been a stable, continuous-growth company? Is the organization a start-up operation, or is it established, having been around for years? Is the organization in a type of industry that historically takes risks, like technology, or one that does not, such as the confectionery industry? Does the organization's public image support risk-taking? Does the organization have more appetite for risk than it has financial ability to retain the risk?

When assessing **innovation, product development,** and **marketing,** consider how critical these activities are to the organization. Does the survival of the organization depend on creating new and better products (as is true in the high-tech arena), or is it a more sedate, stable industry? What is the market position and market share of the organization? Who is the competition and are they risk-takers?

Contractual analysis means understanding the effects of contracts on the company. Is the company assuming or transferring risk to others through its contractual agreements? Is the legal department considering the risk factors included in each contract?

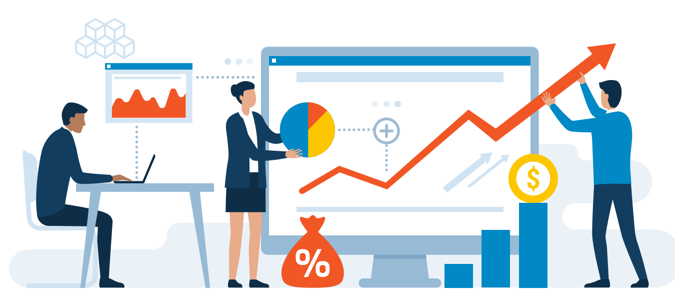
In the **compliance and regulatory analysis** area, is the organization subject to heavy regulation? Is management aware of regulatory governmental requirements? Does the company have an organizational structure that monitors changes in laws and regulations? Has the organization been assessed any penalties or fines, and how did that affect the public image of the organization? What is the history of enforcement?

Human resources and employee safety issues are an important part of the qualitative risk assessment area. Does the organization have a union? Has management been receptive to safety programs? Do safety programs exist and are they followed? Have safety issues impacted employee productivity? Is the organization subject to possible terrorist acts against employees or facilities? Does the organization have a security plan?

Social responsibility and citizenship analysis includes determining whether the organization has a high profile among the general public or within its industry segment. Is management concerned with such issues? What would be the effect of negative press?

Internal policies also need to be reviewed as part of the qualitative risk assessment. Audit and oversight (internal, external, and board involvement), employment issues (leasing, contract, seasonal, mobile, and employment practices), product guarantees, and product recall should be evaluated. Does the organization have an ethics code of conduct with related accountability? Are outside auditors used?

Financial Assessment



The purpose of a financial assessment is to identify and evaluate those broad loss exposures that may have a financial impact on the organization and are difficult to quantify. These broad loss exposures include profitability, revenue growth, earnings per share, and financial capacity. The risk manager should consider how risk management activities, initiatives, and decisions affect these broad loss exposures, and how these exposures affect risk management activity. If available, an excellent source for this information is a company's annual report, and quarterly filings.

Profitability is concerned with adequacy of return in either total dollars, earnings per share, profit margins, or return on equity. Is the organization meeting its profitability goals? Where does the organization stand in terms of profitability measures compared with their competitors, or the industry as a whole? How critical is profitability to the organization? What is the organization's profit margin? What is the nature of the organization, and where is it in the growth cycle?

Revenue growth is concerned with the growth of revenue relative to growth in expenses and fixed costs. Think of total revenue of the company's industry as a pie. Is the pie simply getting bigger, or is the company's slice of that pie getting larger? In other words, is the organization improving its market share compared to competition?

The final area of qualitative financial assessment, **financial capacity** is ability to fund the activities and investments the organization wants or needs to do. The risk manager should look at current needs versus future opportunities, internal financing versus external financing or transfer options, liquidity and cash flow, long-term debt, and the cost of capital (credit rating, borrowing costs, and outstanding letters of credit).

Insurance Market Analysis

Insurance market analysis is concerned with the overview of the market, maximum probable loss versus maximum possible loss, and insurance pricing and loss costs. These factors will affect the decision of how much insurance to purchase and the amount of retention.

Market overview asks if the insurance market is hard or soft in both the primary and reinsurance markets, and if the insurance market is willing to cover the organization's risk. Also consider "unbundling" opportunities in the company's risk management program, tailoring of insurance products and policies (manuscript policies for example), and the financial positions of the organization's insurance carriers (solvency and company financial or claims-paying ratings).

Maximum probable loss versus maximum possible loss analyzes the values exposed to loss in both current and future projections. Probable maximum loss for a given peril, under normal circumstances, is the most likely loss to occur. Maximum possible loss is the greatest damage that could occur in a loss. Assessment of maximum possible loss is frequently forgotten, but this exposure is the most critical, since it absolutely will threaten the organization's survival. The risk manager must assess the organization's ability to procure adequate financing to cover the maximum possible loss and to manage what cannot be financed.

The risk manager must understand the fundamentals of **insurance pricing and loss costs.** The astute risk manager knows the cost of insuring predictable losses will nearly always be greater than the cost of retaining them. If the risk manager can accurately predict losses, so can the underwriter, and the underwriter will add a "premium" for the unfavorable variance in loss, plus acquisition expenses such as underwriting costs, commissions, taxes, and profit. The insurance premium will normally equal the expected losses divided by the complement of the insurance company's expense ratio.

The risk manager is always concerned with **the amount of insurance to purchase.** To determine this, he/she must determine the value of the exposure, the ability to absorb the maximum possible loss, the willingness to absorb the maximum possible loss, and the value and cost of available insurance.

An organization predicts ten losses, each of $10,000, and an insurance company expense ratio of 35%. What will it cost to transfer the losses to an insurance company?

Expected Premium Formula:

$$\text{Expected Premium} = \frac{\textbf{Average Frequency x Average Severity} \ \textbf{(Expected Losses)}}{\textbf{1 – Expense Ratio}}$$

$$\frac{10 \times \$10{,}000}{1 - 0.35} = \frac{\$100{,}000}{0.65} = \$153{,}846$$

Expected Premium = $153,846

Expected Losses = $100,000

On average, it will cost $1.54 to transfer each $1.00 of loss to the insurance company, as $153,846 > $100,000.

Though certain loss exposures can be difficult to quantify, this does not lessen the financial impact that they can have on an organization. Qualitative assessment is an essential component of risk analysis because it helps an organization to identify types of exposures. By examining each of the seven risk assessment areas, as well as conducting financial assessments and insurance market analysis, an organization can identify the scope and potential impacts of these hard-to-quantify exposures.

Knowledge Check

1. You are a new risk manager with a new software/technology startup. Choose three of the seven main areas of qualitative risk assessment that you feel might be priorities for this type of company and explain their significance.

2. Your company is especially concerned with profitability. Explain the type of qualitative assessment that might be most important to your organization and describe its main components.

Qualifying Data for Analysis

Learning Objective

2. *Identify the characteristics of quality loss data and describe how those characteristics impact analysis.*

Loss Data Analysis

The purpose of loss data analysis is to identify and apply various methods of assessing loss data, and to identify and understand the impact those losses may have on the organization's risk management policy and their ultimate total cost of risk. The *quality* of the data is of major concern in loss data analysis.

Evaluating and Ensuring the Quality and Credibility of Loss Data

To ensure the quality of loss data, the risk manager must be able to ensure statistical credibility and completeness, and to identify changes in loss environment, as well as consider other variables.

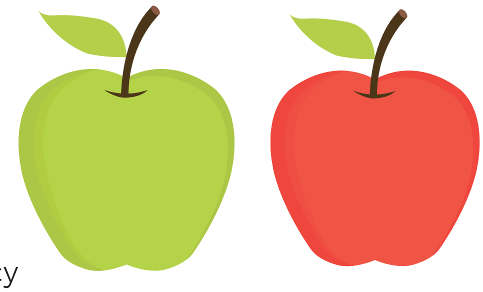
Valid Data Sets

A small number of highly variable losses over a short period of time have limited predictive value. In other words, for the analysis to be statistically credible, there should be a substantial number of losses extended over a sufficient period of time. One year is never enough, and even five years may be suspect (despite the insurance underwriter's insistence on that time frame).

However, more years are not always better. For example, if 20 years of losses are used for employee injuries, technology in the workplace may have changed over that lengthy time period, biasing the results.

There should also be minimum variability in frequency and severity of losses, and stable operations over time (consistent size and makeup of exposure base). A key to improving the quality and format of data is to work closely with third-party administrators and insurance carrier claims departments. Even then, the formats and practices of outside organizations such as third-party administrators and insurance carriers are primarily designed for their convenience and use, not for the risk manager's credibility.

Consistency in Reporting



Comparisons of data are invalid if comparisons are not made on an "apples-to-apples" basis. To ensure completeness, validity, and consistency of data, the data must have the same reporting format, the criteria for reporting data should be consistent and well understood, and the same definitions should be used for hazards, cause, and injury type. There should be a system in place for validity checks to limit duplicate reporting and incorrect coding. The loss runs should have consistent policy years, deductibles, and valuation dates. If they do not, data manipulation should be used to make them consistent. Also, incurred but not reported (IBNR) reserves should be considered. (Some risk managers use a "comparison period" as opposed to a "policy year.") Any risk management information system (RMIS) should allow selection of any period for comparison, e.g., the policy may be on a July 1 renewal period, but the risk manager wants to do comparisons on a calendar year basis.

The quality of loss data can be affected by changes in the loss environment that may have influenced past losses and the predictability of future losses. This would include changes in areas such as:

- New products or services
- Equipment, materials, or work process
- Any acquisitions, divestitures, or restructuring
- Legal and regulatory requirements
- Social and economic environment
- Any additional or resolved labor and management issues
- Statutory benefits, inflation, or any other changes in wages
- Incentive or safety awards programs
- Deductibles
- Insurance carriers or third-party administrators
- Claim handling procedures
- Exclusions or broadenings in insurance coverage that may affect loss reporting
- Demographics, e.g., age, gender, education level, ethnic background, or turnover.

Organization of Data

Another consideration regarding the quality of data is the organization of the data. The typical loss run, or loss history, prepared by an insurance carrier or many third-party administrators is grouped according to policy period, and within the policy period, losses are shown chronologically. While there is an important reason for grouping losses by year, the risk manager should consider other possible sorting options, such as size of loss, date of reporting, department or location, day of week, or any other criteria that will address the needs of the risk manager.

Additional Considerations

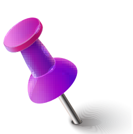
Other considerations that could affect the credibility and evaluation of data would be the cost of collecting data, any difficulty in collecting data, and the relevance and usefulness of data. There is a point of diminishing returns when the cost to collect the last possible bit of detail does not add any value to the claims settlement and recording process. The data collected must be relevant to the problem the risk manager is attempting to solve and it must be useful in that exercise. Finally, the risk manager must be acutely aware of the need to secure confidential data and protect it from improper disclosure or from improper access or use.

Characteristics of Quality Loss Data

Without a degree of comfort in each of the following areas of data quality, it is impossible to make accurate projections of loss trends.

Completeness – There must be enough loss data to make an analysis meaningful. The number of years of data required varies by type of exposure or line of insurance. Generally, five years of data is considered appropriate, although more years are always preferred. With some types of exposures or lines of coverages, 20 or more years are desired. However, the risk manager must be aware of possible events over the time period, such as implementation of a new loss control measure (or removal of such a measure), technological change (e.g., robotics over manual operation of machinery), acquisition or divestiture of a division or product line, or any other change that would be likely to have an impact on the frequency and severity of losses. There must be enough data included about each claim or accident to make an analysis meaningful (e.g., date of loss, person causing loss or person injured, cause of loss, type of loss, dollar value of loss, etc.). The risk manager must know what is included in paid and reserve amounts. Does the loss data include allocated loss adjustment expenses (ALAE), incurred but not reported (IBNR) losses, and defense costs?

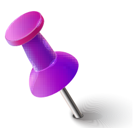
Consistency of data – The same types of data should be provided for each claim or accident (e.g., the type of loss, cause of loss, time of loss, claimant name, length of employment, etc.). There should be no change in policy year, accident year, or calendar year; a change might mean that the data would need to be manipulated to make it consistent. There should be no change in recording methodology (e.g., from one carrier or third-party administrator to another). Once again, a change might mean that the data would need to be manipulated to make it consistent.



Tip: The terms “calendar year,” “policy year,” and “accident year” describe ways in which the premiums and losses, including loss reserves, are calculated, and reported. Calendar year reporting is exactly how it sounds: premiums collected, and losses incurred during a calendar year are calculated and reported. Policy year reporting collects the same type of information on a period defined by the policy date, i.e., May 1, 20X1 to April 30, 20X2. Accident year reporting collects information on all losses occurring and all premiums earned in a given calendar year, regardless of policy periods or when the accident is reported or paid. Each serves a different purpose, with policy year and accident year primarily used by regulators and actuaries for purposes of maintaining solvency, measuring reserve adequacy, and in rate making. Financial accountants primarily use calendar year.

Integrity – The data should be reliable, whether it is from an insurance company, third-party administrator (TPA) or generated in-house. The data should be checked for input accuracy. Data needs to be current, a characteristic enhanced by prompt reporting of claims. Loss reserving needs to be accurate; it needs to be checked with whomever is reserving for losses, whether that is the insurance company, TPA, or in-house claims department. The risk manager should understand the reserving philosophy and practice of whomever is setting the reserves. For example, are claims reserved to the ultimate expected cost of the claim? Are claim reserves based on discounted or non-discounted reserve estimates?

Relevance – The data that is collected should yield information on matters about which the organization is concerned. It is not necessary to continue including data from operations that are no longer a part of the organization, whether through divestiture, discontinued operations, or transferred exposure to a third party (e.g., leasing employees).



Tip: When the company acquires an organization, it is not necessary to include all loss data from the acquired organization if the company is only acquiring a portion or particular operation of the other organization. For example, if the organization is acquiring the restaurant operation of a diverse company, it would not be necessary to obtain the loss data on the meat processing operation. Loss data from diverse operations should not be combined when trying to analyze losses (e.g., as in the above example, restaurants and meat processing plants). The data from one operation is not relevant to the other because the frequency, severity, types, and causes of losses will not be consistent. Data that is not relevant to the type of losses being analyzed should not be collected.

Useful Organization of Data – A fifth aspect of quality data is its useful organization, but this aspect is not natural to the data; the risk manager adds this to the complete, consistent, reliable, and relevant data. Data is always organized, but rarely in a useful manner. The loss run created by the insurance carrier (and many TPAs) is generally first organized by policy year, and then within a policy year by the date of occurrence. Chronological organization has limited use to the risk manager except in some manner for determining the age of a loss. More useful organization methods may include a listing of losses according to severity, or by location, shift, employee demographics, or some other specific type of data that the risk manager believes is important when managing the exposures and losses.

Types of Analyses to Be Performed on Loss Data

When analyzing data, *it is important to remember not to mistake data for information.* Data is the input, but information is what becomes useful after the data has been analyzed. The risk manager should provide the leadership team with information in the form of a summary or analysis of the data so that it is useful and relevant, meeting with them periodically to ensure that the reports suit their needs and allow them to make decisions.

There are as many ways to analyze loss data as there are senior managers to accept the reports. A few of them will be discussed here.

Evaluate Cost Effectiveness of Alternative Methods for Financing Losses

When evaluating potential costs/benefits of loss control alternatives, the risk manager can use loss data to assist in deciding which risks to avoid, which to control, which to transfer, and which to finance. Furthermore, the risk manager can use loss data to assist in the risk financing decision between retention and insurance (internal versus external financing), and whether a loss-sensitive or cash flow financing plan is appropriate.

Establish a Basis for Allocating Premiums and Loss Costs

When establishing a basis for allocating premiums and loss costs, the risk manager can create incentives or disincentives to help reduce and control losses by charging back losses to the departmental level. However, the risk manager must always be careful not to erase the positive operations results of a location with the allocation of the costs of one loss. The risk manager should use an objective basis for sharing the total cost of risk. Consider a blend of exposure base and experience base, assigning the cost of insurance and cost of losses to the cost center responsible. Many risk managers use a “minimum/maximum” model to prevent a single shock loss or one bad year from eliminating a cost center.

Also, certain lines of insurance and categories of the total cost of risk are not allocated to the various departments or locations as determined by either/or the risk manager or senior management. Some risk managers allocate only those lines of insurance for which the cost center manager can impact premiums and losses, such as workers’ compensation, auto liability, general liability, and employment practices liability, but not fiduciary liability or directors and officers liability. It is helpful to check with the CFO or company’s finance department to obtain their concurrence in the cost allocation method used by the risk manager.

Most organizations do not allocate risk management department cost except through regular overhead cost because the cost center manager cannot impact the risk management department cost, but the various departments would get their share of the cost the old-fashioned way through “corporate overhead.”

Risk Management Performance

The risk manager can also use loss data to identify the causes of the most frequent and serious losses, to recognize trends quickly and easily in loss experience, to help focus management on the organization's overall total cost of risk and gain their support for loss control efforts, and to evaluate potential costs/benefits of loss control alternatives.

Benchmarking Opportunities/Considerations

Gathering and analyzing loss data can also be used as a method for evaluating performance between operating units, vendors, and in-house adjusters, as well as benchmarking loss experience.

Benchmarking is continually comparing an organization's performance against that of the best in industry (competitors) or best in class (those recognized in performing certain functions) to determine what should be improved. Xerox was the first company to use this concept to improve its own performance. A company will want to benchmark when management is putting a baseline program into place, when internal trending and comparisons are underway, and when improvement opportunities are sought.

The benefits to benchmarking are being able to keep track of continued improvement, being able to enhance "out-of-the-box" thinking and creativity and being able to prioritize areas that need improvement.

Benchmarking Considerations

It will be important to keep in mind that many risk management decisions will be based on the data collected. Senior management will need to know how the company compares with others in the industry, and how the performance of the organization compares from one year to the next or from one period to the next.

The smart risk manager knows to be aware of the common pitfalls of benchmarking. Having a lower number on a given scale is not always better. It depends upon what is being compared; some comparisons should yield higher numbers. In addition, precision in results should not be implied where precision does not really exist.

As with other types of data analysis, comparisons have to be made "apples-to-apples" for consistency. Comparing a manufacturing operation to a sales office will not be a meaningful comparison. Also, comparing data that varies from one group to another will not give meaningful results. For instance, comparing the profits of one group to the sales of another will not result in a meaningful comparison. However, comparing loss trends across similar divisions within the company can provide useful information and meaningful comparisons for the organization.

Additionally, benchmarking is used when considering product or service development and pricing. The total cost of risk is included in the price of the product or service, or the product or service may be redesigned based on expected losses.

Renewal Pricing and Optimum Program Selection

The risk manager must also be able to satisfy insurance underwriting requirements when insurance is selected as a financing option. Working with an agent or broker (or sometimes directly with a carrier), the risk manager will use loss data to negotiate premiums and coverage restrictions or exclusions, to set equitable reserves for retrospectively rated programs, and to establish the amount of letters of credit or other required collateral.

Other

The risk manager must have the ability to respond to litigation or regulatory actions by federal or state agencies, such as the federal or state Occupational Safety and Health Administration (OSHA), Consumer Product Safety Commission (CPSC), Environmental Protection Agency (EPA), or Food and Drug Administration (FDA). By gathering and analyzing loss data, the risk manager can respond in a meaningful way.

Finally, the risk manager may gather and analyze loss data to use as a basis for establishing and monitoring vendor performance agreements, such as those used with a third-party administrator or loss control service.

There are countless ways to use and analyze loss data once it has been collected. However, data analysis is useless if the data is not of high quality. This means that risk managers must stay committed to using best practices with respect to the completeness, consistency, integrity, relevance, and organization of loss data.

Knowledge Check

1. Safe Products, Inc., acquires the cleaning products operation of ABC Corporation. When analyzing losses for this new acquisition, the risk management team also includes loss data on ABC Corporation's pharmaceutical operation. Explain why the loss data on the pharmaceutical operation should not have been collected, and how it might impact analysis.

2. You have recently started working as a risk manager with ABC Corporation. You discover they routinely use data sets collected over the course of only one or two years. Moreover, the data often includes different types and causes of loss. Which characteristic(s) of quality loss data are missing, and how might this impact data analysis?

Qualitative Analysis Tools

Learning Objective

3. *Differentiate between the different data measurement tools and explain how they can be used in risk analysis.*

Classifying and Categorizing Loss Data

Logical Classifications of Exposure

Losses can be classified by type of exposure using logical classifications. The four logical classifications of exposure are as follows:

1. **Property:** These exposures include both real property and personal property. The report should include the locations of properties that have sustained losses and identify the perils causing the losses: human perils (e.g., arson, pollution), economic perils (like obsolescence, inflation, strikes), or natural perils (e.g., hail, earthquake, etc.). It should also include claim count and severity of loss information.
2. **Human Resources:** These exposures are related to employee injuries, terminations, retirement, etc.
3. **Liability:** Loss reporting should include claim count and severity loss reports by type of liability coverage (auto liability, general liability, product liability, etc.). It should also include a report on litigation and large losses.
4. **Net Income:** This exposure typically does not involve loss reports, except when included as part of a property loss report. However, net income losses can arise from human resource losses or liability losses, or they can occur independently of any property, human resource, or liability loss. Net income losses are a decrease of net income or an increase of expenses and will show up in the financial statements and notes to the financial statements.

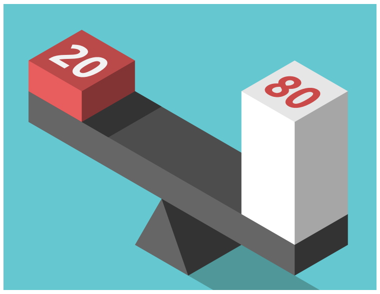
Employee Injuries

Categorizing employee injuries is accomplished by using qualitative methods. The categories to investigate are:

- Accident repeaters
- Length of employment when injured
- Cause of injury
- Type of injury
- Body part injured,
- Evaluation of time intervals
- Location of accident (whether company location or at another location, etc.)
- Any other appropriate or meaningful (relevant) categorization.

The injuries should also be categorized according to claim count and severity (the dollar value of the claims).

The Pareto Principle



According to the **Pareto Principal,** or 80/20 Rule, 80% of the problems are the result of 20% of the causes. Taking that into consideration, the risk manager can understand how frequency and severity can be evaluated, looking at the number of losses in each severity range, whether it is dollar cost or lost time days, and examining the number and cost of those losses (organizing the losses by location, by product line, or by type of vehicle). This allows the risk manager to focus on the most likely causes of loss or hazards, rather than apply efforts across the board to all exposures. The hazards, causes of losses, or types of injuries with the highest costs should also be of concern to the risk manager, as well as frequency of injury as it relates to a worker's length of service or other demographic variable.

Check-In

Directions: Match the letter of the logical classification in the left-hand column with its corresponding loss example in the right-hand column.

A. Property	______ An employee is seriously injured in an on-the-job accident, and files a worker's compensation claim for medical expenses.
B. Human Resources	______ A deep freeze and blizzard results in significant property damage to a company headquarters, including burst pipes and a partial roof collapse.
C. Liability	______ A company must upgrade its entire computer network and invest in new data security features after a hacking incident. The cost is significant and affects the annual revenue.
D. Net Income	______ A skincare company is faced with a class action lawsuit after customers suffer adverse reactions from a new line of lotion.

Measurement Scales of Qualitative Analysis

Although not subject to specific financial measurements, qualitative risks can be assessed for potential harm to the organization. An attempt should be made to assess the impact on the organization of all realistic qualitative exposures. For example, they can be categorized into critical, important, and unimportant risks. Critical risks are those exposures which could cause losses that could bankrupt the organization, threaten survival, or stop operations. Important risks are those in which the financial impact could result in the need to borrow funds from outside the organization to continue operations. Unimportant risks are those with a low financial impact that would do little harm to operations or that could be paid from existing cash flows.

Hazard Identification Indexing

Hazard identification indexing is an analytical tool that provides non-risk management personnel with information to make basic decisions concerning activities within the scope of their jobs. As Table 2.1 shows (see the Stanford University Hazard Identification Index), hazards are indexed by multiplying the severity of a risk by its probability.

Refer to **Table 2.1** (on the following page) as you contemplate this next example.

For example, Echleburg College Professor Wilson is planning on taking his archeology class on a dinosaur dig in a mountainous area of Wyoming. The risk manager for Echleburg College gives Dr. Wilson a simple set of questions that ask him to rate the frequency of a loss and the accompanying severity for the activities he is contemplating. Dr. Wilson rates the likelihood of a student being bitten by a rattlesnake as 3 and the severity as 3, and the likelihood of a student falling off a rock face as 4 with severity of 4. The snake bite rates as a 9, suggesting it is appropriate to initiate corrective actions when practical, so Dr. Wilson decides to equip the students with snake boots, gaiters, and heavy gloves and to train them on using correct placement of hands when lifting rocks or reaching. The rock face fall rates as a 16, suggesting that Dr. Wilson take immediate corrective action. This might be expressed as not allowing the students to climb higher than six feet above the ground and having them wear hard hats with chin straps. In the extreme, Dr. Wilson could prohibit any student from climbing or being higher than 18 inches from ground level at any time.

If the risk manager were to undertake an evaluation of this activity, he/she might simply inform Dr. Wilson that students cannot take part on any dinosaur dig outside of the classroom. By allowing Dr. Wilson to self-evaluate, he becomes a risk owner and can tailor a loss control strategy to manage the two risks being considered. The risk manager, in this case, provides the tools for others to use in conducting a risk assessment, improving risk awareness and risk ownership.

Table: 2.1 Stanford University Hazard Identification Index
(as used by Echleburg College Risk Management Department)

Step 1: Assign a score for probability.
(Over life of condition)

1.	Remote	Extremely unlikely to occur
2.	Low	Possible but unlikely to occur
3.	Moderate	Moderate risk of occurrence
4.	High	Likely to occur
5.	Probable	Very likely to occur in immediate future

Step 2: Assign a score for severity.

1.	Slight	Minor first aid injuries	Losses under $50
2.	Appreciable	Injuries requiring a physician's attention	Losses between $50 and $1,000
3.	Serious	1 or more serious injuries or illness	Losses between $1,000 and $100,000
4.	Severe	A death or disabling injury or illnesses	Losses between $100,000 and $1 million
5.	Catastrophic	Multiple deaths and/or disabling injuries	Losses in excess of $1 million

Step 3: Find the cell where the assigned probability and severity scores intersect (or simply multiply the probability score by the severity score).

Probability	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Severity					

Based on the resulting score, take the action indicated by the scale below.

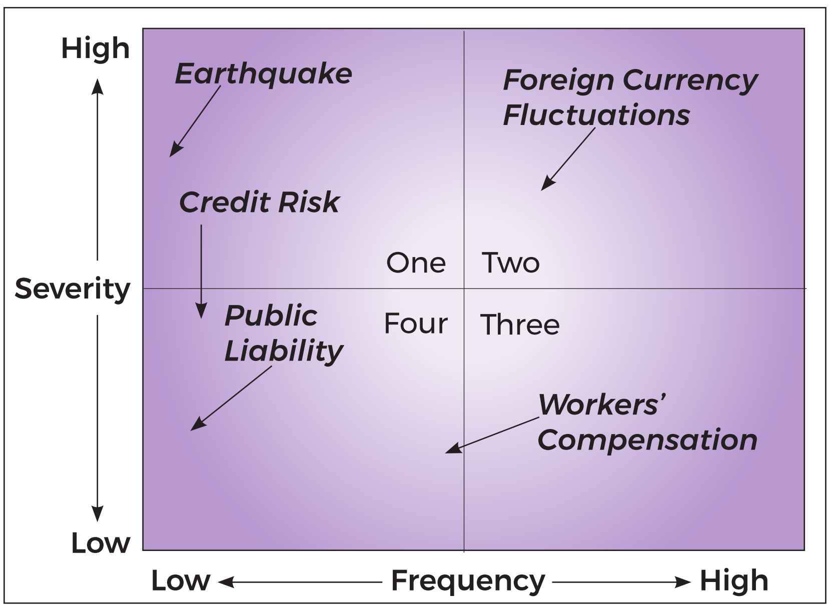
1–4 Institute corrective action if and when appropriate
5–9 Initiate corrective actions when practical
10–15 Institute all reasonable corrective action ASAP
16–25 Take immediate corrective action

Risk Mapping

Risk mapping is a visual analytical tool by which all risks of an organization can be identified, and the potential impact can be understood. Risk maps may be simple or complex and can be a powerful representation of an organization's vulnerability to unforeseen loss exposures. Risk maps are useful tools for risk managers to convey important risk information to accompany the risk manager's recommended treatment plans to senior management. They are useful when making certain risk control decisions, when determining risk financing decisions, when modeling the effects of potential exposure scenarios that might develop in the future, when tracking risk reduction results, and when monitoring changes in exposures over time.

A simple risk map consists of a graph divided into four quadrants, each reflecting a different blending of frequency and severity characteristics for each risk.

Example: A Simple Risk Map



In the above example, the arrows represent the desired movement of the risk exposures—from right to left. Risks that are placed in Quadrant Four tend toward low frequency and low severity. Each quadrant relates to costs: the farther up and to the right, the more costly the risk. Ideally, organizations take precautions to avoid or transfer the effects of risks that represent extreme frequency and severity. Risks that inhabit Quadrant One can be dangerous to the company's resources in several ways. In this area, low frequency may mean that actuarial predictability is extremely low or nonexistent, yet the severity of potential losses is high.

Heat Mapping

Heat maps provide a visual representation of complex data sets that uses colors to concisely indicate patterns or groupings, thus making the data more actionable. Heat maps are helpful because they can provide an efficient and comprehensive overview of a topic at-a-glance. Unlike charts or tables, which must be interpreted or studied to be understood, heat maps are direct data visualization tools that are innately self-explanatory.

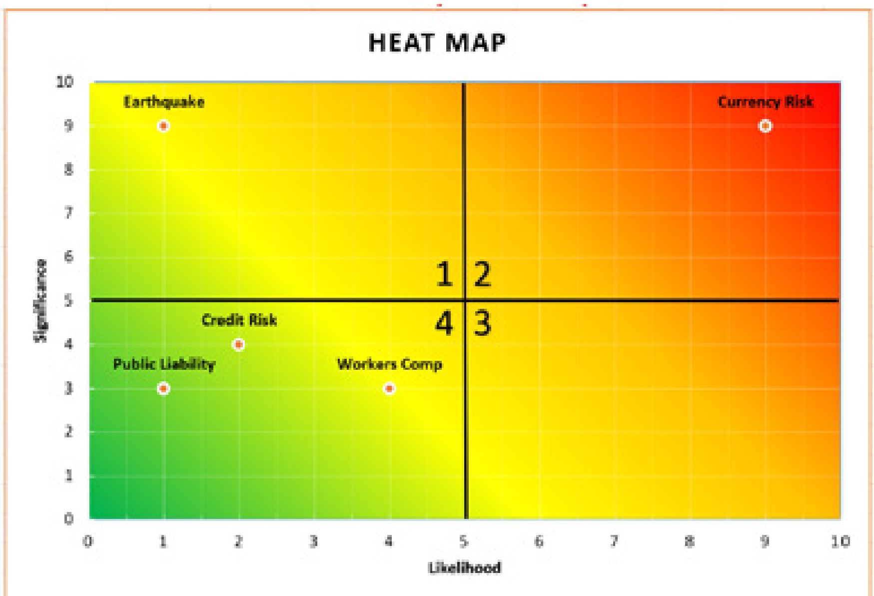
For each risk being evaluated, the risk manager assigns values based on measurement scales for both severity (impact) and frequency (likelihood). The measurement scales can be categorical labels, such as high, medium, or low for both severity and frequency. Each risk is plotted on the map in a location corresponding to its severity and frequency. Colors are used to indicate the criticality, or intensity, of the risk to the organization. Some heat maps will assign a numerical value to each box by multiplying the assigned scale for frequency and severity. Heat maps generally are used to show relationships between two variables (frequency and severity). By observing how colors change across each axis, the reader can observe changes in frequency and severity for the different risks plotted on the map. The variables plotted on each axis can be of any type, whether they take on categorical labels or numeric values.

Uses of Heat Maps

Heat maps have many uses, and there are several types of heat maps. Four-quadrant maps, 3x3 (usually qualitative only), 10x10, two dimensional, and three dimensional. In risk management heat maps are found in enterprise risk management applications and in risk prioritization.

Typically, heat maps are graphs drawn in two dimensions, where frequency or probability lies on the horizontal axis, and severity, or impact, lies on the vertical axis. Traditionally, the scale moves from low to high away from the intersection of the two axes. The lower left quadrant is the area of lowest risk; the upper right the area of highest risk; and the remaining quadrants are the areas of medium risk.

Example: Two-Dimensional Heat Maps



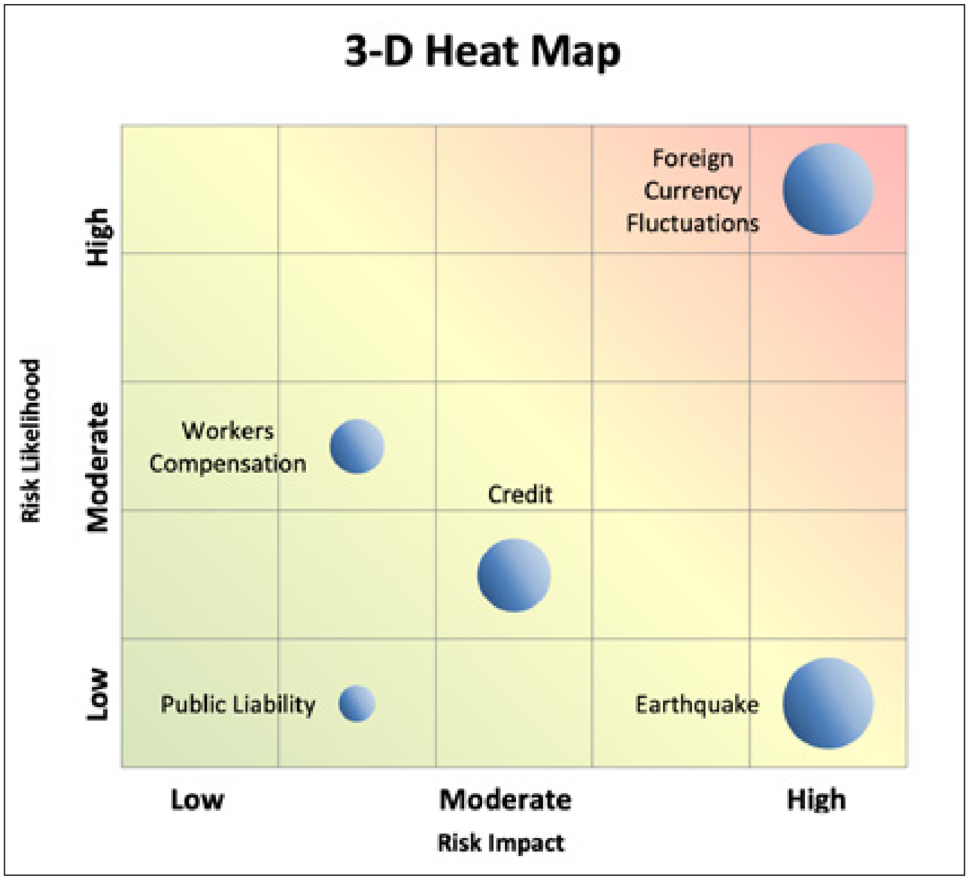
1 – Treatment: insurance, transfer, avoidance
2 – Treatment: loss control, large retentions
3 – Treatment: loss control and aggregate retentions
4 – Treatment: loss control

3x3 Heat Map

Severity	High (3)	3	6	9
	Medium (2)	2	4	6
	Low (1)	1	2	3
		Unlikely (1)	Possible (2)	Probable (3)
		Frequency		

A second possible depiction of risks using a heat map is three-dimensional, where the time of the possible event is depicted on the third axis. This depiction is driven by Murphy's Law, which indicates that the loss event will occur at the worst possible time, and the expected (ordinary) frequency or severity is less relevant than the timing of the event.

Example: A Three-Dimensional Heat Map



Challenges

When using heat maps, metrics must be defined. Don't let the reader guess how to read your map. A heat map is an efficient way to convey information about risks facing the organization, however, make it easy for the reader to understand.

Heat maps can be subject to inconsistency in the application of measurement scales. There are many different types and formats for heat maps as we have seen here. We have only touched the surface. Make sure the one you use is appropriate for the data, and the audience.

Risk Register

A **risk register** (risk log) is used to track issues, likelihood, potential impact, and mitigating measures. It is customizable to the organization and may include the date, risk owner, etc. It may be implemented based on the organization's needs and goals, or as part of a certification, such as ISO 9001.

How does a risk register work, and how do you create one? The simplest example is to think of a Microsoft® Excel spreadsheet. On the rows, you list the known or anticipated risks an organization faces. Include only **pure risk**—the risk of loss or no loss, and no chance of gain. Risks are recorded on the risk register and assigned a score for probability (likelihood of occurrence; the perceived frequency) and impact (the anticipated severity) in columns to the right. In subsequent columns, indicate control measures, contingency plans, and who owns the risk.

Risk registers are used in both risk management and project management. They provide a comprehensive list of risks for the risk manager to assign in listing, tracking, and prioritizing the risks facing the organization. A risk register can be a very useful tool in your risk management toolbox. Risks can be prioritized based on scoring, and the impact of risk reduction efforts can be tracked. Some RMIS (risk management information systems) have a risk register component. This risk analysis method leads to the next steps in the risk management process, in that proper analysis will help in the determination of which risks should be controlled and/or financed.

Example: As part of the project development of a rail link (a railroad route between two places), a detailed risk register is used to consider the various categories of risk that existed or emerged in all elements of the project.

The register is a live document held on a RMIS, assessed by multiple councils and rail companies contributing to the project.

The risk register is constantly being updated to reflect modifications in design and variation changes to the project, regardless of the geographical location or project team members. Project team members hold regular workshops to:

1. Reassess the number of relevant risks
2. Identify new risks
3. Alter existing risk scores
4. Update risk
5. Determine mitigation ownership

Risk Description
As a result of the multiple partners involved and the protracted timescale, there is a risk that significant (6–12 mo.) program delays may result in a withdrawal of support or commitment by key partners.

	Current Risk Score				Target Risk Score		
Prob	**Impact**	**Rating**	**Risk Owner**	**Controls**	**Prob**	**Impact**	**Rating**
2	16	32	Larry Hedstrum	1. Legal agreements 2. Mayor's transport strategy 3. Line protection	1	16	16

Risk Description

As a result of successful objections to the proposals, there is a risk that some aspects of the project may need to be revisited/revised, resulting in delays.

	Current Risk Score				Target Risk Score		
Prob	**Impact**	**Rating**	**Risk Owner**	**Controls**	**Prob**	**Impact**	**Rating**
3	8	24	Jules Brown	1. Clear communication 2. Early mgmt. of objections 3. Technical briefings	3	8	24

Risk Description
As a result of significant changes to the project scope, there is a risk that the project costs may be higher than budgeted, resulting in the inability to secure funding.

	Current Risk Score				Target Risk Score		
Prob	**Impact**	**Rating**	**Risk Owner**	**Controls**	**Prob**	**Impact**	**Rating**
2	16	32	Mary Stamper	1. Design changes agreed to in master plan 2. Monthly design meetings 3. Consultant outputs	2	8	16

Knowledge Check

1. Describe a risk map and its uses.

2. Your coworker exclaims, "There is no point to using qualitative assessment because all the company really needs to know is the financial impact of a risk." Explain to your coworker three categories of potential impact that can be assessed qualitatively.

Delphi Method

Delphi method (Delphi technique) is a series of surveys/questionnaires used to form a consensus opinion on the anticipated impact of a risk.

How It Works

A panel of experts is sent a questionnaire about a risk management issue. The questionnaire results are compiled, and anonymous responses are shared with the panel with instructions to reconsider the previously stated opinion based on other responses and to comment upon the other responses. A revised questionnaire detailing broad opinions is sent to the same panel with similar instructions. As a consensus opinion starts to form, the results are shared once more with similar questions and instructions. Each round of questionnaires should yield a smaller range of responses.

Advantages

The method is very versatile and may be used with unclear, emerging, or unknown risks, especially when there is not a standard industry response. A consensus from a group of experts is more accurate than individual opinions of experts. The refinement of responses leads to a more realistic prediction of what would happen than do the original, often theoretical, responses. The method can also be applied without having to bring everyone together for a physical meeting. Since the responses of the panelists are anonymous, individual panelists don't have to worry about repercussions for their opinions. Consensus can be reached over time as opinions are swayed, making the method very effective.

Disadvantages

The Delphi method may not result in the same sort of interactions as a live discussion. A live discussion can sometimes produce a better consensus, as ideas and perspectives are introduced, discussed, and reassessed. Response times with the Delphi method can take longer, which can slow down the assessment of the risk.

The risk manager of an organization is unsure of the potential impact and control measures of an emerging risk such as legalized recreational marijuana and the effect on risk control policies and procedures, as well as human resources policies and procedures.

The risk manager identifies a panel of experts drawn from the medical profession, law enforcement, claims, underwriting, and human resources to participate in a Delphi method analysis.

The risk manager creates a questionnaire consisting of several inquiries into the panel members' opinions regarding the effect of legalized recreational marijuana on the organization.

The panelists complete the survey indicating their opinions and return it to the risk manager.

The risk manager compiles the answers, creating a general opinion with outlying opinions, and submits the results to the panelists with the instruction to consider the responses and 1) reaffirm their original opinion, or 2) change their opinion based on other responses, and 3) critique other opinions.

The returned second-round opinions are compiled, and the previous step is repeated.

When the third-round opinions are compiled, the results are the consensus opinion with identifying outlying opinions.

Root Cause Analysis

Learning Objective

4. *Summarize the methods and purpose of root cause analysis and explain how risk managers use it to avoid recurrence of losses.*

Root cause analysis (RCA) is a systematic process for identifying "root causes" of problems or events and an approach for responding to them. RCA is based on the basic idea that effective risk management requires more than merely "putting out fires" for problems that develop but finding a way to prevent them. Think of weeds that may grow in your yard. Unless you get them out by the root, they are likely to come back. RCA helps the risk manager "get the weeds in the workplace" out by the roots.

By using RCA, the risk manager can avoid the tendency to single out one factor to arrive at the most expedient (but often incomplete) resolution. It also helps to avoid treating symptoms rather than true, underlying problems that contribute to a problem or event. In other words, RCA helps to engineer the risk out of the process, task, or procedure. The goals of RCA are to analyze an issue, problem, loss, or injury and identify:

- what happened
- how it happened
- why it happened

By doing so, the risk manager can initiate actions to prevent a reoccurrence of the incident.

Do you have these issues at your workplace?

- Major accidents
- Everyday incidents
- Minor near-misses
- Human errors
- Maintenance problems
- Medical mistakes

If so, then RCA can serve as an important tool in your risk management arsenal to address these business risks.

Methods of Root Cause Analysis

Ishikawa/Fishbone Diagram

So, how does RCA work? One method is using an Ishikawa diagram (fishbone diagram), which is a systematic method used to determine underlying and contributing causes.

How It Works

Think of fishbones—start with the "head" of the fish, a problem statement that defines the issue. Then put "ribs" on the fish. Most fishbone diagrams have six "ribs," (better known as categories).

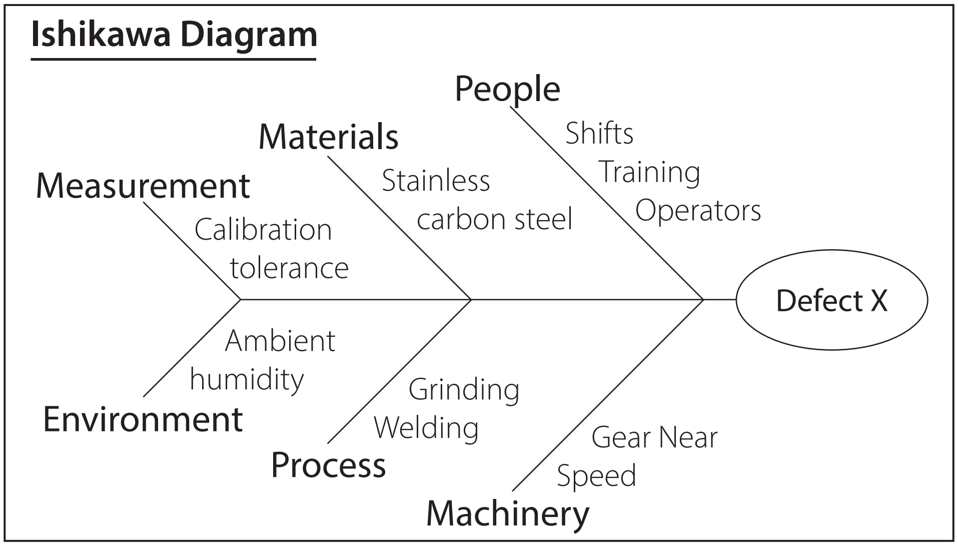
1. People
2. Process/Method
3. Measurement
4. Machinery
5. Environment
6. Materials

By structuring this approach with categories, potential causes are explored that might not otherwise be considered.

Fishbone diagrams in RCA are useful when problems, issues, or injuries, are influenced by multiple areas, job functions, or factors. They are also useful in more complex risks that have multiple, sometimes contributing, or concurrent, factors. This method allows multiple contributing causes to be viewed at once. It can also assist in identifying the root cause, which can help the risk manager determine how the risk can be properly controlled or financed.

As the example below shows, a fishbone diagram doesn't require an elaborate system or software; a simple white board drawing can suffice. OSHA even supports the concepts of fishbone diagrams in their Incident Investigations guide for employers (see **Table 2.2**).

Basic Fishbone Diagram and OSHA Incident Investigations Guide



To see more on fishbones, visit https://www.edrawsoft.com/fishbone-diagram-benefits.php

Table: 2.2

OSHA®

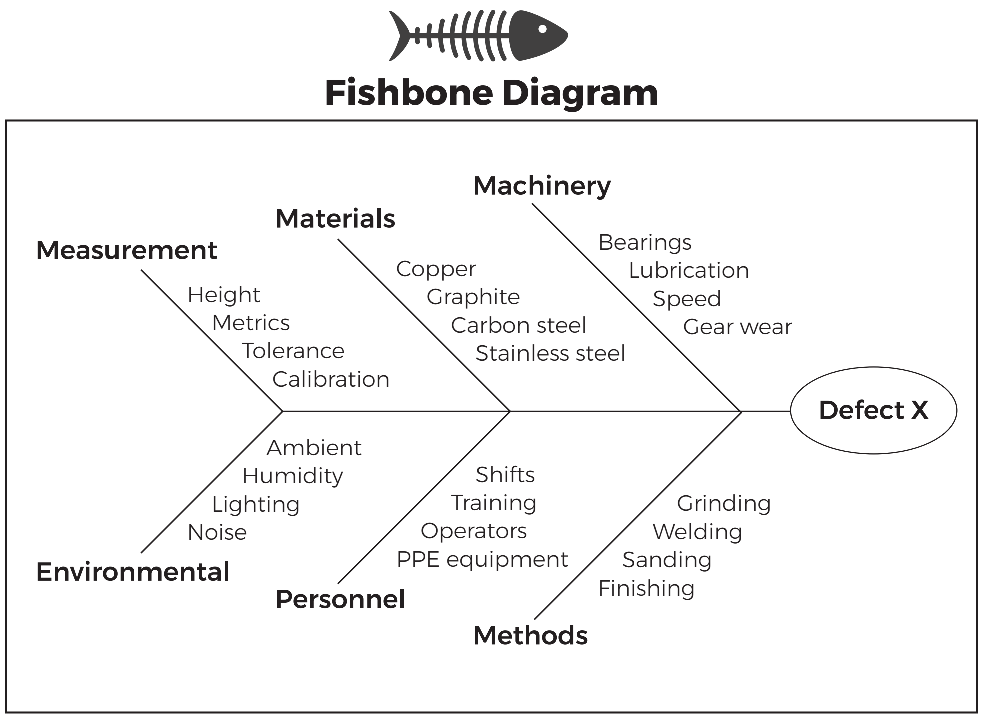
Incident Investigations: A Guide for Employees

The questions listed below are examples of inquiries that an investigator may pursue to identify contributing factors that, in turn, can lead to root causes:

- **If a procedure or safety rule was not followed**, why was the procedure of rule not followed? Was the procedure out-of-date or safety training inadequate? Was there anything encouraging deviation from job procedures such as incentives or speed of completion? If so, why had the problem not been identified or addressed before?
- **Was the machinery or equipment damaged, or did it fail to operate properly?** If so, why?
- **Was a hazardous condition a contributing factor?** If so, why was it present? (e.g., defects in equipment/tools/materials, unsafe condition previously identified but not corrected, inadequate equipment inspections, incorrect equipment used or provided, improper substitute equipment used, poor design or quality of work environment or equipment)
- **Was the location of equipment/materials/worker(s) a contributing factor?** If so, why? (e.g., employee not supposed to be there, insufficient workspace, "error-prone" procedures or workspace design)
- **Was lack of personal protective equipment (PPE) or emergency equipment a contributing factor?** If so, why? (e.g., PPE incorrectly specified for job/task; inadequate PPE; PPE not used at all or used incorrectly; emergency equipment not specified, available, properly used, or did not function as intended)
- **Was a management program defect a contributing factor?** If so, why? (e.g., a culture of improvisation to sustain production goals, failure of supervisor to detect or report hazardous condition or deviation from job procedure, supervisor accountability not understood, supervisor or worker inadequately trained, failures to initiate corrective actions recommended earlier)

If you want to get a bit more sophisticated, below is an example created using Excel. However, whether you use a white board, piece of paper, Excel, or a risk management information system (RMIS), a fishbone diagram can be useful for conducting a thorough RCA.

Excel Fishbone Diagram



Job Hazard Analysis

A **job hazard analysis** (JHA), also called a **job safety analysis** (JSA), is a technique to identify the dangers of specific tasks to reduce the risk of injury to workers. Once the risk manager knows what the hazards are, they can be reduced or possibly eliminated before anyone gets hurt. The JHA can also be used to investigate accidents and to train workers how to do their jobs safely. It will take a little time to do your JHAs, but it's time well spent. Be sure to involve employees in the process—they do the work and often know the best ways to work more safely.

What are the benefits of a JHA? Primarily, it leads to a safer way to do the job. It may result in changes in equipment or engineering controls because they can eliminate the hazard (e.g., machine guards, improved lighting, better ventilation). It may also result in changes in the work processes, administrative controls, how the task is done, available PPE, training, etc.

How to conduct a JHA in a steel fabrication shop.

1. *Break the job into tasks.*
2. *Word the instructions for each step starting with a verb. Avoid making the task description too detailed or too broad.*
3. *Identify the hazards associated with each task.*

4. *Review the hazards with subject matter experts who also might be the employees performing the tasks! Ask them what could be done to reduce or eliminate the hazards.*
5. *Ask participants to list some hazards in the "hazards" cells.*

TASK	HAZARDS	RECOMMENDATIONS
Reach into box to the left of the machine, grasp metal plate, and carry to grinding wheel to grind off sharp corners.	List some hazards.	
Push plate against wheel to grind off sharp corners.	List some hazards.	
Place finished plate in box to the right of the machine.	List some hazards.	

6. *On the next slide, show the task and hazards, and ask them to list solutions in the "recommendations" cells.*

TASK	HAZARDS	RECOMMENDATIONS
Reach into box to the left of the machine, grasp metal plate, and carry to grinding wheel to grind off sharp corners.	Strike hand on edge of metal plate; cut hand on sharp edges; drop casting on toes	List some solutions.
Push plate against wheel to grind off sharp corners.	Strike hand against grinding wheel; get sparks in eyes; inhale dust; get sleeves caught on grinding wheel	List some solutions.
Place finished plate in box to the right of the machine.	Strike hand against metal plate or grinding wheel	List some solutions.

7. *7. The JHA process provides a clear picture of the specific tasks, hazards, and recommended solutions.*

TASK	HAZARDS	RECOMMENDATIONS
Reach into box to the left of the machine, grasp metal plate, and carry to grinding wheel to grind off sharp corners.	Strike hand on edge of metal plate; cut hand on sharp edges; drop casting on toes	Provide gloves and safety shoes.
Push plate against wheel to grind off sharp corners.	Strike hand against grinding wheel; get sparks in eyes; inhale dust; get sleeves caught on grinding wheel	Provide larger guard over wheel. Install exhaust system. Provide safety goggles. Instruct employee to wear short sleeved shirts.
Place finished plate in box to the right of the machine.	Strike hand against metal plate or grinding wheel	Provide tool for removal of completed stock.

Five (5) Why Analysis

For anyone who has worked with or been around children, they frequently ask "Why this?" "Why that?" "Why can't I do this?" "Why can't I do that?" Little did you know, that child was preparing to be a problem-solver looking for root causes when they grow up. The 5 Whys Problem Solving technique is a simple, team-based approach to asking questions about the potential causes of a problem, or accident. The process helps to solve a problem (or determine why an accident occurred) by repeatedly asking the question, "Why?" to peel away the layers of symptoms that can lead to the root cause of an accident or injury.

How it Works

- Start with a problem statement. You can use a white board, flip chart, or other visual display, and list five potential reasons for your problem.
- Evaluate: Using data, subject matter experts, or experience, evaluate each of the five potential reasons.
- Select: Select the one reason that is the most likely potential cause.
- List again: Now list five potential reasons for the potential cause that you selected.
- Evaluate again: Evaluate those five new potential reasons.
- Select again: Again, select the one reason that seems to have the most potential as a root cause.
- Ask and answer the question, "Why?" to drill down to the root cause of the accident or incident.

- Works best with a team, not one person only.
- Focus on the cause—not the solution. The solution to a sore muscle may be to take medication, whereas the solution to preventing a sore muscle is to find out what is causing it and eliminate it.

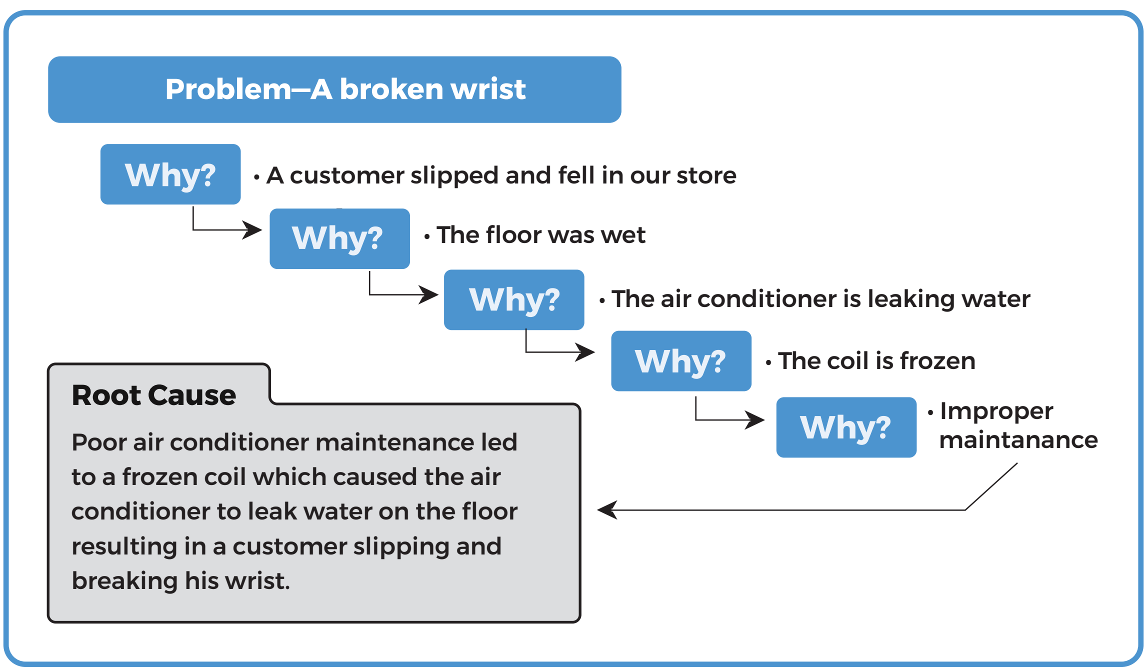
Uses

- For problems with simple to moderate complexity.
- Also helpful for reoccurring incidents.

Benefits

- An effective method that can be easily understood and implemented.
- It is a simple yet powerful tool.
- Asking "why" five times focuses the team on getting to the root cause. It also helps avoid jumping to conclusions before the most likely causes have been identified and investigated.
- It can engage the people who deal with the problem. Getting input from the people who deal with the problem and making them part of the solution can result in better buy-in and engagement.
- It can be helpful in incident and accident investigation but may also be used for production and product issues.
- It encourages collaborative problem-solving.

Example



Regardless of the method used, root cause analysis can be a powerful tool for a risk manager, because it provides the structure needed to identify the "what," "how," and "why" of an issue and address the underlying causes. In doing so, risk managers can help to prevent risks, rather than simply treating their symptoms after incidents have occurred.

Knowledge Check

Jeff is a district manager who oversees a warehouse distribution center. Recently, there has been an increase in workplace accidents at the warehouse. Several employees have sustained injuries, ranging from minor (cuts, scrapes, bruises) to more serious (a broken arm and a concussion). Additionally, stock was damaged in a recent forklift accident. Jeff visits the warehouse and notices that the lighting is dim. "I'll just bring in brighter bulbs, and that should solve the issue," Jeff says.

1. Explain the flaw in Jeff's thinking. What might he be missing by not conducting a root cause analysis?

2. Explain which RCA method you think could be most helpful to Jeff in this instance, and why.

Risk Modeling

Learning Objective

5. *Distinguish between predictive analytics and catastrophe modeling and identify their uses.*

Risk modeling is the use of relevant historical data and past behaviors to find correlations and extrapolate data to predict future losses based on assumptions, as determined by experts. It is useful in assessing supply chain risk and other vulnerability analysis, risk tolerance determination, natural disaster frequency and severity analysis, and insurance pricing. It also provides "what if" testing and quantitative analysis on complex risks, as well as early alert on industry changes and emerging risks.

There are several types of risk modeling, but the more frequent types of modeling encountered by the risk professional are predictive analytics and catastrophe modeling.

1. **Predictive analytics –** use of statistical techniques such as data mining and modeling through analysis of current and historical facts and transactions to make predictions of future unknown events
2. **Catastrophe modeling –** a computerized system that generates a very large set of simulated events to estimate the likelihood, magnitude or intensity, location, degree of damage, and ultimately, insured and uninsured losses arising from a catastrophic event such as a hurricane, earthquake, tornado, flood, wildfire, winter storm, terrorism, war, pandemics, or cyberattack

While most risk managers will not do the modeling themselves, they are frequently the recipients of the output from risk modeling. Some of the challenges with risk modeling include:

- Model risk—the model fails to perform or performs inadequately
- Assumptions and limitations not fully understood
- Model cannot account for all possibilities
- Using the right data for the models

Predictive Analytics

How It Works

Predictive analytics are conducted through machine learning that finds hidden patterns in a large volume of historical data that makes a prediction of future results. The basic requirement is a large enough set of data where data quality is not a concern. Types of data used are:

- People data – behaviors, preferences
- Sensor data – breakdowns or service interruptions, weather patterns

The model is an arithmetic formula that creates a score of risk by using a regression formula. The model implements a classification function, such as safe driving habits or payment habits, which results in a score.

Uses of Predictive Analytics

- Marketing campaigns aimed at customer retention by focusing on the customers who might leave, without wasting effort and money contacting customers who would stay, anyway
- Cross-selling and up-selling
- Auto insurance – risk of accidents predicted from information obtained from drivers, such as traffic violations, age, credit score; sensor data from GPS, or accelerometer inputs that show actual driving behavior
- Early notification for emerging trends and risks, such as predicting which claims are more likely to move into litigation, or which claimant will retain an attorney
- Reserve setting – TPAs can use data from predictive analytics to help set reserves

Challenges

- Historical data may not always accurately predict future losses.
- There may be "unknown unknowns" in data collection; in other words, unexpected or unforeseeable conditions that may impact data.
- There may be undiscovered errors in the modeling algorithm.
- Models can be manipulated for ulterior purposes (i.e., to show a certain desired outcome rather than the actual predicted outcome).

Catastrophe Modeling

While catastrophe modeling is often not performed by the risk manager or the organization, utilizing catastrophe modeling from outside sources can be very beneficial to risk managers as they seek to understand the potential frequency and severity associated with catastrophic events, such as natural disasters, human casualties (war, terrorism, etc.), and more.

How It Works

1. A computer-generated model is created.
2. Input is required from subject matter experts (SMEs) in fields such as structural engineering, actuarial science, computer science, and meteorology.
3. The computer model generates an estimate of losses, probable maximum losses, and average annual losses.
4. Estimates can be based on a specific location, event, or series of events.

Uses

- Ratemaking
- Insurance portfolio management and optimization
- Risk selection and underwriting
- Cost of reinsurance
- Loss mitigation strategies
- Allocation of resources, including pre-loss and post-loss reserving
- Strategic planning – identification of market opportunities and concentrations of risk
- Financial and capital adequacy (ratings)

Challenges

1. Outside resource usually needed for catastrophe modeling
2. Source unlikely to reveal all assumptions and limitations
3. Generally based on a single peril

Knowledge Check

Directions: State whether each of the following scenarios is an example of predictive analytics or catastrophe modeling and explain your reasoning.

1. A homeowners' insurance company uses a computer-based model to predict the likelihood of tornadoes in various regions and uses this information when calculating rates.

___

___

2. An auto insurance company has an incentive program in which drivers can get discounts by using an app that monitors their driving safety. The insurance company uses this data to forecast accident risks.

___

___

Directions: Provide one additional example of how each of these risk modeling techniques might be used.

___

Summary

Qualitative assessment seeks to identify and analyze those risks which, while not quantifiable, can still hold the potential for significant damages to an organization.

There are seven main areas of qualitative assessment:

1. Management's appetite for risk
2. Innovation, product development, and marketing
3. Contractual analysis
4. Compliance and regulatory analysis
5. Human resources and employee safety issues
6. Social responsibility and citizenship analysis
7. Internal policies

Additionally, financial assessments can serve to identify and evaluate broad, hard-to-quantify loss exposures, while insurance market analysis can provide a market overview, including maximum probable loss vs. maximum possible loss, as well as pricing and loss costs.

Because qualitative risks cannot be measured using traditional, mathematical methods, they require a different thought process from that used in quantitative analysis. Still, it is crucial to obtain quality loss data by ensuring consistency, validity, and integrity throughout the data collection and analysis process. There are a number of tools available for measuring qualitative data, including risk and heat maps, risk registers, and root cause analyses. Additionally, risk managers can use risk modeling techniques such as predictive analytics and catastrophe modeling to predict future losses based on historic data (extrapolated by computer and AI programs).

Though qualitative analysis can provide robust insights into risks which cannot be measured numerically, it must still be used in conjunction with quantitative analysis. Qualitative analysis seeks to answer the question, "What?" while quantitative analysis answers the question, "How much?" When used in conjunction with one another, the two can create a full risk analysis, both quantifying risks and determining their potential scope and impact. In the following sections, we will take a deeper look at the tools used in quantitative analysis.

Review of Learning Objectives

- *Discuss the assessment of broad loss exposures that may have a financial impact on the organization but may be difficult to quantify.*
- *Identify the characteristics of quality loss data and describe how those characteristics impact analysis.*
- *Differentiate between the different data measurement tools and explain how they can be used in risk analysis.*
- *Summarize the methods and purpose of root cause analysis and explain how risk managers use it to avoid recurrence of losses.*
- *Distinguish between predictive analytics and catastrophe modeling and identify their uses.*

Section 2 Self-Quiz

Directions: Answer the questions below. There may be more than one correct choice.

1. Which of the following is/are an example(s) of qualitative assessment? (Select all that apply.)
   - ☐ Financial assessment
   - ☐ Cost-benefit analysis
   - ☐ Insurance market analysis
   - ☐ Loss data analysis
   - ☐ NPV (net present value) analysis
   - ☐ Root cause analysis

2. Which of the following is/are NOT one of the seven main areas of qualitative risk assessment? (Select all that apply.)
   - ☐ Human resources and employee safety issues
   - ☐ Social responsibility and citizenship
   - ☐ Management's appetite for risk
   - ☐ Company mission, vision, and values statements
   - ☐ Innovation, product development, and marketing
   - ☐ Insurance underwriting guidelines

3. Which of the following is/are an example(s) of a characteristic of quality loss data? (Select all that apply.)
   - ☐ A significant data sample collected over five years or more
   - ☐ Data collected for the same types of loss during the same policy year
   - ☐ Data collected for all operations in the last 15 years, including areas that are no longer part of the organization
   - ☐ Data that has been checked for input accuracy
   - ☐ Data that is organized by policy year only

Directions: Use the words from the word bank to fill in the blanks. Answers may only be used once, and not all answers will be used.

risk mapping	**job hazard analysis**	**risk register**	**catastrophe modeling**
predictive analytics	**logical classifications**	**Pareto Principle**	**heat mapping**
maximum probable loss	**root cause analysis**	**Ishikawa diagram**	**maximum possible loss**
hazard identification indexing	**risk modeling**	**RMIS**	**Delphi method**

1. Property, human resources, liability, and net income are examples of ________________________________ of exposures.

2. ________________________________ is a visual analytic tool used to identify risks and understand their impact. In its simplest form, it consists of a graph divided into four quadrants, with the y-axis representing severity, and the x-axis representing frequency of risks.

3. A(n) ________________________________ lists known or anticipated risks in rows, and impact or anticipated severity in columns, and can be used to track and prioritize risks, as well as potential impact and mitigating measures.

4. A(n) ________________________________ is one method of root cause analysis, which typically lists a problem statement and then branches off into six categories to explore possible causes of an issue.

5. ________________________________ uses colors to indicate patterns or groupings, providing a visual representation of complex data sets.

6. ________________________________ is the most likely loss to occur for a given peril, while ________________________________ is the greatest damage that could occur in a loss.

7. The ________________________________ states that 80% of problems stem from 20% of causes.

risk mapping	**job hazard analysis**	**risk register**	**catastrophe modeling**
predictive analytics	**logical classifications**	**the Pareto Principle**	**heat mapping**
maximum probable loss	**root cause analysis**	**Ishikawa diagram**	**maximum possible loss**
hazard identification indexing	**risk modeling**	**RMIS**	**Delphi method**

8. The ______________________________ uses a series of questionnaires to refine expert opinions and move toward consensus.

9. ______________________________ uses computers to generate a very large set of simulated events to estimate losses arising from disastrous events, while ______________________________ uses machine learning to find patterns in large volumes of historical data to forecast future losses.

Section 3: Quantitative Analysis Tools

Section Goal

In this section, you will acquire a fundamental understanding of data-related statistics that will enable you to make statistical calculations and general observations on data sets.

Learning Objectives

1. *Understand how to calculate three measures of central tendency and interpret the effect of extreme values on each measure.*
2. *Understand how to calculate two measures of dispersion and explain how these measures are used by risk managers.*
3. *Describe the role of the standard deviation in a normal distribution and explain the differences between a normal and skewed distribution.*
4. *Be able to draw a simple histogram showing individual losses versus annual totals.*
5. *Forecast future losses by describing and calculating confidence intervals and simple linear regression.*

Introduction to Quantitative Analysis Tools

In the previous section, we discussed the use of qualitative assessment in risk management. Equally as important is quantitative assessment, or the use of traditional, acceptable methods of assigning numerical value to risk exposures. Where qualitative analysis answers the question, “What?”, quantitative analysis answers the question, “How much?”

Risk managers use statistics—the mathematical body of science that pertains to the collection, analysis, interpretation or explanation, and presentation of data—as part of the quantitative risk analysis process needed to properly control and finance risk. Since the volume of loss data and exposure data that may be available to a risk manager can be daunting, statistics allow a logical and reasonable method of reducing this mass of data (the population) to a more manageable level (a sample set that fairly represents the population). While much of this can be done in a risk management information system (RMIS) or through other computer systems, it is important for risk managers to understand the concepts and terminology.

Section Terminology

The Law of Large Numbers

In statistics, as the sample size increases, the average of the sample gets closer to the average of the whole population.

Use in Insurance

As the number of policyholders increases, the actual losses become more predictable. The average of the actual loss per policyholder gets closer to the projected average loss per policyholder as the number of policyholders increases.

To see more on Law of Large Numbers, visit https://www.youtube.com/watch?v=MntX3zWNWec

Sample

A subset, randomly chosen, of a larger group assumed to have the same characteristics of the group (unbiased by the selection process)

Population

The entire group of observations

Outlier

An extreme value that is much higher or lower than the other values in the data set

Risk managers must be concerned about outliers because they are so common. For example, most losses are small, so the catastrophic loss represents an outlier. There are several statistical and financial techniques the risk manager can use to manage the effect of outliers.

Application of the Law of Large Numbers in Risk Management

The risk manager needs to understand when to use a population or a sample when studying loss data. As we will discuss later (in Section 4), not all loss data is known at any one time; however, the risk manager assumes all loss information is either complete or adjustments are made to achieve as much completeness as possible. This fulfills the purpose of having a reasonable degree of quality, or wholeness, in the loss data when forecasting losses. Thus, the risk manager uses an entire population of loss data for forecasting, but because the organization and their losses are not static over time, the risk manager usually limits the loss data being used to the most recent time period—say three, five, or ten years.

To some, this sounds like the risk manager is using a sample—a subset of the larger group of losses. However, this is not true, as a sample must be random. The "last five years" of losses is not random; it is the entire population (albeit a smaller population of the large data set of losses) that is assumed to reflect the most current conditions in the organization and its environment.

There are some situations when a risk manager might wish to use a true sample, but not when forecasting or projecting losses. For example, the risk manager might wish to study only the length of time between when a claim is first reported and its final conclusion, or the allocated loss adjustment expenses associated with a certain type of claim. In such a case, the risk manager may choose to draw a random sample from the larger population to draw inferences about how such claims are handled. The Law of Large Numbers is still relevant, since the group of losses being studied, e.g., the last five years, or the true, random sample, must be of sufficient size to have statistical credibility.

Skills Application Examples

Below are examples of how you will apply quantitative analysis tools to solve real-world problems. As you review these examples, consider your current skill level and level of confidence in answering these types of questions.

Frequency History for Unbelievable Company		
Year	**No. of Losses**	**Total Losses**
X1	250	$281,250
X2	250	$281,250
X3	250	$281,250
X4	250	$281,250
X5	250	$281,250
X6	?	?

Severity per loss for X6 has been separately predicted to be an average of $1,125 per loss.

(Number of Losses)	*x*	*(Severity of Loss)*	=	*(Total Losses)*
250	*x*	$1,125	=	$281,250

1. Is this prediction reasonable?
2. Is it reasonable to expect X6 will follow exactly the same as the prior five years?
3. Does this example reflect the real world?
4. What can be done to make better predictions?

Let's compare two companies: Smooth-On and Jumping Jack. We want to forecast their expected frequencies for year six.

Frequency History of Smooth-On and Jumping Jack		
Smooth-On	**Year**	**Jumping Jack**
240	X1	120
260	X2	383
230	X3	247
270	X4	301
250	X5	199
?	X6	?

Severity per loss for X6 has been separately predicted to be an average of $1,125 per loss for both facilities.

1. What will predicted losses be in X6?
2. What is the range of possible losses that might be predicted to occur?
3. Can we assign probability or determine a degree of certainty for losses not exceeding some number?

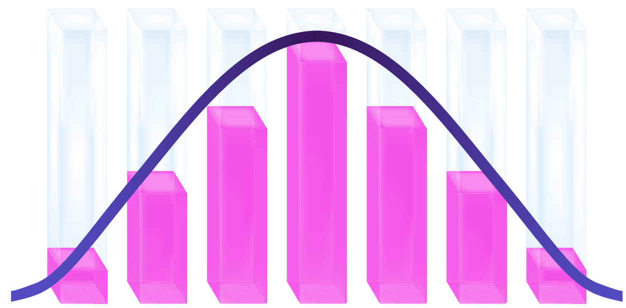
By the end of this section, you should be able to complete the calculations needed to solve problems such as these.

Measures of Central Tendency

Learning Objective

1. *Understand how to calculate three measures of central tendency and interpret the effect of extreme values on each measure.*

One important basic statistic is a measure of central tendency, or a statistic that conveys information regarding the most likely outcome of an event, such as an accident or loss. In fact, there is no "single measure." There are three common measures of central tendency: the mean, the median, and the mode.



These measures of central tendency are most useful when used on data that is normally distributed, such as height or weight of the general population, IQ scores, tosses of a pair of dice, etc. Such distributions are often displayed graphically as a bell-shaped curve.

Mean

The **mean,** commonly known as the **average** or **arithmetic mean,** is the sum of all values divided by the number of observations. While very useful, the mean is highly susceptible to extreme values or outlying observations.

Definition

The mean is the sum of all observations divided by the number of observations.

Example

Using the following values:

150	180	105	270	170

Find the sum: 150 + 180 + 105 + 270 + 170 = 875

Divide the sum by the number of values (observations): 875 ÷ 5 = 175

Uses

The mean is most effective when there is a normal distribution (bell-shaped curve). We will discuss distribution of data later in this section.

Impact of Extreme Values

The mean is highly susceptible to extreme values or outlying observations (also called skewness).

Median

Definition

The **median** is the midpoint of the observations ranked in order of value. Also known as the 50th percentile, the median lies between the bottom half of the observations and the top half of the observations. When there is an even number of observations, the median is the average of the two middle values. This measure of central tendency reduces the impact of extreme values or outliers.

Example 1: an odd number of values

1. Using the following values:

150	180	105	270	170

2. Arrange the values from lowest to highest:

105	150	170	180	270

3. Find the middle value:

105	150	**170**	180	270

170 is the median.

Example 2: an even number of values

1. Using the following values:

   100 150 105 180 270 170

2. Arrange the values from highest to lowest:

   270 180 170 150 105 100

3. Average the two middle values:

   150 + 170 = 220 ÷ 2 = 160

160 is the median.

Uses

The median is most effective when data is skewed, as it limits the impact of outliers. We will discuss skewness later in this section.

Impact of Extreme Values

The median reduces the impact of extreme values or outliers, or when data is skewed.

Mode

Definition

The **mode** is the observation that occurs most often in the sample; it has the highest frequency of occurrence. There may be none, one, or more than one mode.

Example 1: types of injury

Falling	Collision	Inhalation	Falling	Cut

In this example, the most common type of injury, or the mode, is Falling.

Example 2: number of losses per year

100, 135, 75, 100, 75, 120

The mode is 100.

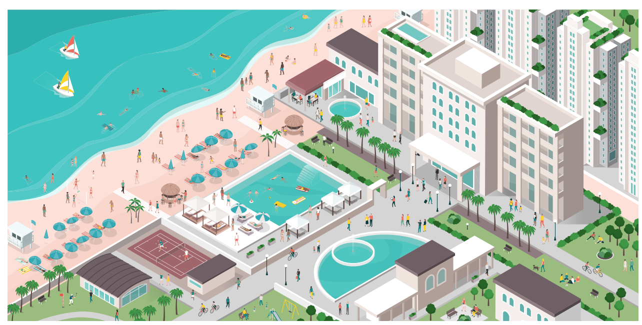
Uses

The mode is most effective with non-numeric data (data that falls into categories such as types of injuries rather than claims costs).

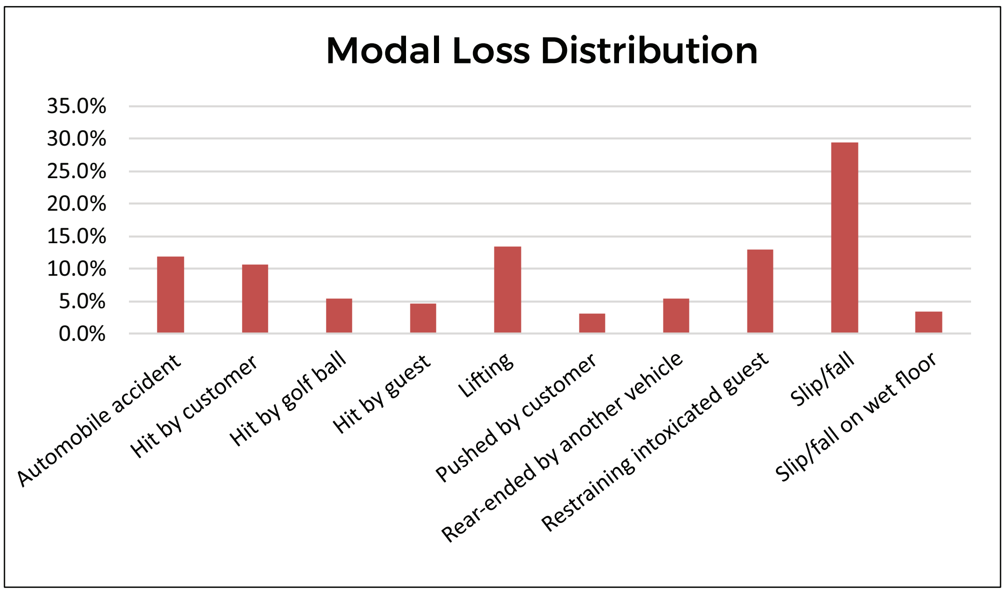
Impact of Extreme Values

Outliers have no impact on the mode.

Example: Often, the mode of nominal data is shown in a chart or graph format, as shown next, for a fictitious resort and casino. What is the mode of this distribution?



Cause of Loss	Distribution
Automobile accidents	11.8%
Customer strikes someone	10.7%
Hit by golf ball	5.3%
Guest strikes someone	4.6%
Lifting	13.4%
Pushed by customer	3.1%
Rear-ended by another vehicle	5.3%
Restraining intoxicated guest	13.0%
Slip/fall	29.4%
Slip/fall on wet floor	3.4%



The mode of this distribution is slip/fall because this is the loss that occurred the most frequently.

How a Risk Manager Might Use the Three Measures of Central Tendency

In the examples above, the risk manager might use the mean or the median, if there is evidence of skewness, such as a very large loss, to make a single point estimate of losses for the coming year (i.e., the loss pick). The mode might be useful for directing loss control efforts, such as focusing on slip/fall hazards not involving wet floors as opposed to slip/fall hazards that do involve wet floors.

Using Excel

While these measures of central tendency can easily be calculated by hand, as you have just done, Excel allows the risk manager to calculate these with its formula functions. While the Excel functions will not be covered in this course, they will be included in the Appendix at the end of this Section, and you are encouraged to review them.

Knowledge Check

1. Calculate the three measures of central tendency for the following seven numbers:

1, 4, 2, 1, 1, 7, 5

Mean	
Median	
Mode	

2. Recalculate the three measures of central tendency for the following eight numbers:

1, 4, 2, 1, 1, 7, 5, 100

Mean	
Median	
Mode	

3. Compare the measures of central tendency that you recalculated in question 2 to your answers from question 1. Explain what impact (if any) extreme outliers can have on the mean, median, and mode.

4. Calculate the three measures of central tendency using the following information:

Total Return on the S&P 500

Year	Percentage
2018	31.23
2017	16.34
2016	5.67
2015	18.54
2014	31.06
2013	5.97
2012	22.31
2011	20.37
2010	(4.85)
2009	31.48

Mean	
Median	
Mode	

Measures of Central Tendency in the Population

In risk management applications, the risk manager generally prefers working with the entire population of all losses within a given period, rather than taking a small sample from that population, measuring the sample, and then drawing inferences from the sample to the population. It is far more precise to simply work with the entire population of known data. In reality, the risk manager knows it is likely that not all the data concerning loss is presented when a display of losses is considered, but the risk manager also knows there are techniques that make that adjustment for the "unknown" portion of known losses and the "unknown" losses. (These techniques will be covered in Section 4.) Consequently, the risk manager assumes the loss data being considered is the population of losses, and the mean or average of those losses can be used to project losses. However, the risk manager is aware that not all data points (e.g., the number of losses) contribute equally to the average, so an additional technique, the **probability-weighted mean,** is useful in forecasting losses based on the mean.

Probability Concepts:

1. Probabilities vary from 0 to 1.00.

2. Probabilities must total 1.00 for all possible outcomes.

Probability-Weighted Mean

The probability weighted arithmetic mean is similar to an ordinary arithmetic mean (the most common type of average), except that instead of each of the data points contributing equally to the final average, some data points contribute more than others based on probability.

Expected Loss (Probability-Weighted Mean)

What is the effect on the expected loss to an asset related to a fire exposure with and without loss control procedures in place (automatic sprinkler system)?

1. Without loss control

Severity	Probability of Loss	(Prob x Loss)
$0	0.79	$0
$10,000	0.12	$1,200
$50,000	0.06	$3,000
$100,000	0.03	$3,000
	1.00	$7,200
Expected Loss = $7,200		

2. With loss control in place (only reduces severity)

Severity	Probability of Loss	(Prob x Loss)
$0	0.79	$0
$5,000	0.12	$600
$7,500	0.06	$450
$50,000	0.03	$1,500
	1.00	$2,550
Expected loss = $2,550		

As you can see from this example, the probability of a loss occurring is used to weight the severity of losses, which in turn, impacts the overall expected losses.

For example, if just the severity of losses were considered, the total expected losses would be $53,333.33. By considering the actual probability that the losses will occur, the total expected losses is reduced to only $7,200.

Note that the loss control measures only impact severity—the probability factors remain the same.

Each of the measures of central tendency can provide useful insights regarding the most likely outcome of an event, and each can be useful in different scenarios. Mean is most valuable in situations where data is distributed normally (in a bell curve), while median is a better measure for situations with skewed data. Mode is most beneficial when used with non-numeric, categorical data. However, none of the measures of central tendency can paint the full picture on its own. In the next portion of this section, we will examine how a risk manager can employ statistics to measure dispersion from central tendency.

Measures of Dispersion

Learning Objective

2. *Understand how to calculate two measures of dispersion and explain how these measures are used by risk managers.*

While measures of central tendency are useful, the picture they present is incomplete. For example, if there is a sample of 100 observations, with 50 valued at 1 and 50 valued at 3, the mean value is 2 (50 + 150, or 200 ÷ 100 = 2). If there is a second sample of 100 observations, with 99 valued at 1 and 1 valued at 101, the mean is still 2 (99 + 101, or 200 ÷ 100 = 2), but these two samples are dramatically different. In risk management terms, the first sample implies all losses are small, but the second sample indicates many, many small losses, with a single catastrophic loss skewing the results.

To develop a better understanding of distributions, the risk manager will consider statistics that measure dispersion from the central tendency. There are two measures: range and standard deviation. Range is not commonly used; standard deviation is the common measure of dispersion.

Range

Definition

Range is the difference between the largest and smallest values.

How It Works

Range is a statistic consisting of a single value; some people erroneously refer to the range as being 100 to 900, but that is not the statistical range. The values may *range* from 100 to 900 (where range is used as a verb); however, the statistical range is 800.

Example: The largest possible property loss for an organization is $500,000; losses can vary from $0 to $500,000, but the range is $500,000.

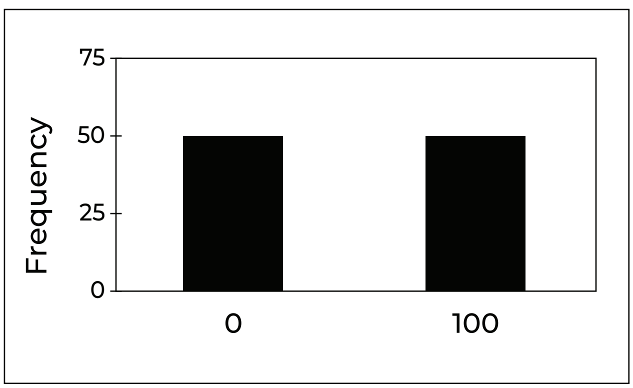
Uses

Range is a useful statistic, as it captures the total extent of variation or dispersion from the central tendency.

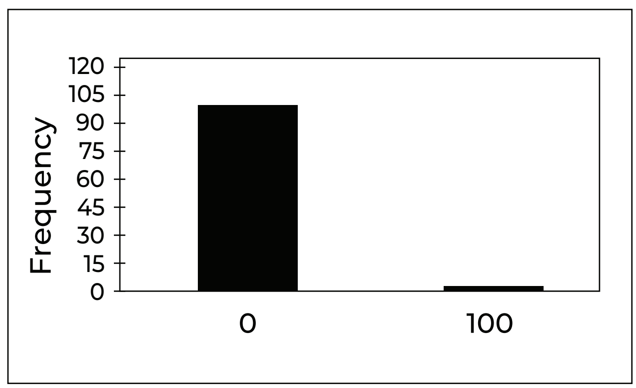
Impact of Extreme Values

As the graphs below show, it is not possible to distinguish between scenarios with extreme outliers and those without. If there are 50 instances of 0 and 50 instances of 100, the range will be the same (100) as if there are 99 instances of 0 and only one instance of 100.

50/50



99/1



Variance

From a statistical view, there is another measure of dispersion, but it is so seldom used in risk management, we will not discuss it other than in passing. The **variance** refers to the amount of variation or dispersion in a set of data values, or how the data points differ from the mean. The variance is the squared deviation of each value from the arithmetic mean of those values, and it is used in calculating the standard deviation.

Standard Deviation

Definition

The square root of the variance (how data points differ from the mean) is called the **standard deviation.** It is a measure of how far a set of data (numbers) are spread out from their mean (average) value.

How It Works

Calculating the standard deviation using a calculator is a laborious process involving calculating the mean of the observations, subtracting the mean from *each* observation, squaring each of the deviations, adding those squared deviations, calculating the average of *those* squared deviations (the variance), and taking the square root of the variance.

Thanks to the prevalence of computers and spreadsheet applications, the risk manager only has to load the loss data into the spreadsheet and apply the standard deviation function, and the work is done electronically in a split-second. In the Appendix at the end of this Section, you will find instructions for calculating standard deviation using Excel.

Some organizations have a Risk Management Information System (RMIS) available to them. Most RMIS have the capability of calculating a standard deviation (as well as all the other measures of central tendency, dispersion, and other techniques to be covered in the following sections).

Uses

- Provides an indication of variability and predictability of the data set
- Shows how far data points are from the mean. A small standard deviation indicates the data points are close together with little variance, while a large standard deviation indicates the data is not grouped together.

Impact of Extreme Values

Because each data point is used in the calculation, outliers increase the standard deviation.

For the purposes of this course, the standard deviation will be given. No calculations or use of spreadsheets will be required.

Measures of dispersion from central tendency provide a clearer understanding of how the data is distributed. Next, we will explore how standard deviations within a normal distribution can help risk managers to more accurately forecast losses.

Knowledge Check

Given the following array of numbers,

7 25 6 34 55 30

1. Calculate the range.

2. You are examining the loss data from two organizations—Smooth-On and Jumping Jack.

Smooth-On	Year	Jumping Jack
240	X1	120
260	X2	383
230	X3	247
270	X4	301
250	X5	199

Your Excel spreadsheet program gave you the averages and standard deviations of the population.

Average	250	250
Std. Dev.	14.1	89.2

Which organization has more variability in its losses? Why is that so?

3. If you had to make a loss forecast for these organizations, which organization's forecast would you be more comfortable in making? Why?

Example: Skills Application

Let's revisit the skills application exercise we reviewed at the beginning of this section. Based on what we have learned so far, can we answer these questions yet?

Frequency History of Smooth-On and Jumping Jack		
Smooth-On	**Year**	**Jumping Jack**
240	X1	120
260	X2	383
230	X3	247
270	X4	301
250	X5	199
?	X6	?

Severity per loss for X6 has been separately predicted to be an average of $1,125 per loss for both facilities.

1. What will predicted losses be in X6?

    ____

2. What is the range of possible losses that might be predicted to occur?

    ____

3. Can we assign probability or determine a degree of certainty for losses not exceeding some number?

    ____

To answer these questions and provide a range of possible losses with a degree of certainty, we need to understand **confidence intervals.**

Empirical Rule and Confidence Intervals

Learning Objective

3. *Describe the role of the standard deviation in a normal distribution and explain the differences between a normal and skewed distribution.*

Normal Distribution

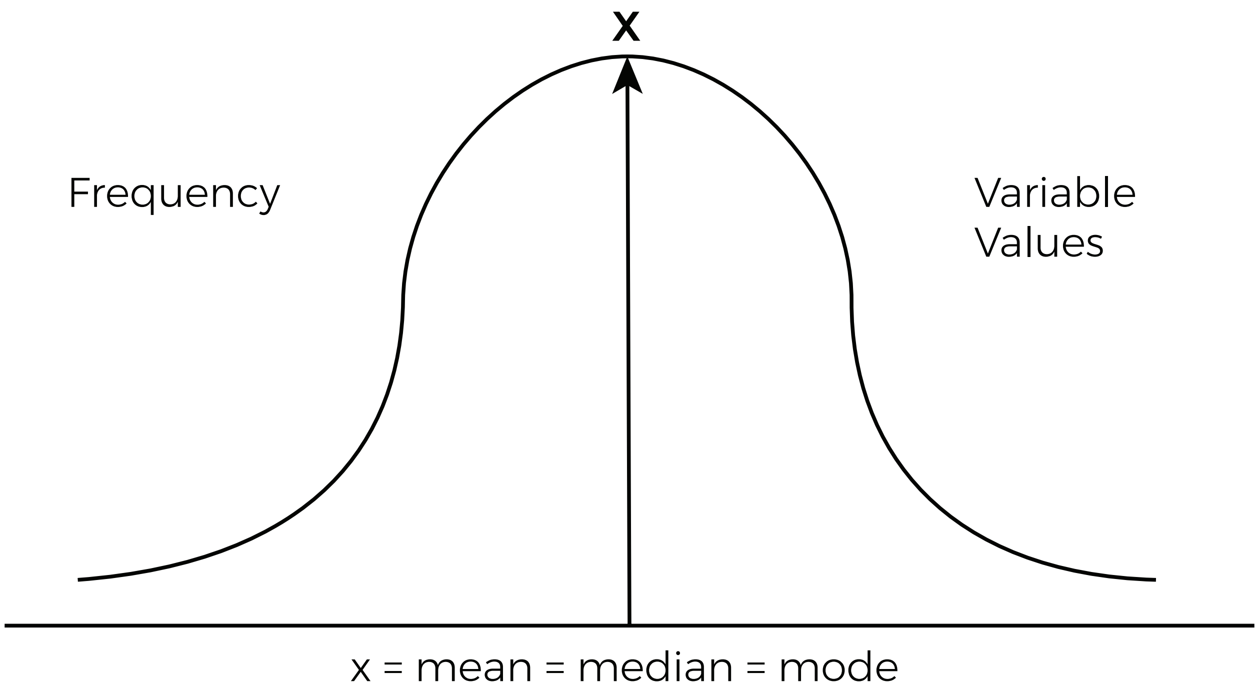
Confidence Intervals Using Normal Distributions

One of the key tasks of a risk manager is to be able to effectively forecast and prepare for risks. Of course, there is no magical crystal ball to see into the future, so the risk manager must use statistical analysis to make reasonable predictions. One way to do this is through the use of **confidence intervals**, which Investopedia defines as, "the probability that a population parameter (the estimate of losses) will fall between a set of values for a certain proportion of times. In other words, risk managers can use standard deviations to forecast losses with a specific degree of confidence.

An underlying assumption required for using a confidence interval is that the distribution to which confidence intervals will be applied is a normal distribution.

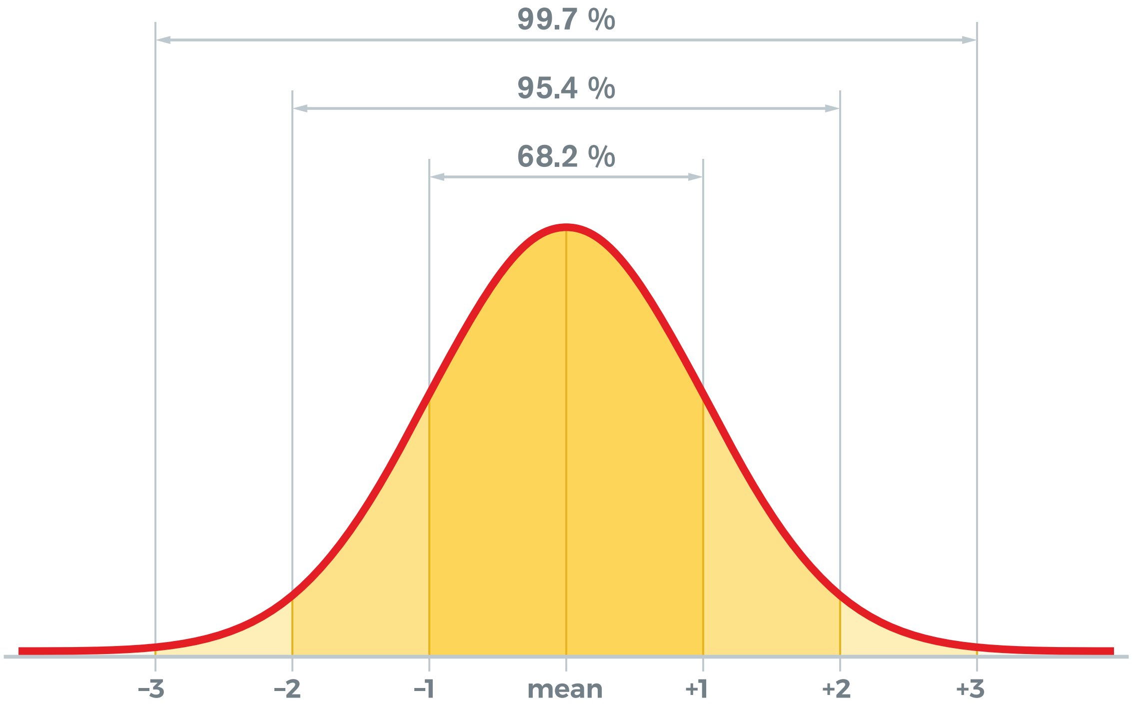
Normal distributions

In a normal distribution, often called a bell curve, the mean, median, and mode have the same value at the high point of the graph.



Empirical Rule

The **Empirical Rule** states that nearly all values will lie within three standard deviations of the mean in a normal distribution. The percentage of the bell-shaped curve defined by one standard deviation above and below the mean is 68.2%. When two standard deviations are used, 95.4% of all values lie within that defined area. At three standard deviations, the area within the bell curve contains 99.7% of the values. For our purposes, we will simplify these percentages by rounding them to 68%, 95%, and 99%.



Using confidence intervals, the risk manager can ascribe a **confidence level**, or assumed level of certainty, in the predicted losses. In other words, if the confidence interval estimates that total losses will vary from $100 to $1,000 at a 95% level of confidence, the risk manager feels comfortable that 95% of the time, predicted losses will fall within the confidence interval. Yes, a few times, the estimate of the losses will be incorrect, but few things are 100% certain in business or in life. Using a single point estimate, or loss pick, is virtually guaranteed to be incorrect 100% of the time.

These sets of minimums and maximums are called **confidence intervals.**

1. 68% of values lie within one standard deviation of the mean.

2. 95% of values lie within two standard deviations of the mean.

3. 99% of values lie within three standard deviations of the mean.

The significance of a standard deviation in a normal distribution is that statistical measures of central tendency can be readily used to forecast losses.

Central Limit Theorem

Another issue facing the risk manager is the question of having enough data to have some degree of credibility in projections or other statistical measures. Insurance and other types of risk financing often depend upon the Law of Large Numbers for those financing mechanisms to work effectively. Most organizations do not have a sufficiently large number of exposure units to assure a reasonable level of credibility, but when those exposures are combined with those of other organizations in a rating authority or a large insurance company, a higher level of credibility frequently exists. On an individual organization basis, the risk manager may have to make do with the organization's smaller number of exposures, and for that process, the Central Limit Theorem provides some assistance.

Here, the risk manager must assume the smaller number of exposures represents the larger population of exposures held by others. The **Central Limit Theorem** states that with an appropriately large sample, commonly 30 or more values, that sample's average can be treated as if it were drawn from a normal distribution.

Why 30?

You need at least 30 values before you can reasonably expect an analysis based upon the normal distribution to be valid. It represents a threshold above which the sample size is no longer considered "small." This "rule" was first put forth in 1733 by a mathematician writing about the tossing of a fair coin and the heads/tails outcomes. Interestingly, William Gossett, a statistician and head brewer for Guinness, used a variation of the Central Limit Theorem because he knew that even Guinness would limit the amount of product for testing (as well as affecting the sobriety, and therefore credibility, of the testers). For those of you with knowledge of statistics, Gossett's discovery is commonly known as Student's t-distribution—a statistic that addresses the errors in very small samples.

Normal Distribution and the Central Limit Theorem

A normal distribution or a smooth, bell-shaped curve makes statistical analysis simpler because it is necessary only to determine measures of central tendency and dispersion to fully describe the distribution. Insurance companies rely on the Law of Large Numbers to ensure a normal distribution when setting rates and premiums. Most organizations face a small sample size that may require adjustments to the data for skewness and kurtosis (distribution of data from the mean).

Skewness

In risk management, many distributions are not normal. For example, individual losses are not normally distributed, as the lower limit of the distribution is, by definition, zero, and the upper limit is, theoretically, unlimited. Such distributions are right-skewed, or the "tail" of the distribution is on the right because of the infrequent but very large loss dragging the mean to the right of the median. Skewed distributions have differing values at the high point of the graph. Skewness is the measure of the degree of asymmetry of a loss distribution. Again, Excel and other spreadsheet applications allow the risk manager to easily calculate the degree of skewness in a distribution.

Definition

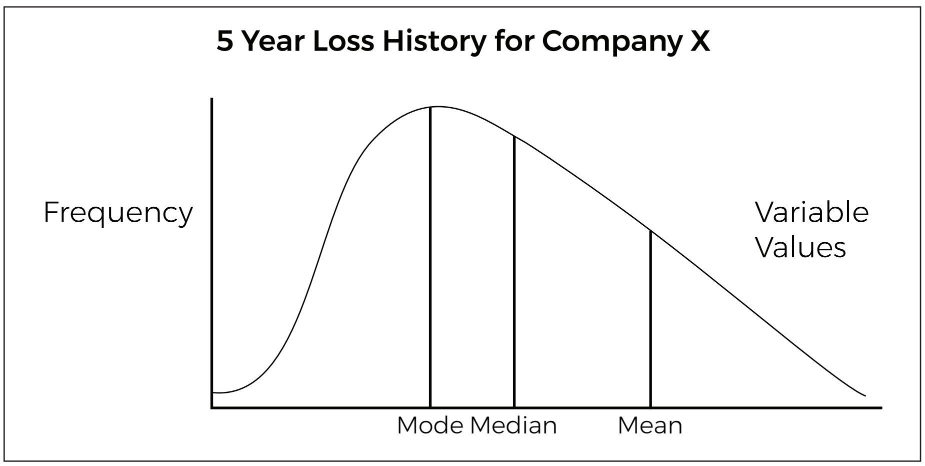
Skewness is defined as the measure of the degree of asymmetry or distortion from a symmetrical bell curve of a frequency distribution.

How It Works

1. Right skew — positive skew
    - Common in risk management
    - The mean is to the right of the median; the average is greater than the median value, and the "tail" is on the right.

Example: Right-Skewed Distribution

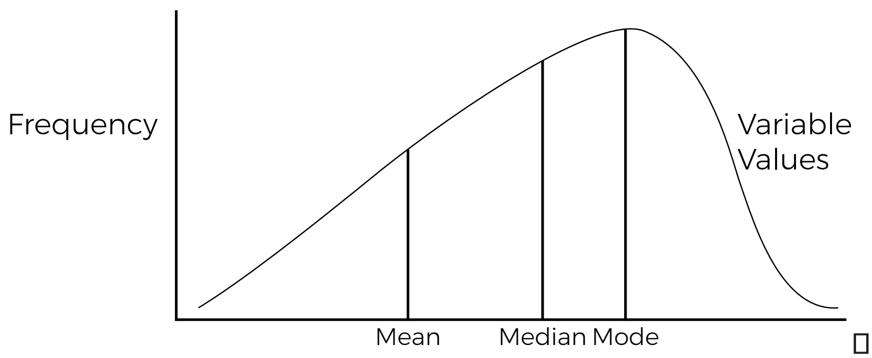
Individual severity (loss size) distributions are skewed to the right, as most losses are small relative to the maximum possible loss. In this case, the values missed by using standard deviations to "capture" the losses would be the infrequent but severe losses.



2. Left skew — negative skew
    - In a negative, or left-skewed, distribution, the mean is to the left of the median; the average is less than the median value, and the “tail” is on the left.
    - In statistics, a negatively skewed (also known as left-skewed) distribution is a type of distribution in which more values are concentrated on the right side (tail) of the distribution graph while the left tail of the distribution graph is longer.
    - A negative skew highlights the risk of left tail events or what are sometimes referred to as “black swan events.”
        - While a consistent and steady track record with a positive mean would be a great thing, if the track record has a negative skew, then you should proceed with caution.

Example:

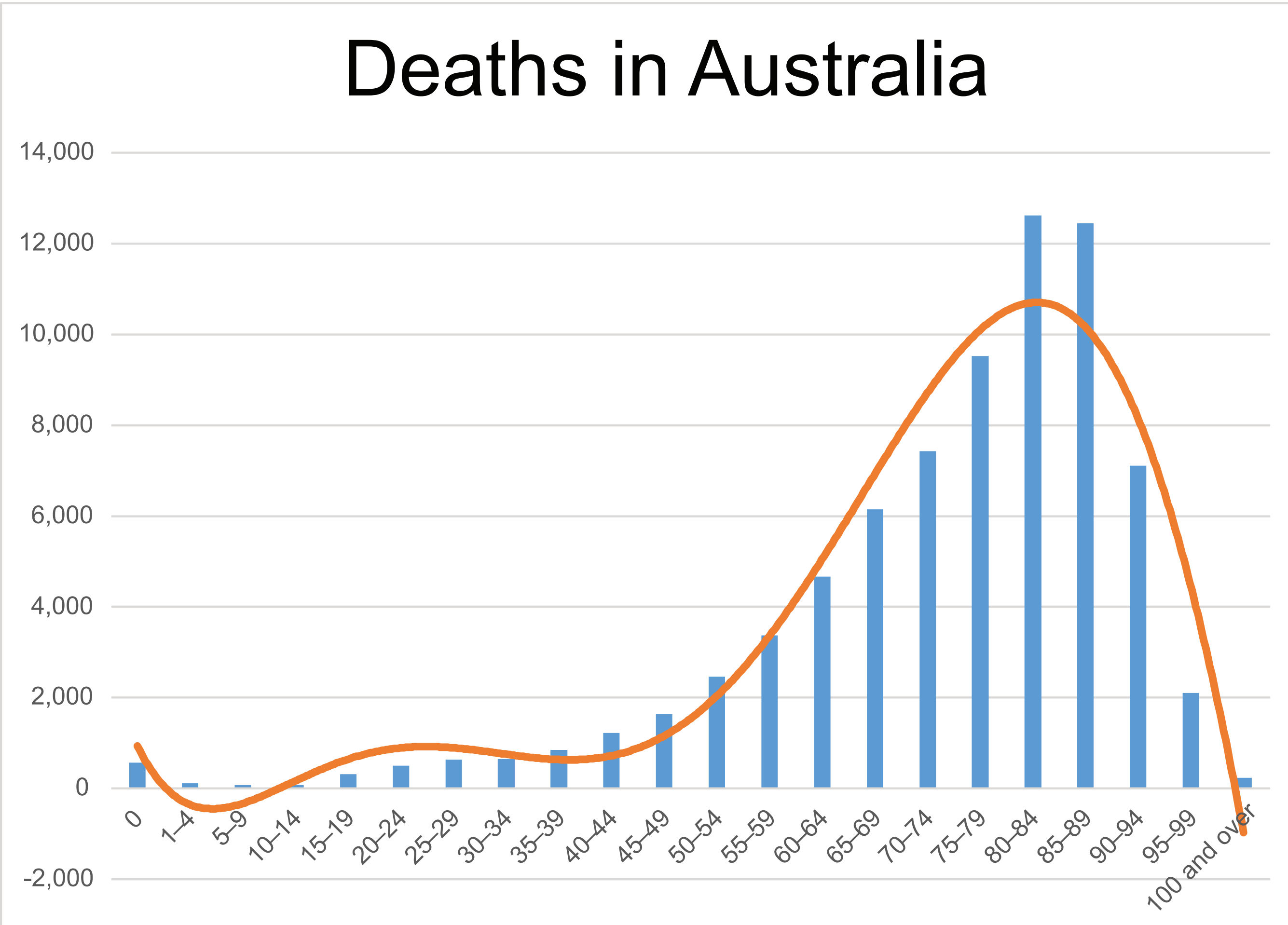
U.S. Retirement — Ages in the Past Five Years



The Empirical Rule does not hold for right-skewed or left-skewed distributions. It is used only with normal distributions.

Knowledge Check

Directions: Use the graph to answer the questions.



1. Does this graph show a positive or negative skew?

____

2. What does the skew of this graph tell us about the relationship of age to the average death rate?

____

____

3. Does the Empirical Rule apply to this graph? Why or why not?

---

4. Which type of skew is most common in risk management? Explain why.

Histograms

Learning Objective

4. Draw a simple histogram showing individual losses versus annual totals.

The histogram is used to show frequencies for broader ranges than losses, as it would be totally impractical—and nearly impossible—to depict every loss individually on a graph. Instead, the risk manager groups the losses into bins (or groups of data) of equal size and counts the number of observations in each bin. The number of losses or the proportion of losses falling into each bin is the statistic that is used to create the histogram.

Definition

A **histogram** is graphical representation of the distribution of data that is used to illustrate the spread of numerical data

How it Works

Data:

Losses (in $1,000s)							Total
40	10	50	70	10	10	20	**210**

1. Sort the data in ascending size order.

Losses in Ascending Order						
10	10	10	20	40	50	70

2. Select the number and size (range) of bins (groups of data). Generally, it is best to use three to five bins of equal size. Trial and error may be required. In this case we will use:

0–25
26–50
51–75

3. Sort the data into the selected bins.

0–25	Four occurrences: (10, 10, 10, 20)
26–50	Two occurrences (40, 50)
51–75	One occurrence (70)

4. Calculate percentages.

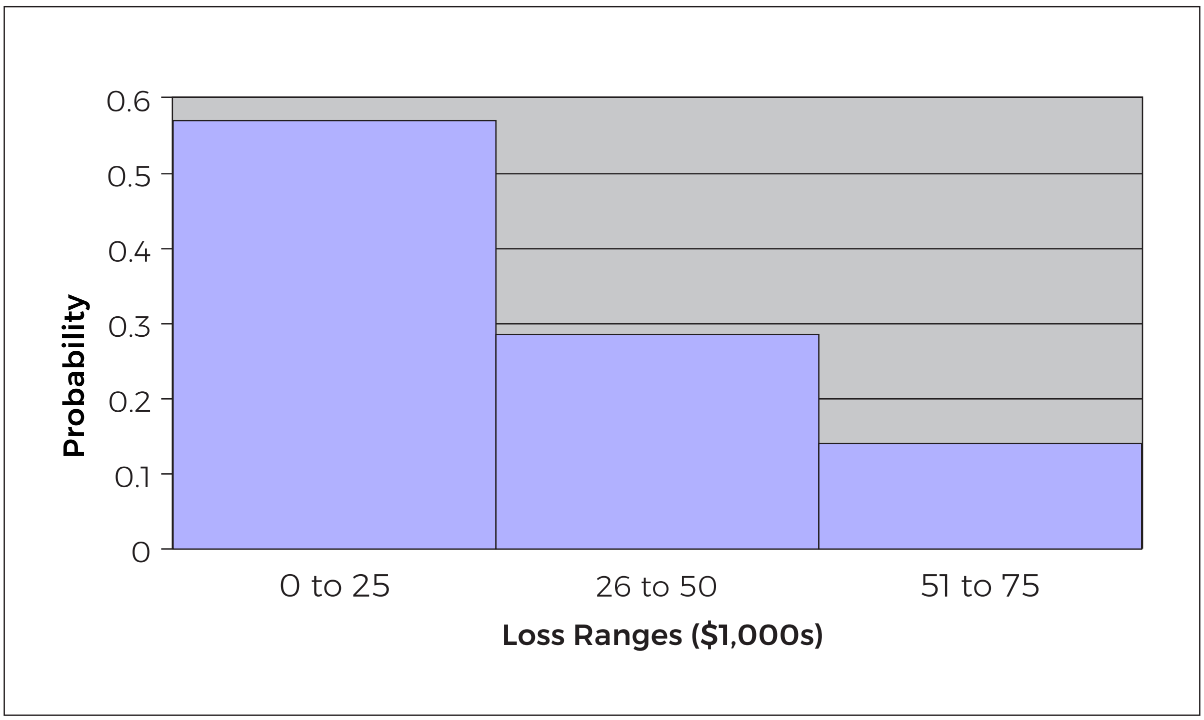
   Divide the number of occurrences in each bin by the total number of occurrences.

0 to 25	=	4 ÷ 7	=	0.571	=	57.1%
26 to 50	=	2 ÷ 7	=	0.285	=	28.5%
51 to 75	=	1 ÷ 7	=	0.143	=	14.3%

5. Draw the graph.

   The ranges of losses (bins) are on the X-axis.

   Percentages (probabilities) of those losses occurring are on the Y-axis.



Knowledge Check

1. Create a histogram using the loss data provided.

Losses (in $1,000s)							
30	40	30	75	50	100	10	60

Work Area

2. Provide a brief explanation of the histogram and what it conveys.

Forecasting Losses Using Confidence Intervals

Learning Objective

5. *Forecast future losses by describing and calculating confidence intervals and simple linear regression.*

An important application of statistics in risk management is to assist the risk manager in forecasting losses based upon loss history. When a normal distribution of losses can be assumed, confidence intervals and the Empirical Rule can easily be used to determine the likely minimum and maximum losses expected.

The mean value of the loss distribution is used to determine the point estimate for losses, commonly called the loss pick. By calculating confidence intervals, the risk manager can ascribe an assumed level of certainty that the confidence range will include the actual losses. For example, if the confidence interval estimates that total losses will vary from $400 to $600 at a 95% level of confidence, the risk manager feels comfortable that 95% of the time, losses will fall within the confidence range.

Example: Let's compare two companies: Smooth-On and Jumping Jack. We want to forecast the expected losses for year six, and we will do so by calculating confidence intervals and the standard deviations provided below.

Frequency History of Smooth-On and Jumping Jack		
Smooth-On	**Year**	**Jumping Jack**
240	X1	120
260	X2	383
230	X3	247
270	X4	301
250	X5	199
1,250	Total	1,250
1,250 ÷ 5 = 250	Mean	1,250 ÷ 5 = 250

250	Frequency predicted for X6	250
15.81 (16)	Standard deviation (rounded)	99.75 (100)
31.62 (32)	+ two standard deviations	199.50 (200)
218 to 282	95% confidence interval (mean +/– two standard deviations)	50 to 450
	[frequency x average severity ($1,125) = total expected losses]	
$245,250 to $317,250		$56,250 to $506,250

Note: In risk management, it is common to round standard deviations to the nearest whole number. While this creates a small mathematical error, the desired result, a projection of losses, is exactly that: a projection, and everyone knows that being "close enough" is adequate when budgeting for revenues and expenses. A Chief Financial Officer does not care that the risk manager predicts losses to be between $245,677.50 and $316,822,50. In fact, the CFO is likely to accept a projection of $245,000 or $250,000 to $325, 000 or $350,000. Despite the implied precision of mathematics and statistics, risk management is an art, not a science. "Close enough" works.

Confidence Intervals of Total Expected Losses

1. Given the mean and standard deviation for both organizations, determine the 95% confidence intervals—the range of outcomes that should occur 95 times in 100. For simplicity, focus on the upper range only.
   a. The mean is 250 losses for each of the organizations. Average predicted losses for each are $1,125 x 250 = $281,250.
   b. For Smooth-On, the standard deviation is calculated to be 15.81. Two times the standard deviation is 31.62, rounded to 32. Add 32 to the mean, and the upper end of the 95% confidence level is 282 losses. This result, multiplied by an average severity of $1,125, is $317,250.
   c. For Jumping Jack, the standard deviation is 99.75. Two times the standard deviation is 199.5, rounded to 200, added to the mean of 250, is 450 losses. 450 multiplied by $1,125 is $506,250.

2. Interpret the results and compare the two organizations.

Note that even while having the same mean, the predicted losses for Smooth-On are significantly lower than those of Jumping Jack. That is because of the difference in the standard deviations which, as you will recall, is derived from the actual observations and their distance from the mean.

Linear Regression

Confidence intervals are not the only option for forecasting, and depending on the circumstances, they might not always be the most effective option, particularly when there appears to be a trend in the data. Simply looking at the data and seeing what appears to be a trend is not enough to make a forecast, but it is enough to warrant conducting a linear regression analysis to learn more about the relationship in the data. This "eyeballing" the data is often called "ocular regression."

Regression analysis is a statistical technique of modeling the relationship between variables by fitting the "best" line to a scatter of dots, each representing a level on the X-axis with a level on the Y-axis. Regression analysis produces a better projection than confidence intervals when there is a strong relationship between the independent variable(s) and the dependent variable; for example, an increase in the number of employees (the independent variable) is directly related to an increase in the number of worker injuries.

In the simplest example, the Y-axis represents the independent variable (for example, the number of employees), and the X-axis represents losses (frequency or severity). Thus, regression analysis can model the effect of a change in the dependent variable because of a change in the independent variable or variables, such as miles driven, hours worked, payroll, sales, or any other exposure base. When two or more independent variables are considered, the analysis is called a **multiple regression.**

Most regression analysis performed by risk managers is a simple linear regression in which a line is fitted to the data such that the sum of the squared deviations is minimized.

Definition

Regression analysis is the statistical technique of modeling the relationship between variables by fitting the "best" line to a scatter of dots.

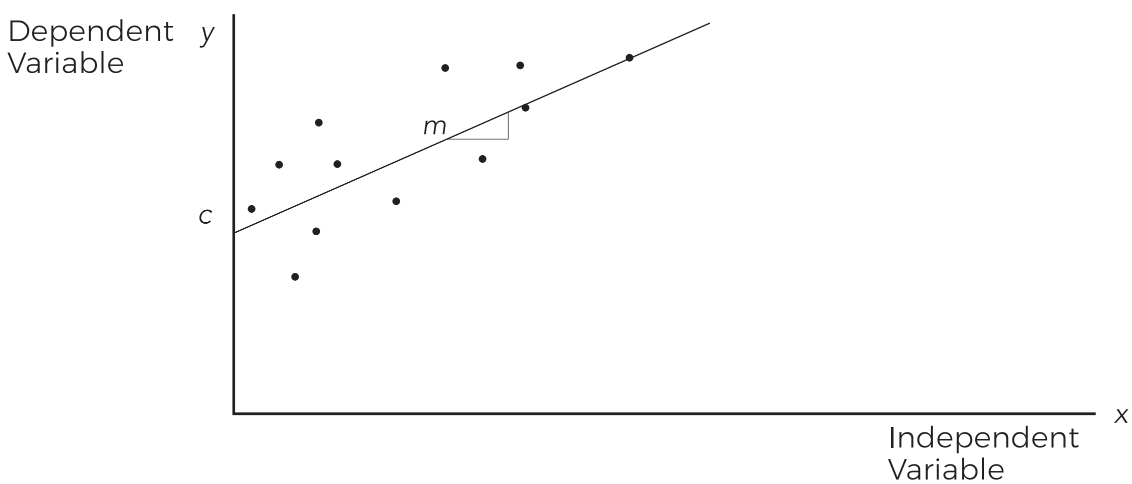
How It Works

Linear regressions are typically obtained using special software. Most RMIS and spreadsheet applications contain the formula for several types of regression analysis. In Excel, the formula is "FORECAST.LINEAR." (See the Appendix at the end of this Section for a full explanation.)

Benefits of Linear Regression

Regression analysis will produce a better projection than a confidence interval when a time trend or other relationship is strong.

Scatter Plot and Graph



$y = mx + c$

where y = the dependent variable
m = the slope of the regression or the slope of the line
x = the independent variable
c = the intercept on the y-axis

Excel's data analysis package (Analysis Toolpak) provides these statistics. The risk manager must only perform the simple mathematical process of substituting the values provided by Excel into the y = mx + c formula to arrive at the forecast.

However, before that forecast can be completed, there must be consideration of two other descriptive measures provided by Excel—the correlation coefficient and the coefficient of determination, along with the common-sense test of causality.

Correlation

Even if a trend is apparent from simple "ocular" regression, or "eyeballing" the data, another statistic must be calculated and considered before the regression analysis is used to forecast or predict. This statistic, the correlation coefficient, is calculated by Excel's data analysis package (or comparable spreadsheet application) as part of the regression analysis. Its purpose is to measure the degree of correlation, or how the variables move in relation to one another.

Definition

Correlation is the measure of the strength of a linear relationship between two variables.

How It Works

1. The Excel program gives the correlation coefficient as part of the output of the regression.

2. The correlation coefficient, r, varies from –1 to +1.

   $-1 < r < +1$

3. When $r = 0$, there is no correlation between the variables.

4. When r is positive, the variables move in the same direction; the closer to +1 (a perfect positive correlation), the stronger the relationship.

5. When r is negative, the variables move in opposite directions; the closer to –1 (a perfect negative correlation), the stronger the inverse relationship.

Examples:

Positive — A correlation between an increase in distracted driving and higher accident frequency

Negative — A correlation between an increase in gas prices and a decrease in accident frequency

Causality

Causality is the relationship between one variable and another variable in which the second variable is a direct consequence of the first. However, correlation between two variables does not necessarily imply causality. Additionally, statistical correlation does not imply a meaningful direct relationship. Common sense must be applied in determining causality.

In the late 1960s, enterprising financial analysts discovered an interesting correlation in predicting movements of the stock market. If one of the original National Football League teams beat one of the American Football League teams in the newly created Superbowl, the stock market would end higher in the coming year, and vice versa. For 30 years, the market responded as predicted over 95% of the time. However, common sense says the winner of the Superbowl has nothing to do with the way the stock market moves. This is an example of strong correlation but not causality; the independent variable (Superbowl winner) has nothing to do with the dependent variable (the stock market).

Coefficient of Determination

The coefficient of determination is a descriptive measure of the strength of the regression relationship or how well the regression line fits the data. It measures the percentage of the variation in the dependent variable explained by the regression. r^2 varies from 0 to 1.00: the closer r^2 is to 1.00, the better the relationship is explained by the independent variable; the closer to 0, the worse the fit. As r^2 increases, the better the fit, and with that, the risk manager has a higher degree of confidence in the regression. r^2 measures the percentage of the variation in the *y* variable explained by the regression

1. r^2 ranges from 0 to 1.00.

2. When $r^2 = 1.00$, 100% of the variation in *y* is explained by the *x* variable (a perfect fit).

3. When $r^2 = 0$, the regression line explains nothing.

4. The higher the r^2, the better the fit and the higher the degree of confidence in the regression.

5. The error term "e" represents the unexplained variance.

6. Rough guidelines for r^2 (not statistically absolute):

   $r^2 > 0.90$ very good predictor

   $r^2 = 0.80 – 0.89$ good predictor

   $r^2 = 0.60 – 0.79$ fair predictor

   $r^2 < 0.60$ poor predictor

Note: Lowercase r^2 indicates only a single independent variable (simple regression) while uppercase R^2 indicates more than one independent variable (multiple regression). Excel always uses r^2.

Example: A new organization, Up-Up-and-Away, is added to the two organizations from the example used previously. Up-Up-and-Away experienced the same trend of loss frequencies as did Jumping Jack. However, there is one major difference; the trend for Up-Up-and-Away indicates the frequency is worsening over time, not jumping around like Jumping Jack.

Year	Smooth-On	Jumping Jack	Up-Up-and-Away
X1	240	120	120
X2	260	383	199
X3	230	247	247
X4	270	301	301
X5	250	199	383
Total	**1,250**	**1,250**	**1,250**

1. Forecast X6's frequency of loss using a 95% confidence interval.

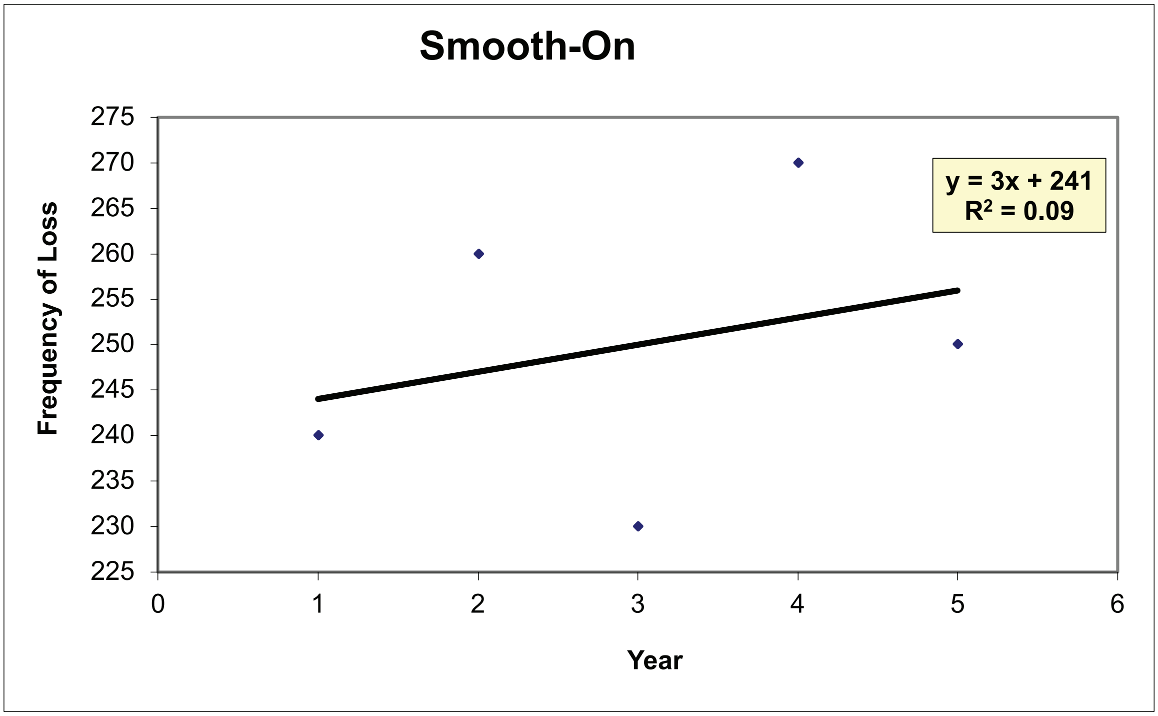
Mean	250	250	250
One standard deviation	16	100	100
Two standard deviations	32	200	200
Intervals (± two SD)	218 to 282	50 to 450	50 to 450

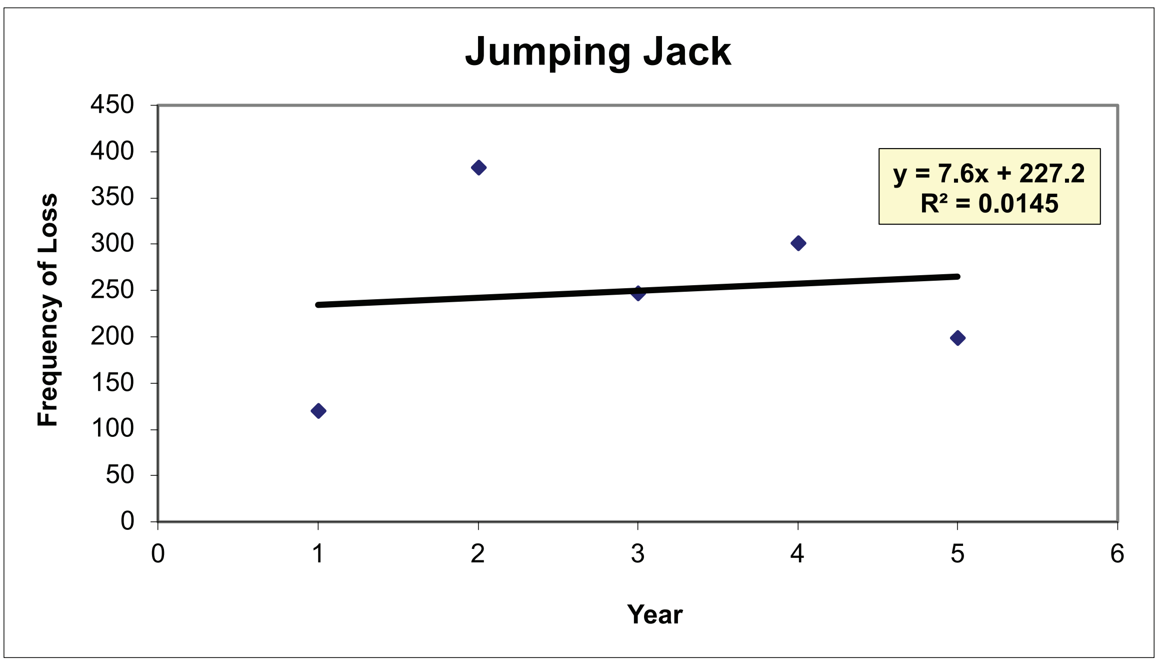
Notes:

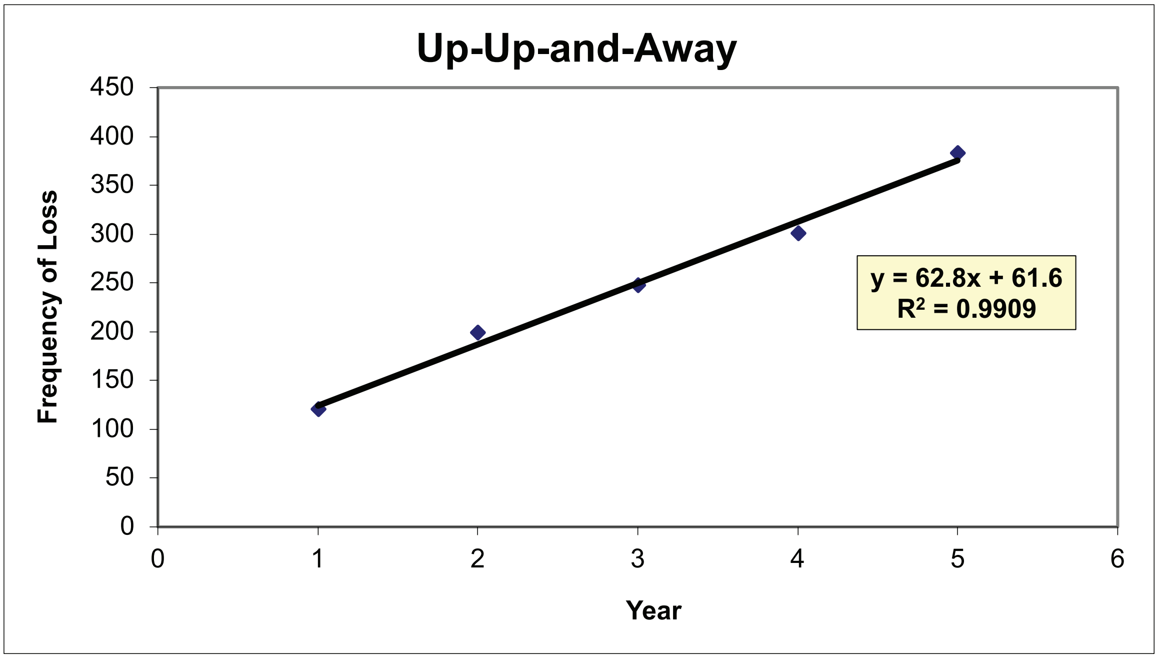
- The numbers for Smooth-On and Jumping Jack are found in the previous example.

The calculations for Up-Up-and-Away and Jumping Jack are the same because their frequencies are the same; they are listed in a different order.

Trend Analysis of the Frequency of Loss


Smooth-On
Frequency of Loss
275
270
265
260
255
250
245
240
235
230
225
0
1
2
3
4
5
6
Year
y = 3x + 241
R² = 0.09


Jumping Jack
Frequency of Loss
450
400
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
Year
y = 7.6x + 227.2
R² = 0.0145



Forecast X6's frequency using regression analysis, if appropriate.

For Up-Up-and-Away, the FORECAST.LINEAR function returned the intercept as 61.6, and the Data Analysis package results are shown in the next table.

SUMMARY OUTPUT for Incident Rates

Regression Statistics	
Multiple R	0.589080346
R Square	0.347015655
Adjusted R Square	0.129354206
Standard Error	0.060121252
Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.005762668	0.005762668	1.594290845	0.295936044
Residual	3	0.010843695	0.003614565		
Total	4	0.016606363			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	0.236638242	0.063055701	3.752844535	0.033051743	0.035966672
X Variable 1	0.024005557	0.019012009	1.262652306	0.295936044	-0.036499198

The R square suggest regression is an excellent forecasting method. The formula, y = mx + c can be easily completed by substituting the intercept for c, the X variable for x, and the projected exposure for m.

a. The graphs shown above were created using Excel's Chart Wizard. An "XY Scatter" was chosen as the chart type. "Series Options" were selected to display the regression equation and r^2.

b. Smooth-On's r^2 is .09 and Jumping Jack's r^2 is .015. Since they are well below 0.60, both are too low to indicate a trend. The confidence intervals calculated in the exercise above should be used instead of regression analysis.

c. Up-Up-and-Away's r^2 is unbelievably high at .991. Therefore, it is an ideal candidate for forecasting X6 using regression analysis.

The important values are found in this summary output:

R square 0.990915

c, the intercept, is 61.6

x, the X variable, is 62.8

M, the projected exposure, is 6

1) The regression equation is shown on the graph to be:

   y = mx + c

   y = 62.8x + 61.6

2) The calculations for X6's projected frequency are:

   # losses = 62.8(# of yrs.) + 61.6

   = 62.8 (6) + 61.6

   = 376.8 + 61.6

   = 438.4, rounded to 438

As you may recall, the 95% confidence interval for Up-Up-and-Away's X6 frequency of loss was 50–450. Regression analysis provides a more precise forecast of 438.

Considerations

It is important to remember to exercise caution when using linear regression. Linear regression will result in an equation that can be used to make predictions, but it may not make sense if the data is widely scattered (in other words, if the r^2 is too low). A good rule of thumb to follow is to use linear regression when a trend is apparent, but if there is no apparent trend, a confidence interval may be more appropriate. Further, when a trend is apparent, but the coefficient of determination is low, a confidence interval may be more appropriate. Finally, always apply common sense with respect to causality.

Knowledge Check

1. With the following claim information and the standard deviation of 74.96 (rounded to 75), calculate the high/low claim projections for the upcoming year, using 95% confidence.

Claim Values:				
125	234	152	340	204

2. For each of the following r^2 values, state whether linear regression or confidence intervals would be more appropriate for forecasting.

r^2 Values	Linear Regression	Confidence Intervals
.6		
.8		
.32		

Summary

Quantitative data assessment calculates numerical values for risks and loss exposures using widely accepted methods. There are a number of tools that can be used to quantify risks. One important basic set of tools is the measures of central tendency, which include:

- Mean: the sum of all values divided by the number of observations; strongly impacted by extreme outliers.
- Median: midpoint of the observations ranked in order of value; also known as the 50th percentile; reduces the impact of extreme values or outliers.
- Mode: the observation that occurs most often in the sample; it has the highest frequency of occurrence; not impacted by extreme values or outliers.

While the measures of central tendency can be useful, they also do not paint a complete picture of how data is distributed. Risk managers can employ measures of dispersion to gain a better understanding of distributions. These include:

- Range: The difference between the largest and smallest values.
- Standard deviation: The square root of the variance.

When data falls into a normal distribution, standard deviations can be used to develop confidence intervals, or degrees of certainty that a value will fall within a certain parameter. Confidence intervals are possible because the Empirical Rule shows that 99.7% of all data will fall within three standard deviations of the mean in a normal distribution. Not all data, however, will be distributed in a normal bell curve. Skewness measures the degree of asymmetry in a loss distribution. Distributions that skew to the right (such as individual loss distributions) has a positive skew, while distributions that skew to the left have a negative skew.

Because it would be essentially impossible to depict all losses on a graph, histograms are used to show broader loss frequencies, by grouping data into “bins” and calculating the percentage of observations that fall into each bin.

Data is typically depicted in one of two ways when forecasting future losses. As mentioned previously, when data is distributed normally, risk managers can use confidence intervals and the Empirical Rule to predict minimum and maximum losses. When there is a strong relationship between the independent variable(s) and the dependent variable, it may be more effective to use linear regression analysis, a statistical technique of modeling the relationship between variables by fitting the “best” line to a scatter of dots. This method works best when there is an apparent trend. In the next section, we will take a deeper look at how quantitative tools can be used in forecasting losses.

Review of Learning Objectives

- *Understand how to calculate three measures of central tendency and interpret the effect of extreme values on each measure.*
- *Understand how to calculate two measures of dispersion and explain how these measures are used by risk managers.*
- *Describe the role of the standard deviation in a normal distribution and explain the differences between a normal and skewed distribution.*
- *Draw a simple histogram showing individual losses versus annual totals.*
- *Forecast future losses by describing and calculating confidence intervals and simple linear regression.*

Resources

Important concepts related to the Learning Objectives in this chapter are summarized in separate videos. Online participants can use the links to access the videos. Classroom learners can access the videos at RiskEducation.org/RAresources.

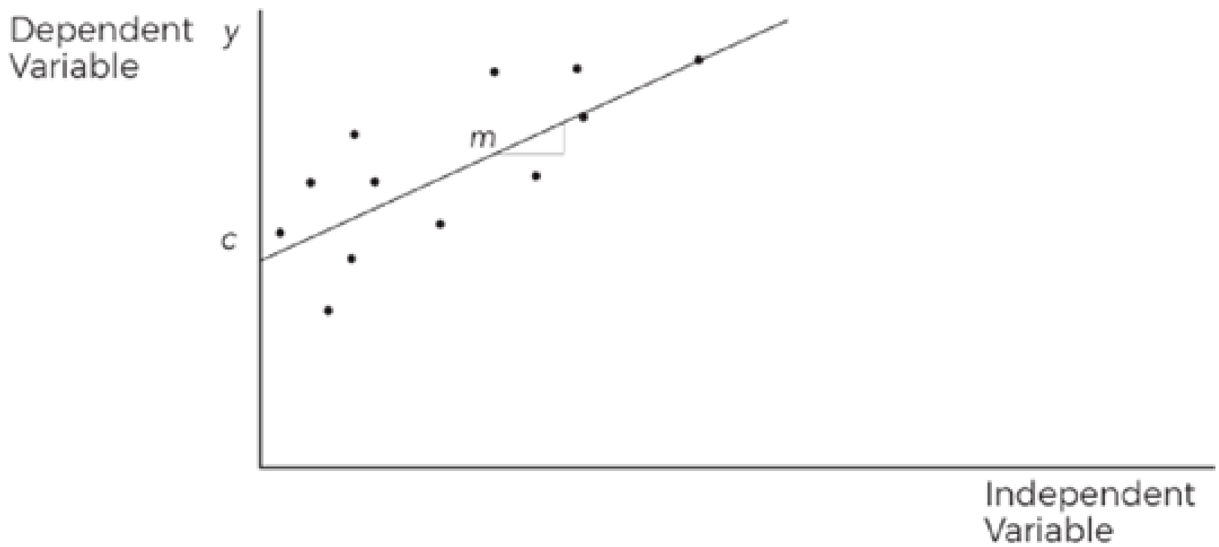
Qualitative Analysis

Section 3 Self-Quiz

Directions: Match the definition or description on the right with the term or phrase on the left.

A. Mean
B. Median
C. Mode
D. Range
E. Variance
F. Standard Deviation
G. Empirical Rule
H. Skewness
I. Central Limit Theorem
J. Linear Regression
K. Confidence Intervals

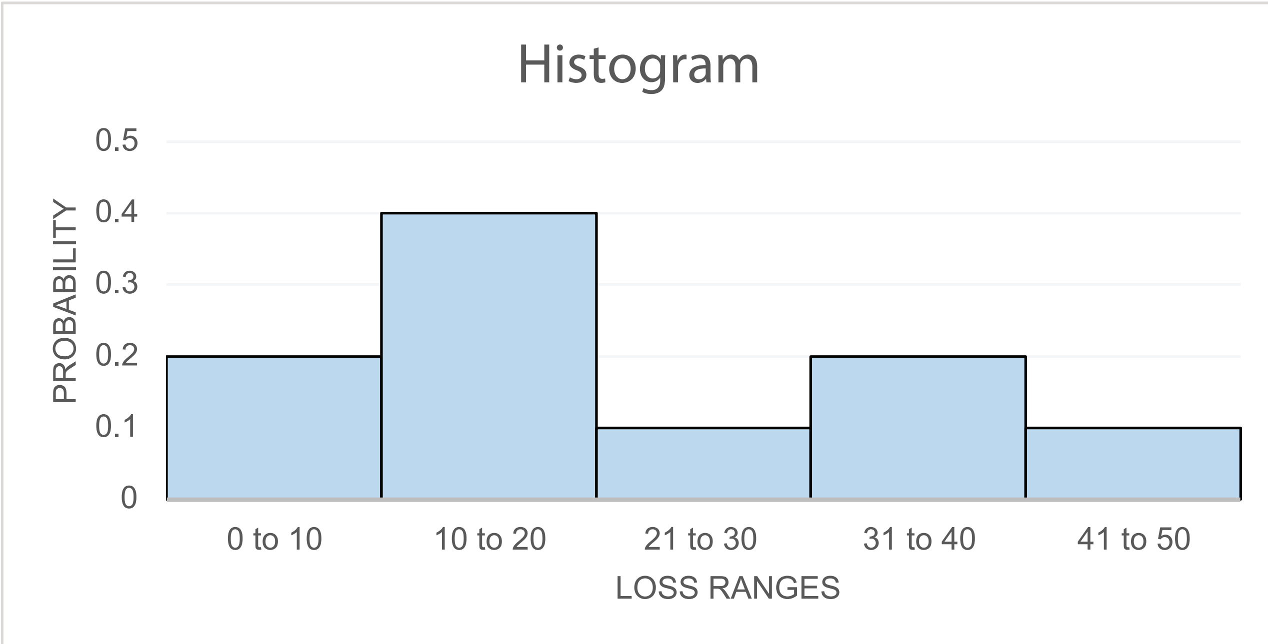
______	The square root of the variance
______	Statistical technique of modeling the relationship between variables by fitting the "best" line to a scatter of dots
______	The measure of the degree of asymmetry or distortion from a symmetrical bell curve of a frequency distribution
______	When there is an appropriately large sample, (30 or more values), that sample's average can be treated as if it were drawn from a normal distribution.
______	The midpoint of the observations ranked in order of value
______	The amount of dispersion in a set of data values
______	The sum of all observations divided by the number of observations
______	A group of continuous adjacent values that is used to estimate a statistical parameter
______	The observation with the highest frequency of occurrence in a sample
______	States that nearly all values will lie within three standard deviations of the mean
______	The difference between the largest and smallest values



Directions: For each item below, select the best answer choice(s).

1. Which of the following statements are TRUE about the scatter plot shown above?
   - ☐ The data shows an apparent trend.
   - ☐ A confidence interval is most appropriate for forecasting losses in this case.
   - ☐ Linear regression is most appropriate for forecasting losses in this case.
   - ☐ The risk manager can determine with 95% confidence that losses in year 8 will be $500,000.
   - ☐ The data shows no apparent trend.

2. Which of the following data sets is correctly depicted by the histogram shown below?



☐

Losses (in $1000s)									
0	5	7	8	10	15	25	29	45	50

☐

Losses (in $1000s)									
5	7	10	15	15	18	25	35	37	50

☐

Losses (in $1000s)									
5	7	8	10	15	15	18	25	35	47

☐

Losses (in $1000s)									
0	5	10	15	15	18	20	25	35	50

3. Which of the following depicts a distribution curve for which the Empirical Rule could apply? (Choose all that apply.)

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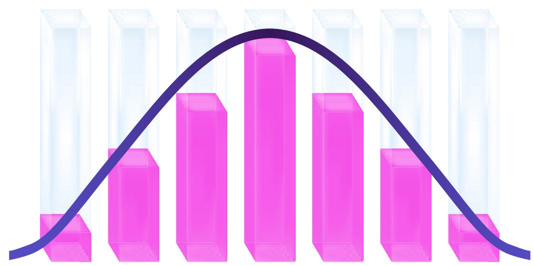

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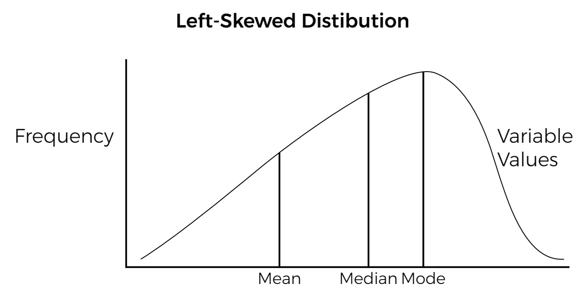

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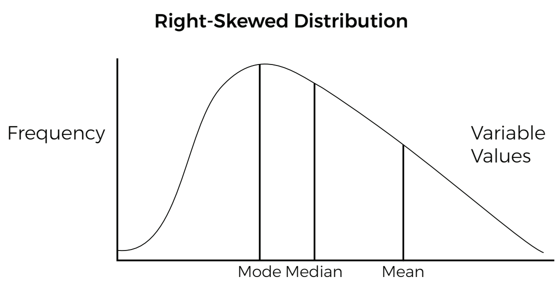

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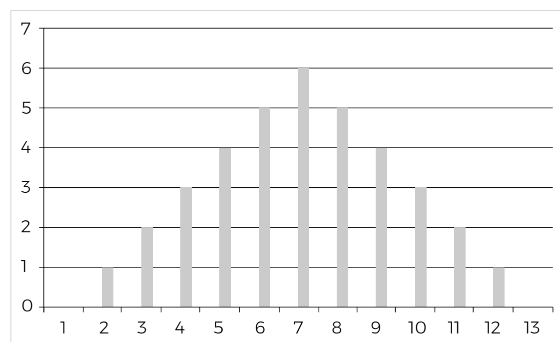


Appendix

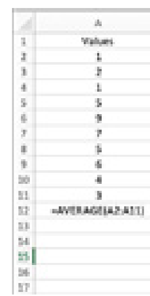
Measures of Central Tendency in Excel

Formula Basics

- = lets Excel know you are inputting a formula.
- Function: a predefined formula in Excel that can be used to perform tasks, such as calculating a mathematical formula, performing a data lookup or logic testing data.
- ( ) indicates the ranges of cells to be used for the function.

Enter the Data Set

Mean



- Using the AVERAGE formula (in Excel, the mean is referred to as the average)
- =AVERAGE(A2:A11) will result in the mean of the values in cells A2 through A11.
- Result of this formula is 4.3.

Median

- Using the MEDIAN formula
- =MEDIAN(A2:A11) will result in the median of the values in cells A2 through A11.
- Result of this formula is 4.5.

Mode

- Using the MODE formula
- =MODE(A2:A11) will result in the mode of the values in cells A2 through A11.
- Result of this formula is 1.
- Note that Excel will only return one value for the mode, so if there is more than one value that occurs most frequently, Excel will return only the one that appears first.

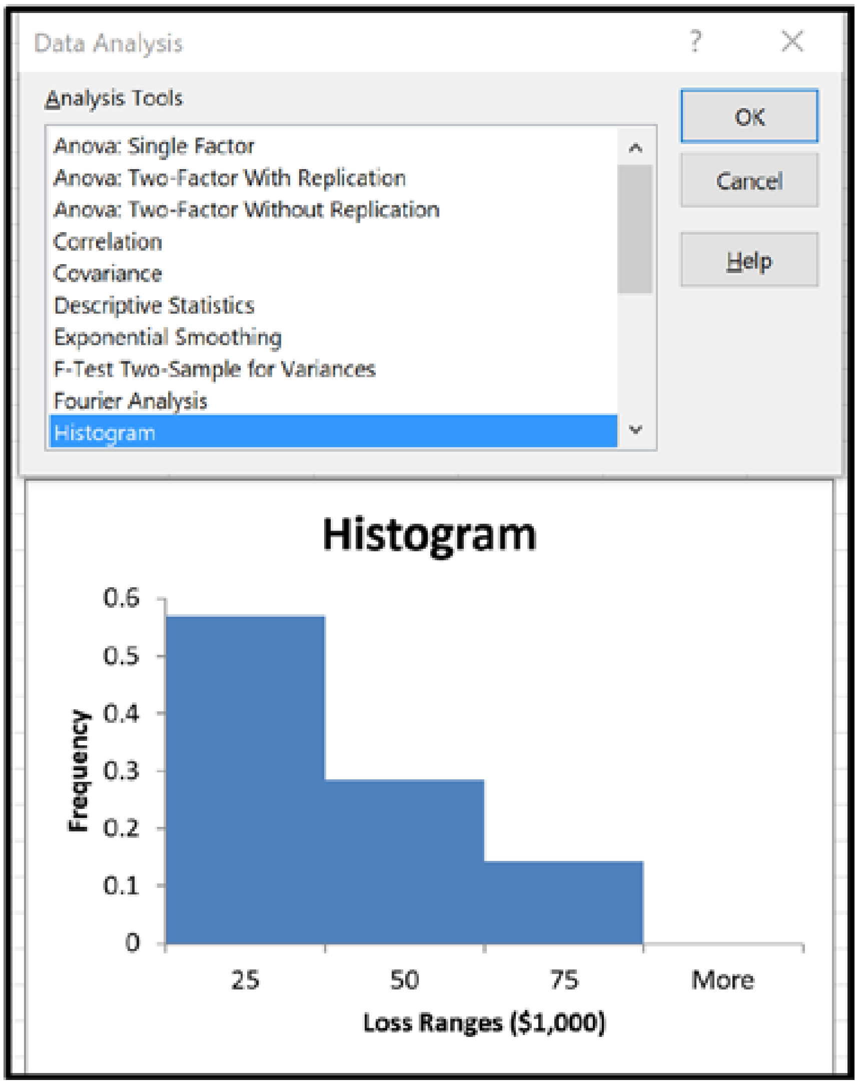
Calculating Standard Deviation Using Excel

Use the STDEV.P function

Calculating Skewness using Excel

Use the SKEW function

Example: A histogram using the data analysis function in Excel



Section 4: Loss Forecasting

Section Goal

In this section, you will learn how to make predictions of frequency and severity by adjusting loss data to reflect current experience and future loss trends.

Learning Objectives

1. *Explain the different types of claim reserves and summarize why reserves are important to a risk manager.*
2. *Calculate ultimate losses for an organization.*
3. *Explain the necessary data requiring adjustment prior to loss forecasting and calculate a loss projection.*
4. *Summarize the different resources available to obtain loss development factors.*

Introduction to Loss Forecasting

In the prior section, we considered various quantitative tools and took all the data as given. A **reserve** is a plan or account for setting aside resources for additional time, personnel, or money to cover risks. In this section, we review the definition of the types of reserves contained in ultimate loss. We will consider a variety of potential adjustments that should be applied to the data before we employ our forecast tools. The key data questions addressed in this review appear below:

Why are reserves critical to an organization and how are they different from each other?

Has the data utilized for calculating ultimate losses been **fully developed** for incurred but not reported (IBNR) losses? What are IBNR reserves and how do they differ from **case reserves**? How do IBNR reserves relate to loss development factors?

Why is loss data adjusted and why is it necessary to develop it? Have the numbers been **adjusted for inflation**? How do **exposures** impact our estimates?

How are development factors for **loss severity** and **loss payouts** constructed? Are industry development and inflation index **factors and values appropriate** for the organization's losses?

How would we forecast ultimate losses if we made adjustments for **changing exposures, developed losses**, and **inflation**?

Before each of the adjustments are separately addressed, it may help to see the key equations utilized in the process. Ultimate losses can be broken down into three components that we will discuss individually. The following definitions are useful as we define and calculate ultimate losses and forecast loss projections:

- (Paid Losses + Case Reserves) + IBNR = **Ultimate Losses**
- (Incurred Losses) + Incurred But Not Reported (IBNR) = **Ultimate Losses**
- (Incurred Losses) x Loss Development Factors (LDF) = **Ultimate Losses**
- (Fully Developed Loss Rate) x {Projected Exposures Next Period) = **Projected Developed Ultimate Losses or Loss Pick**

When we have completed all data adjustments, our quantitative tools can be used to estimate a range of outcomes and build confidence intervals that will indicate the reliability of those estimates.

As it can be challenging to perform all the steps at one time, we will address each adjustment separately. When we are finished with the review, you will be able to walk through all the necessary adjustments that need to be made before building your forecasts with confidence intervals.

Reserves

Learning Object

1. *Explain the different types of claim reserves and summarize why reserves are important to a risk manager.*

Ultimate loss calculations and the resulting reserve estimates are used for several purposes, and many are critical to the risk management department's success. We will cover ultimate loss calculations shortly as these calculations must first be conducted prior to estimating a company's outstanding actuarial reserves. Let's first review the definition of different kinds of reserves and their importance to a risk manager.

Actuarial Reserves (or outstanding liability) are the amount a company must set aside to pay all future obligations that already exist; they are considered liabilities in a company's financial statements. Actuarial Reserves consist of Case Reserves plus IBNR. In other words, actuarial reserves represent the amount of loss the company believes it will ultimately pay out for claims on current policies and for policies it has written in previous years.

Actuarial Reserves garner attention since they are characterized by a great deal of uncertainty. The uncertainty lies in the characteristics of the lines of business written, specifically "long tail" lines where losses may not be apparent for some time—possibly many years after policy inception. It is not uncommon to have cases open for 10+ years, and unfortunately, the largest cases settle last. As time goes on and claims are paid, ultimate loss estimates (and therefore reserve estimates) become much more accurate. Every year, as new information becomes known, companies must re-estimate historical loss reserves.

The variability and volatility of loss reserves require risk managers to pay considerable attention to reserve changes and accuracy. Companies who under-reserve their losses will overstate their income and eventually experience adverse development. **Adverse development** is upward adjustments that must be made to loss estimates when claims are higher than initial estimates. Eventually, adverse development will be required when claims are under-reserved as all claims move closer to settlement. Significant under-reserving causes an overestimation of the company's net worth, making the company's financial health look better than it really is.

If a company is too conservative in its reserving practices, the results may show a large redundancy in reserves. Companies who are overly conservative may allot too much of their capital to reserves, impacting the ability to utilize those funds in other area of the business.

The risk manager will utilize ultimate loss reserves estimates to assist in negotiation of insurance **renewals**, establish limits and deductible amounts on those renewals, and evaluate and implement self-insurance programs or captives. Pricing of renewals is directly tied to ultimate loss calculations and will impact the departments total cost of risk. Most deductible, paid retrospective programs, captives, and some self-insured programs require **collateral**, which is calculated after reviewing both prior ultimate loss estimates combined with the forecast losses for the renewal period.

Historical loss rates provide an indicator of the risk management's overall performance and a starting point for indicators for key loss drivers (frequency or average cost per claim driving results). Allocation of resources to the safety and loss control programs can be modified depending on loss trends and results. The income tax management function will need information contained in loss reserves to the extent the loss reserves are part of a retention plan or a captive insurer. The chief financial officer of a public corporation will need loss reserve information for completion of any financial statements that will be made for compliance with the Securities and Exchange Commission or any stock exchange. Lastly, operations management and legal departments will need loss reserve information as part of the negotiation and pricing of deals in mergers, acquisitions, or divestitures.

Understanding how actuaries determine and set reserves is a key responsibility of a risk manager.

Check-In

Directions: State whether each scenario is an outcome of under-reserving or over-reserving.

1. A company overstates their income, making their financial health look better than it really is.

   Under-reserving   Over-reserving

2. A company is unable to invest in a new project because they have allocated too much of their capital to reserves.

   Under-reserving   Over-reserving

3. An accounting consultant reviews a company's books and notices a large redundancy in reserves.

   Under-reserving   Over-reserving

4. A company must use adverse development to account for claims that exceed initial estimates.

   Under-reserving   Over-reserving

Types of Reserves

There are two types of reserves risk managers work with: case reserves and incurred but not reported (IBNR) reserves.

Case Reserves

When a claim is initially filed, a **case reserve** is established for payment of that claim. Case reserves are generally set by a claims adjuster on individual claims. This reserve is an estimate of what the claim could ultimately cost and is based on the information available at that time. As additional information becomes available, the adjuster makes adjustments to the reserve amount. Many companies have an automated process for individual case reserves, including:

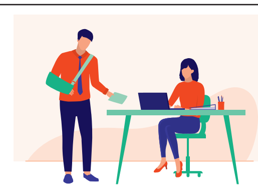
- Stair Stepping or Judgment Method
- Bulk Reserving
- Factor or Tabular Reserves

While the estimate of case reserves will be more reliable than any estimate that includes unreported claims, there is always some uncertainty as new developments related to claims change over time as claims trend towards final settlement. This makes it difficult for an organization to set estimates of ultimate liability using only case reserves.

IBNR Reserves

While claims adjusters set the case reserve on individually reported claims, actuaries look at reserves in aggregate to determine if they sufficiently reflect the total ultimate losses that are expected to be paid out over time. Again, case reserves are normally inadequate for setting estimates of ultimate liability for an organization. As a result, industry experience shows that additional incurred but not reported (IBNR) estimates are often required.

These **IBNR loss reserves** must be held for claims payments that have been incurred but not reported, for claims that reopen, claims in transit, and for additional adverse development of known claims. The **bulk reserve**, or gross IBNR, is composed of four elements:

Four Elements of Bulk Reserve		
Adverse Development	The provision for future adjustments of case reserves	
Reopened Claims Reserve	The provision for claim files that are closed but may reopen	
Incurred but Not Reported (IBNR)	Claims that have occurred but have not been reported to the carrier	
Reported but Not Recorded (RBNR) **(Also known as pipeline claims)**	Claims that have been reported to the insurer but have not yet been recorded on the insurer's books	

Note: Pure IBNR is the sum of IBNR and RBNR. It is industry practice to simply refer to the bulk reserve, or gross IBNR, as simply IBNR.

IBNR represents the liability for unpaid claims not reflected in the case reserve estimates for individual losses and must be calculated to determine estimates of ultimate loss. **Ultimate losses**, therefore, include what has been paid to date, case reserves, and IBNR liabilities. While an adjuster will see the incurred losses (paid losses and case reserves) of all claims, it is critical to add the IBNR so that the company's ultimate losses (paid losses, case reserves, and IBNR liabilities) can be accurately estimated.

Other Reserves

Loss is only part of a total claim cost. There is also a need for reserves for the expenses associated with adjusting losses. Expenses such as investigation, litigation, and administration are included in a separate item called "**loss adjustment expenses**" or LAE. These reserves can be broken down into Allocated Loss Adjustment Expenses (ALAE) and Unallocated Loss Adjustment Expenses (ULAE).

ALAE are expenses that are directly assigned to or arise from a particular claim (expenses that go into the claim reserve). An example of ALAE includes court fees and outside counsel. ALAE costs varies by coverage; ALAE are generally low (approximately 5%) for workers' compensation and higher for general liability (approximately 20–40%).

ULAE are those expenses not specifically allocated or charged to a particular claim. This includes claim administrative salaries, overhead, rent, and other related adjustments. UALE generally range from 8–15%. These costs are included as underwriting expenses.

Risk managers don't have a stack of cash labeled "case reserve" and another called "IBNR reserve." Instead, the reserves are each a part of the total reserve, which is treated as a liability on the balance sheet. The total claims reserve (the one that goes on the balance sheet) holds reserves for cases, IBNR, and ALAE. By making sure the assets are large enough to cover all the liabilities, the company can ensure all reserves are sufficiently covered.

Knowledge Check

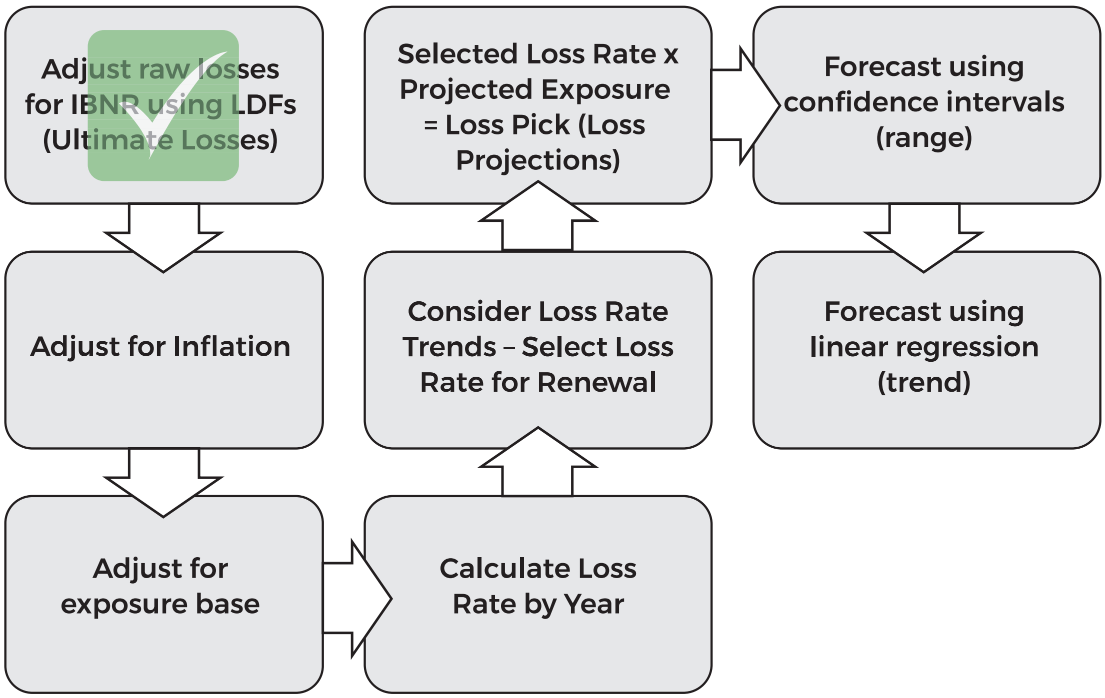
1. Explain the difference between case reserves and IBNR reserves.

2. Why is it necessary to have both?

Ultimate Losses

Learning Objective:

2. *Calculate ultimate losses for an organization.*



Loss Data

Loss data is collected as reported and stored in a loss run or RMIS as raw data. This data must be adjusted to reflect changes in expected additional development of open claims for risk management decision-making purposes. As previously mentioned, complex losses, such as a workers' compensation injury or products liability claim, could take years to develop or reach their final claim amount. Loss development is used to calculate the final anticipated ultimate losses. When making these calculations, the following factors are considered:

- Age of the losses
- Length of time to close claims
- Accidents that have occurred but have not yet been reported

Data may be incomplete because of delays in reporting (frequency) and the natural growth of losses over time (severity); therefore, loss data must be developed. Frequency data is developed to discover true IBNR on a year-to-year basis. Severity data is developed (overall development) because of lengthy payout periods or "long tails." Overall loss development includes both dollar severity and frequency development and is often called bulk IBNR. **Payout development** calculates how the overall developed losses are paid over time by measuring actual dollar payment outflows.

Adjusting Raw Losses Using Loss Development Factors (LDFs) to Determine Ultimate Losses

As mentioned previously, reserves (case and IBNR) represent the amount of loss a risk manager believes the organization will ultimately pay out for claims for future renewal policies and for policies it has written in previous years. While case reserves are estimated by the claims adjuster and added to the reported paid losses (providing current incurred losses), IBNR estimates are required in addition with the incurred losses to estimate ultimate loss.

Known loss information on a line of business is provided by a risk management information system (RMIS). The RMIS provides generally (at minimum) the following information:

- Valuation date for all loss and claim information
- Paid losses
- Incurred losses
- Claim counts

Loss Development Factors

The difference between incurred losses and paid losses, provided from the RMIS system, are the estimated current case reserves. The information missing from the loss runs are the IBNR losses. In order to calculate IBNR reserves (to be covered and reviewed shortly), actuaries must first determine **loss development factors (LDFs)**. LDFs, which are unique to each risk, are numerical representations of the IBNR reserves for a risk. They are calculated using a methodology known as **loss triangulation**. The purpose of calculating loss development factors is so they may be applied to a current valuation of incurred losses to determine an estimate of ultimate losses.

Property losses are generally reported in the year incurred and are not expected to change from historical values. As such, they generally have only small additional loss development beyond the current policy year. Liability losses can have significant levels of IBNR, as these losses are slowly reported and resolved (tail exposure). Losses in the most distant years generally require much less development than "green" losses, the losses from the most recent years. This is demonstrated in the example below.

Example: In the following example, development factors are provided to us from our actuarial consultant. LDF selections are calculated by utilizing available industry loss development factors if loss histories (triangles) are not available or by applying the triangulation process utilizing company historical data (or a combination of company and industry data).

Development factors typically are larger for the most current years (X5) as those years are the farthest from full development. As a policy year matures, more information about the individual claims is known, and development factors gradually reflect this by approaching 1.0 (incurred losses equals ultimate losses). Once all claims are reported and closed, the expected applied development factor is 1.0.

Ultimate total losses are projected, based on the current valuations of the data, for what the company will ultimately pay out in losses by policy year. Ultimate total losses for each year are calculated by multiplying the total losses incurred for a given year (column a) by the development factor (column b).

Calculation of Ultimate Total Losses

	a	b	(a x b)
Year	**Total Incurred $**	**Development Factor (given)**	**Ultimate Total Losses $**
X1	125,986	1.00	125,986
X2	469,091	1.11	520,691
X3	386,550	1.30	502,515
X4	291,555	1.57	457,741
X5	357,171	2.51	896,499

Knowledge Check

1. In the example above, explain why the LDFs are applied the way they are.

2. Apply the following LDFs and calculate the ultimate total losses.

2.60 1.17 2.75 1.40 1.00

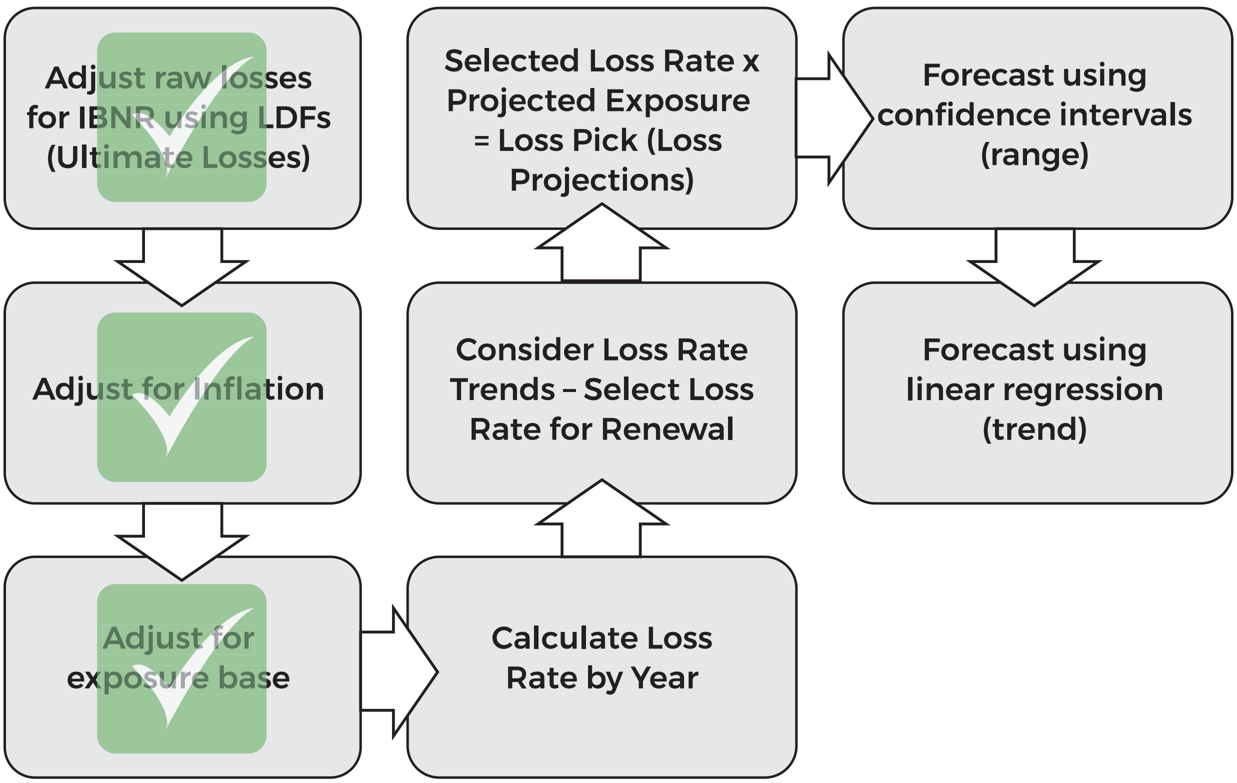
	a	b	(a x b)
Year	Total Incurred $	Development Factor (given)	Ultimate Total Losses $
X1	386,550		
X2	469,091		
X3	125,986		
X4	291,555		
X5	357,171		

Necessary Data Adjustments for Loss Forecasting

Learning Objective:

3. *Explain the necessary data requiring adjustment prior to loss forecasting and calculate a loss projection.*

Once we have calculated historical ultimate losses, we can now turn our attention to projecting losses for the upcoming year. To get started, we must first adjust our completed data, inflating dollar amounts from each previous year so that they are comparable to the forecasted year.



Adjust for Inflation

At the time of the collection of the loss data, the value of each dollar of loss in each time period will differ due to inflation. The purchasing power of a dollar today may not be the same as the value of a dollar when the loss report was created, and probably will not be the same as when the loss occurred. The data must be adjusted to reflect current prices. A price index provides an adjustment factor based on inflation rates for each year beginning with a given year of losses.

Example: After ultimate losses have been calculated (see previous example) to address the dollar amounts covering different time periods, changes in the purchasing power of a dollar over time require an inflation adjustment (indexing). In this example, an inflation rate of 12% per year is assumed for the costs being adjusted. Our goal is to use the inflation index to adjust the ultimate losses for the forecasted losses in year (year X6). For now, we assume the data is already fully adjusted for everything other than inflation. Note that the 12% inflation factor is compounded for each successive year. Thus 1.12 x 1.12 = 1.254 and so on.

Application of Inflation Factors to Ultimate Total Losses

	a	b	(a x b)
Year	**Ultimate Total Losses**	**Inflation Index (12%)***	**Indexed Ultimate Losses $**
X1	125,986	1.762	221,987
X2	520,691	1.574	819,568
X3	502,515	1.405	706,034
X4	457,741	1.254	574,007
X5	896,499	1.120	1,004,079
X6 Today			

* The inflation index is provided, often by an actuarial consultant.

The table below shows how the price index is calculated. Once calculated, ultimate total losses are multiplied by the price index to find the indexed ultimate losses.

(Fully Developed Losses $)

	Ultimate Total	
Year	**$ Losses**	**Price Index*------**
X1	125,986	{1.12)5 = 1.762
X2	520,691	{1.12)4 = 1.574
X3	502,515	{1.12)3 = 1.405
X4	457,741	{1.12)2 = 1.254
X5	896,499	{1.12) = 1.120
X6		

* The index is based on a constant 12% rate of inflation per year.

The oldest data (X1) requires the most adjustment, since prices have changed more over time. This index shows that it will take $1.762 in X6 to purchase what $1 would purchase today (X1). The rule of thumb, related to inflation index numbers, is that the highest index factor applies to the oldest data.

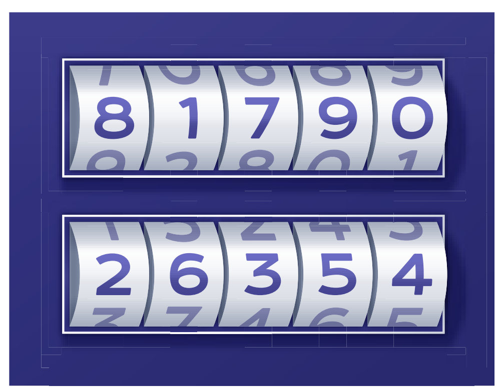
If inflation is constant, the index is (1 plus the interest rate) taken to the power equal to the number of years back from X6. The calculation is based on the fact that there is compounding every year. For example, from X6 to X4, there was inflation of 12% **per year** for two years. This is not just 24% because after prices increase 1.12% for one year, they increase 1.12% again. Thus, we have to multiply 1.12 by 1.12 (or 1.122), which is equal to 1.254 (or a 25.4% increase).

Notice how different the historical ultimate losses are when they are put into X6 prices. The X1 losses of $125,986 become $221,987 when adjusted to the X6 price index, and so on down the list, clearly illustrates that the biggest changes occur over the longest time period. This adjustment is implying that the X1 losses of $125,986 were to happen in X6, those same losses (all things being equal) would cost $221,987 in X6 dollars.

The purpose of this exhibit is to build an understanding of why inflation adjustments are needed and how the indexing works. More adjustments will be performed later in the section.

While this is a relatively simple mathematic process, the risk manager has the challenge of using an appropriate index. The Consumer Price Index (CPI) is based upon the cost of a marketplace basket of common consumer goods and services. This may not be appropriate for some costs. For example, the cost of construction goods and services are not "consumer" costs found in the CPI. Similarly, many medical costs are not contained in the CPI marketplace basket. The risk manager must carefully consider and choose the index that most closely represents the nature of the losses and their costs. Often, factors may be appropriately obtained from actuarial consultants.

Adjust for Exposures



Next, we need to adjust for the company's changing exposures over time. If a company is growing or shrinking, it is important to factor the changing exposures into our forecasts. Many losses are closely related to **exposure units**, some of which are measured in dollars, and some of which are not. Insurance companies tend to use various exposure units in dollars to calculate premiums; however, risk managers do not need to be locked into the same systems as underwriters. Risk managers can select any **exposure base**, or exposure unit, that makes sense and is appropriate for the analysis. For example, the underwriter may wish to use receipts for a trucking client; however, the risk manager may believe that losses are highly related to the number of miles driven.

Exposure Examples:

- Miles driven represents an exposure base for trucking losses.
- Hospital beds or admissions represent an exposure base for hospital losses.
- Payroll represents an exposure base for workers' compensation indemnity losses, but hours worked represents an exposure base for workers' compensation medical-only injuries.
- Area or revenue represent an exposure base for general liability losses.
- Employee head count or vehicle count may be an exposure base for workers' compensation injuries or automobile losses.

If the exposure units are not subject to inflation, such as square feet, acres, number of employees, or miles driven, no adjustment for inflation is needed. If inflation is a factor, an adjustment is typically needed. Year-by-year changes in exposure units are expected, and the adjustment maintains the underlying causality relationship between the losses and exposure units.

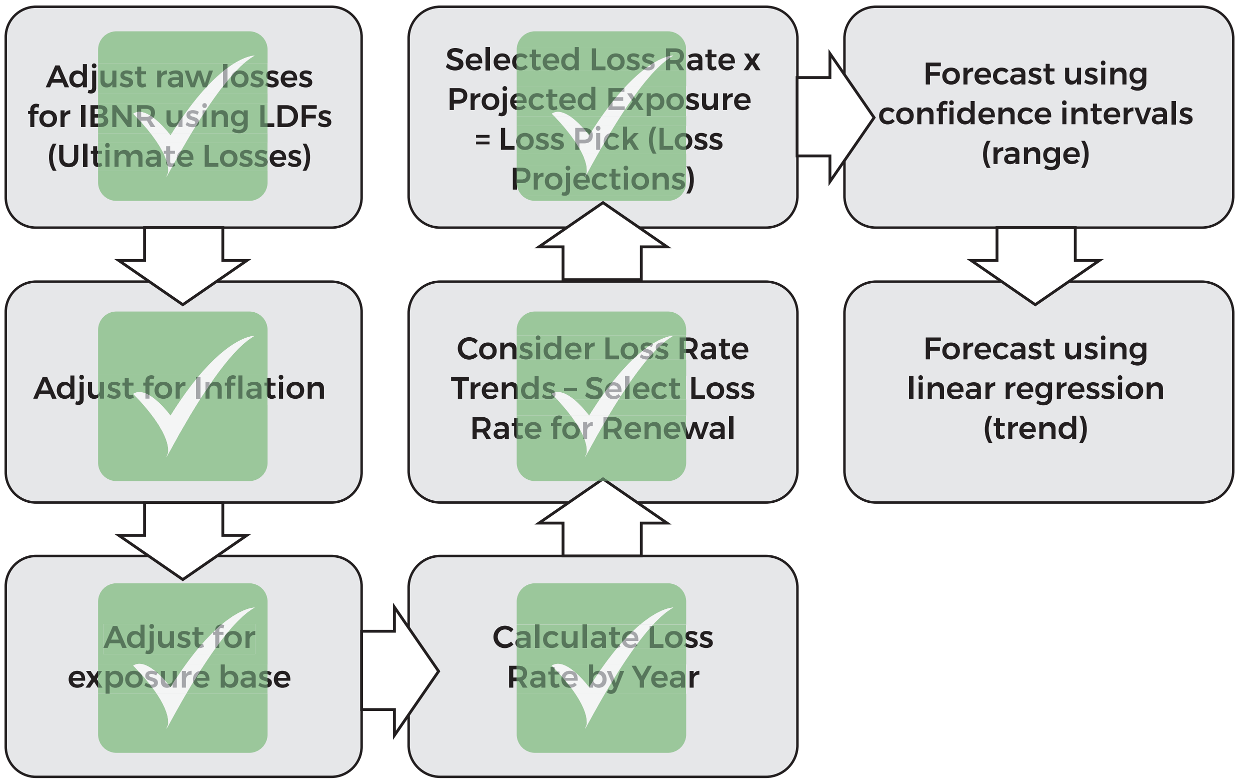
Knowledge Check

Stability is an important variable in loss projections, and operational changes can significantly impact loss projections. For example, let's look at a trucking company that has been in business for several years. The historical loss data shows that one accident for every forty thousand miles driven is a reliable projection. However, the company merged with another company at the beginning of its third year in business, and this merger basically doubled the size of the fleet.

Loss History Chart

Year	Miles Driven Per Year	Number of Accidents	Number of Accidents Per Mile
1	400,000	10 / per year	1 / 40,000
2	600,000	15 / per year	1 / 40,000
3 Year of Merger– Larger Fleet	1,200,000	20 / per year	1 / 60,000

1. How would you interpret these results?



Steps to Calculate Forecasted Losses

1. Calculating Loss Rate by Year

Starting with our original data from our previous example, we can utilize the available exposures (provided by internal resources within the company) over the past five years to calculate loss rates by year ($ loss/exposure ratio). A **loss rate** is a measure of losses to ONE common exposure base, such as losses per $100,000 of revenue. The single loss rate approach represents a composite rate of all losses measured against one common exposure without regard to direct causality.

Divide the indexed ultimate losses by the revenue to obtain the loss rate.

Example: In the following example, the revenue for each year was used as the single, convenient exposure base:

Calculating Loss Rate from Indexed Ultimate Losses

Year	Indexed Ultimate Losses (a)	Revenue (in $1000) (b)	Loss Rate (Losses / $1,000 revenue) (a) / (b)
X1	$221,987	$3,300	$ 67.27
X2	$819, 568	$3,600	$227.66
X3	$706,034	$3,900	$181.03
X4	$574,007	$4,400	$130.46
X5	$1,004,079	$4,800	$209.18
Mean			**$163.12**
X6 Budgeted		**$5,250**	

In this portion of the course, we will analyze loss rates. The rate will be different for different types of insurance products or intended uses. For example, it is common to use losses/revenues rather than losses/other exposures to calculate a loss rate. The loss/revenue rate provides a link to a program profitability analysis.

2. Selecting the Appropriate Loss Rate for Renewal Forecasting

Selecting the loss rate to be used in a forecast is an art as much as it is a science. Provided with identical data, differing actuaries may choose different loss rates for different reasons.

The goal is to select a value that best estimates next year's losses. If the past five years of rates are increasing, we would expect next year to increase as well. We could select a rate that averages the past five policy years (to dampen highs and lows), the past two years (that reflect recent results), or the past five years, minus the highest and lowest value (to eliminate extreme values). Whichever value you select, be prepared to defend your reasoning.

Options for rates for our example include:

Option	Rate selected
5-year average	$163.12
2-year average	$169.82
5-year (minus high/low)	$173.56

For our example, we will simply take a five-year average.

3. Forecasting Losses

To calculate our forecast for X6, we apply the following forecast formula:

(Fully Developed Loss Rate) x (# Projected Exposures Next Period) = **Projected Developed Ultimate Losses or Loss Pick**

(163.12) x ($5,250) = $856,380 (Loss Pick for X6)

If we anticipate $5,250,000 revenue for the next year, the X6 total $ loss estimate would be calculated to be ($163.12) x ($5,250) = $856,380.

If there is no trend in the $/revenue ratio, confidence intervals could be built by using the mean and standard deviation. To build confidence intervals, we will need to calculate and use the standard deviation of the $/revenue ratio to get our interval. There does not appear to be a trend in the $/revenue ratio in this case, so we assume the regression R-square is very low.

Knowledge Check

1. The table below shows the ultimate total losses for Company X. Using an inflation index of 10%, calculate the indexed ultimate losses for years X1–X5..

	a	b	(a x b)
Year	**Ultimate Total Losses**	**Inflation Index (10%)***	**Indexed Ultimate Losses $**
X1	115,780		
X2	378,220		
X3	499,430		
X4	450,300		
X5	700,120		

2. Use the indexed ultimate losses you calculated in step 1 to develop the loss rate and calculate the mean.

Year	Indexed Ultimate Losses (a)	Revenue (in $1000) (b)	Loss Rate (Losses / $1,000 revenue) (a)/(b)
X1		$2,500	
X2		$2,600	
X3		$3,000	
X4		$3,800	
X5		$4,300	
Mean			
X6 Budgeted		**$4,950**	

3. Calculate the loss forecast for X6.

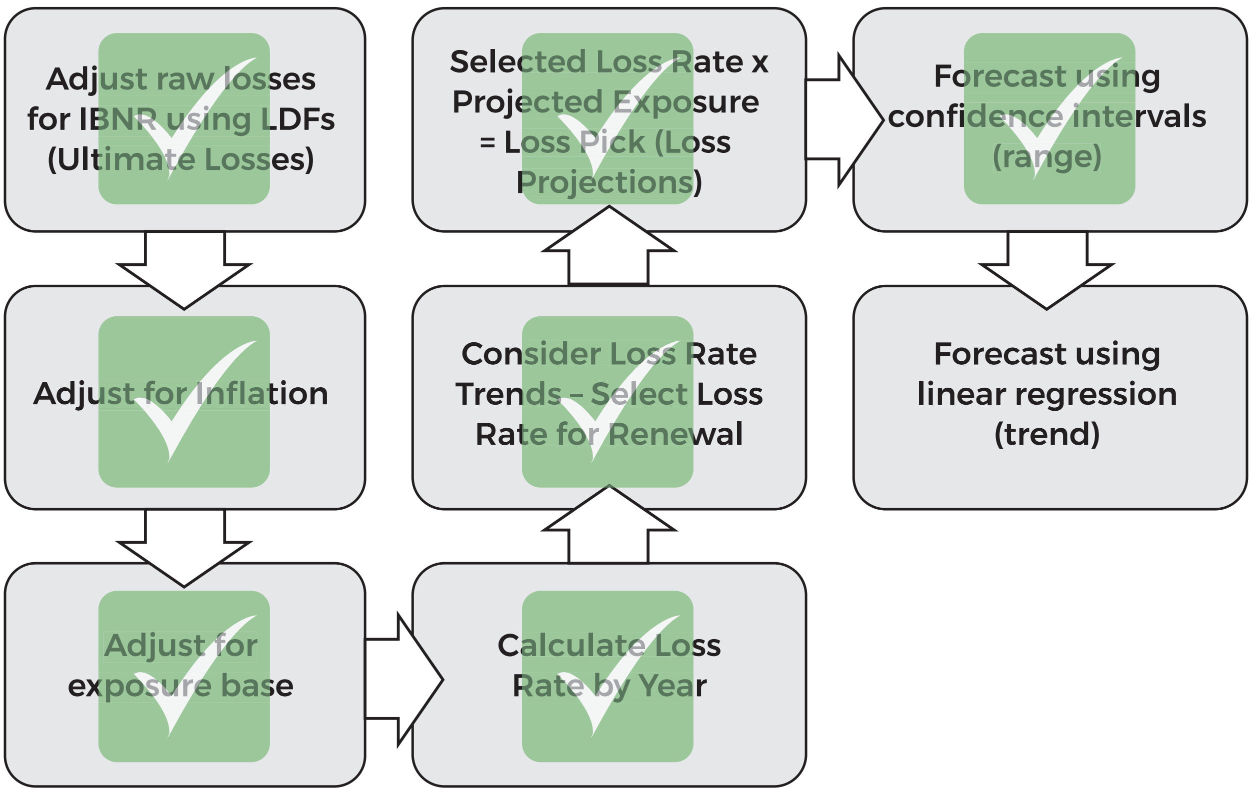
In the previous section, we reviewed a variety of tools that can be employed in quantitative analysis. When we have completed all data adjustments, our quantitative tools can be used to estimate a range of outcomes, including determining the accuracy of loss projections.

From our tools section, you will utilize the following definitions as we move forward:

Mean – in these examples, the average of a series of numbers (the sum of observations divided by the number of observations).

Standard Deviation – the square root of the average of the squares of the variance; a measure of the variability or dispersion of a data set. A low standard deviation indicates that the data points tend to be very close to the same value (the mean), while a high standard deviation indicates that the data is dispersed or spread out from the mean.

Regression R-square – provides a measure of how well future outcomes are likely to be predicted by the model.



Forecasting Losses Using Confidence Intervals

We can build **confidence intervals** for estimates of loss rates and ultimate losses. Rather than estimating a projection by a single value, a confidence interval **is presented that is likely to include the projected loss figure signifying the** reliability of the estimate.

When a forecast is made using a measure of dispersion rather than a measure of central tendency, there is more margin for error. In other words, rather than a point estimate, the risk manager can project with a specified degree of confidence that the expected losses will fall within two extremes. When the lower confidence interval is considered, the forecast is considered to be optimistic, or the "best-case" scenario; when the upper confidence interval is considered, the forecast is considered to be very conservative, or the "pessimistic-case" scenario.

As reviewed earlier, in a normal distribution, the 95th percentile confidence range is estimated by calculating two standard deviations below and above the mean. While our loss distribution might not be a normal distribution, we can use the 95th percentile to estimate "optimistic-case" and "pessimistic-case" scenarios.

Another technique to show a high and low range is to calculate the loss projection at the lowest and highest historical observed loss rates.

In this example, we will demonstrate how to calculate a 95% confidence interval for ultimate total dollar losses, as well as how to calculate a projection using historical observed loss rates.

Example:

Calculating Loss Rate from Indexed Ultimate Losses

Year	Indexed Ultimate Losses (a)	Revenue (in $1000) (b)	Loss Rate (Losses / $1,000 revenue) (a)/(b)
X1	$221,987	$3,300	$ 67.27
X2	$819,568	$3,600	$227.66
X3	$706,034	$3,900	$181.03
X4	$574,007	$4,400	$130.46
X5	$1,004,079	$4,800	$209.18
Mean			$163.12
X6 Budgeted		$5,250	

X6 expected losses = $5,250 x 163.12 = $856,380

The mean loss rate is $163.12.
The standard deviation is $57.39 (given).
Two standard deviations (95% confidence level) is ±$114.78 from the mean.

Calculate the Loss Rate.

Low: 163.12 – 114.78 = $48.34
High: 163.12 + 114.78 = $277.90

Calculate the range of Expected Losses.

Low: $5,250 x 48.34 = $ 253,785

High: $5,250 x 277.90 = $1,458,975

Using 95th Percentile:

Lowest or "optimistic-case" scenario	= $ 253,785	
Midpoint scenario	*= $ 856,380*	*Average the lowest and highest expected losses.*
Highest or "pessimistic-case" scenario	= $1,458,975	

Using Lowest and Highest Observed Loss Rate (from the table above):

Lowest loss rate: $67.27 x $5,250 = $353,168

Highest loss rate: $227.66 x $5,250 = $1,195,215

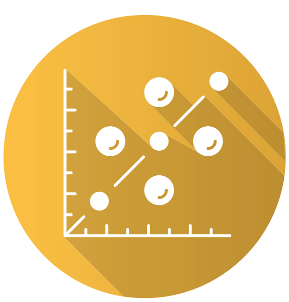
The larger the standard deviation calculated, the more variable and volatile the input data (historical losses) and the less confidence we have with our final forecast. Our example is one with large loss rate swings, indicating instability of predictable historical data and potentially variability within the company's ability to consistently manage their losses. These large swings in annual losses are indicative of potential changes within the operations, potential changes in loss control investments, or changes within the risk management's philosophy in addressing their total cost of risk. The more variable and volatile the historical data (as indicated by the standard deviation), the more conservative one should be with the final selected loss projection.

There are two ongoing challenges when using confidence intervals.

1. The Law of Small Numbers — most exposures have an insufficient number of observations for statistical validity. At a minimum, we need five years of data with 30 observations in each year. Ideally, we would prefer ten years data and hundreds or thousands of observation points per year.

2. The standard deviation and confidence interval assume the data is a normal distribution. Most loss distributions are right-skewed, not normally distributed.

Forecasting Losses Using Linear Regression



If there is an obvious trend in the data, a **linear regression** should be performed and the ***r^2*** **Coefficient of Determination** should be considered. For example, if losses increase 10% a per year in a steady manner, this would show an obvious trend and linear regression would be the appropriate forecasting method. As mentioned in the previous section, if r^2 is high enough (0.70 or greater), the linear regression approach is more likely to yield a better result than the confidence interval approach.

Knowledge Check

Directions: Using the data provided, calculate a 95% confidence interval for the ultimate total dollar losses, including the mean.

Mean Loss Rate: 150
Standard Deviation $45
Budgeted Revenue (per $1000): $4,500

Resources for Obtaining Loss Development Factors

Learning Objective:

4. *Summarize the different resources available to obtain loss development factors.*

As mentioned previously in this section, loss development factors (LDFs) can be calculated from loss history using the **triangulation** process. These factors allow adjustments of reported data to include incurred but not reported (IBNR) losses for a given year in the history.

We begin with loss history data to determine the normal lags that occur before full reporting of all losses. Our goal is to illustrate how triangulation provides the severity development and payout development numbers needed.

For now, we want to see the origin of the **development factors**. Development factors were provided up to this point. Development tends to be more important for casualty losses because it generally takes longer for full reporting of all casualty losses. For example, asbestos losses may take many years to be fully reported for any one year of exposure. Our key objective is to show how development factors can be generated from the loss history data.

Using Internal Data—Loss Triangulation

Risk managers use the loss triangulation methodology to organize data to identify and analyze patterns in the past loss or claim data. Generally, it is preferable to have over five to seven years of loss or claim history for the triangles to be meaningful, ideally ten years or more if available. These loss triangles capture the changes in the ultimate value resulting from natural loss development, or loss and claim growth over time after the initial reserves are established.

If a RMIS system is available, these triangles can be applied to paid losses, incurred losses, or any defined claim type to determine those specific development factors. Loss triangulation is used to calculate IBNR by determining loss development factors. LDFs numerically represent the company's IBNR reserves. LDFs are unique to each risk and will differ depending on the age of the losses evaluated and the deductible considered.

Incurred Loss development factors are applied to a current valuation of incurred losses to determine an estimate of ultimate losses. They are calculated using period-to-period changes in values on the assumption that current losses will be paid in the same pattern as prior losses with similar time of development. Again, the selected LDFs must match with the age of the losses, the risk type, and the deductible limit applied on the losses. Actuaries have tabular tables of thousands of development factors matching risk of all types and ages. It is critical that they apply the correct factor for a given risk.

Triangle Formats

Data Requirements:

- Loss severity and payout are reported and recorded in loss runs or a RMIS raw data provided from format.
- The raw data is collected for each year and valued at the end of each 12-month interval.
- A five-year triangulation requires 15 sets of data: 5 for X1, 4 for X2, 3 for X3, 2 for X4, and 1 for X5 (6 years requires 21; 7 years requires 28).
- A summary of each period's set of raw data is transferred into the triangulation chart as shown below.

Example:

Incurred Claims $ (in thousands)					
	Months from Inception				
Year	**12**	**24**	**36**	**48**	**60**
X1	116	146	154	156	158
X2	77	106	110	116	
X3	100	136	148		
X4	144	195			
X5	138				

Calculating Loss Development Factors

We will first utilize the loss triangle to determine period-to-period values, meaning the change in development from one valuation period to the next. All average period-to-period factors are determined and then multiplied together to determine the ultimate loss development factor for each valuation period. Period-to-period development factors allow for the development of losses at incremental time intervals.

1. Calculate the amount of change between intervals (Year X1).
   a. Divide the 24-month value by the 12-month value: 146/116 = 1.26
   b. Divide the 36-month value by the 24-month value: 154/146 = 1.05
   c. Divide the 48-month value by the 36-month value: 156/154 = 1.01
   d. Divide the 60-month value by the 48-month value: 156/156 = 1.0
2. Repeat for each year (X2–X5).
3. Total each column and calculate the average for each column (see table below).

Age-to-Age Development (months)				
Year	**12–24**	**24–36**	**36–48**	**48–60**
X1	1.26	1.05	1.01	1.01
X2	1.38	1.04	1.05	
X3	1.36	1.09		
X4	1.35			
X5				
Totals	5.35	3.18	2.06	1.01
Averages	1.34	1.06	1.03	1.01

Combining the period-to-period development

To calculate the ultimate loss development factors, we start at the last year of known data, in this case at 60 months. We consult with an actuary to obtain a **tail factor** to supplement our data since our data is limited to only 5 years. Tail factors represent all additional loss development *beyond* the last data available. Here, our consultant advised us that our tail factor is 1.15, or that we could likely expect an additional 5% loss development beyond 60 months. We then cross multiply backwards to determine the ultimate loss development factors for 12, 24, 36, and 48 months.

	Age-to-Age Development Factors				
Year	**12–24**	**24–36**	**36–48**	**48–60**	**60+**
Total	5.35	3.18	2.06	1.01	
Average	1.34	1.06	1.03	1.01	**1.15**
Development to Ultimate Factor	1.69	1.26	1.19	1.16	**1.15**

Steps:

1. Start with tail factor in the last year of known data (60 months).
2. Multiply by 46—60-month average (1.15 x 1.01= 1.16).
3. Multiply by 36—48-month average (1.16 x 1.03= 1.19).
4. Continue to cross multiply backwards for remaining periods.

Summary Table of Results

Think back to the previous examples we have used throughout this section in which we calculated and indexed our ultimate losses. This table shows a summary of all the steps, resulting in the trended ultimate loss rate.

Year	# Claims (Freq.) (a)	Total Incurred Losses (b)	LDFs (c)	Ultimate Losses (bXc)	Inflation Index Factors (Compound Sum $ Table) (e)	Trended Ultimate Losses (dXe)	Exposure (Revenue) $000s (g)	Trended Ultimate Total Loss Rate (h)
X1	156	$125,986	1.15	$144,884	1.762	$255,286	$3,300	$77.36
X2	115	$469,091	1.16	$544,146	1.574	$856,486	$3,600	$237.91
X3	148	$386,550	1.19	$459,995	1.405	$646,293	$3,900	$165.72
X4	192	$291,555	1.26	$367,359	1.254	$460,668	$4,400	$104.70
X5	138	$357,171	1.69	$603,619	1.120	$676,053	$4,800	$140.84

Calculating Payout Ratios

Payout triangles are also provided from the RMIS system. These are important as they show us specifically how much was actually paid by year for the organization. We can utilize this information to determine how much (what percent) each year of the total losses can be expected to be paid in any given year. This is an important calculation for accounting, since they can utilize this information for budgeting. We will also use these payout factors in determining the present value of our loss projections in future chapters.

Example:

Paid Claims $ (in thousands)					
Year	**Months from Inception**				
	12	**24**	**36**	**48**	**60**
X1	41	88	123	140	150
X2	27	64	88	104	
X3	35	82	118		
X4	50	117			
X5	48				

As in the previous example, the amount of change between intervals is calculated for each year. These are then totaled and averaged, as shown in the table below.

Age-to-Age Development Factors				
Year	**Months from Inception**			
	12–24	**24–36**	**36–48**	**48–60**
X1	2.15	1.40	1.14	1.07
X2	2.37	1.38	1.18	
X3	2.24	1.44		
X4	2.34			
X5				
Total	9.20	4.22	2.32	1.07
Averages	**2.30**	**1.41**	**1.16**	**1.07**

As in the previous example, the ultimate development factors are calculated by cross-multiplying backwards, starting with the most recent period.

Age-to-Age Development Factors					
Year	**12–24**	**24–36**	**36–48**	**48–60**	**60+**
Totals	9.20	4.22	2.32	1.07	
Average	2.30	1.41	1.16	1.07	**1.00**
Paid Development to Ultimate Factor	4.03	1.75	1.24	1.07	**1.00**

The second-to-last column in the table is the percentage of ultimate payouts made at the end of a given year. Percentages to ultimate payout ratios are calculated as:

1 / development factor for payouts

For example, at the end of the first year, 1 / 4.03 = 25% of the ultimate dollar payouts were made.

The last column shows the incremental payout pattern, which is calculated by subtracting the ultimate payout from the previous year. For example, in Year 2, 57% – 25% = 32% of the ultimate payouts were made. The 52% represents the percentage of total payouts made in the first two years, so that means 24% of the total payouts were made in the first year, and 24% of the total payouts were made in the second year.

Summary of Payout Pattern Calculations			
Year	**Paid LDF**	**Cumulative Payout**	**Incremental Payout Pattern**
12 mos.	4.03	25%	25%
24 mos.	1.75	57%	32%
36 mos.	1.24	81%	24%
48 mos.	1.07	93%	12%
60 mos.	1.00	100%	7%
Total			100%

Using External Data

If a RMIS system is not available, the development factor can be obtained from other sources, such as rating bureaus (e.g., ISO and NCCI), actuarial consultants, insurance companies, agents or brokers, and other related sources (e.g., financial reporting services, such as AM Best).

Knowledge Check

You want to calculate loss development factors for your organization. You have assembled the following loss data and entered it into the basic triangulation format. (The intent of this exercise is to make you more comfortable with the process, so do not worry about the small amount of data.

X/Months	12	24	36	48
X1	50	75	100	130
X2	40	60	80	
X3	60	80		
X4	30			

1. What steps will you take to calculate age-to-age development factors?

Calculate the development factors.

	Age-to-Age Development Factors		
Year	12–24	24–36	36–48
X1			
X2			
X3			
X4			
Total			
Average			

2. What steps will you take to calculate age-to-ultimate development factors?

____

____

____

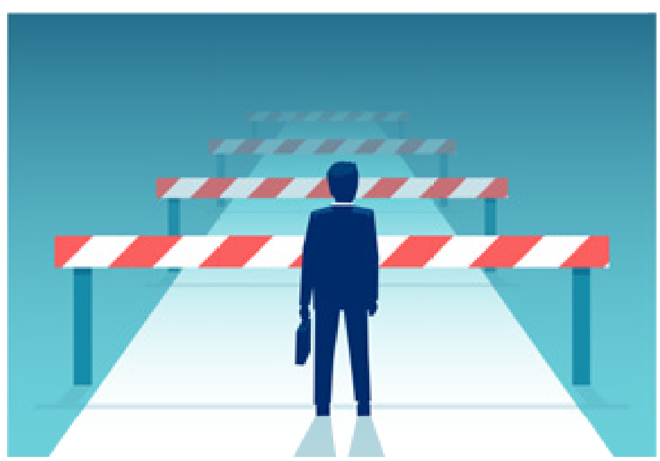
____

Calculate the development factors.

	Age-to-Ultimate Development Factors			
Year	**12–24**	**24–36**	**36–48**	**48–60**
Total				
Average				
Development to Ultimate Factor				

Challenges in Calculating and Forecasting Ultimate Losses

Although this example is simplistic, it shows that there are many challenges with determining outstanding reserve estimates.



First, all components of ultimate loss (case reserves, paid losses, and IBNR) change over time with each new valuation period. As each valuation is re-evaluated, the ultimate loss estimate changes. Consequently, reserve estimates change as well. In other words: IBNR development can and will change, sometimes significantly, as all new information is obtained.

Second, the triangulation concept is predicated on "history repeating itself." It is not valid when significant changes have occurred with the insurance company case reserving philosophy. Additionally, if any mergers, acquisitions, spin-offs, and so forth have occurred during prior periods, data and results can be compromised.

Lastly, the triangulation process is both an art and science. There are many qualitative assessments to the data crunching that produce varying reserve estimates. As such, each reserve estimate varies depending on the assigned actuary producing the analysis and the reader interpreting the analysis.

Check-In

Which of the following are NOT challenges in forecasting ultimate losses? (Choose all that apply.)

- ☐ Ultimate loss and reserve estimates change with each new valuation period.
- ☐ IBNR development is static and new information is rarely available.
- ☐ Organizational changes such as mergers, acquisitions, or evolving case reserve philosophy can significantly impact the triangulation process.
- ☐ Reserve estimates are subject to qualitative assessment methods and can vary depending on who is actually calculating and forecasting losses.
- ☐ The triangulation process is an exact science and can be difficult for new risk managers to understand.

Summary

This section explored how quantitative tools can be used in calculating ultimate losses and in loss forecasting. One of the purposes of loss forecasting is to determine the amount that an organization needs to have on-hand. There are two main types of reserves: case reserves and incurred-but-not-reported (IBNR) reserves. Case reserves typically are established by claims adjusters when individual claims are filed. The bulk reserve, or gross IBNR, consists of four main elements: adverse development, reopened claims reserve, IBNR, and reported-but-not-recorded (RBNR) reserves. There is an additional category of reserves for unallocated and allocated loss adjustment expenses. By making sure the assets are large enough to cover all the liabilities, the company can ensure all reserves are sufficiently covered.

In order to determine its ultimate losses, an organization must adjust its raw loss data using loss development factors. Loss development factors can be calculated using a triangulation process. Incurred losses can be multiplied by the calculated loss development factor in order to determine ultimate losses.

When forecasting losses, data must be adjusted for factors such as inflation. When data has been adjusted for inflation, risk managers can calculate loss rates and use these to project future losses. Two quantitative tools covered in Section 3, confidence intervals and linear regression, can be used in loss forecasting. Linear regression is most effective when there is an apparent trend in the data. When there is no apparent trend, confidence intervals will provide a more accurate estimate of forecasted losses.

Forecasting losses is not an exact science, and risk managers must consider a number of challenges when analyzing loss data. As new data is obtained, IBNR development will change as well, sometimes quite significantly. Additionally, company changes can significantly impact, and in some cases invalidate, the triangulation process. Finally, reserve estimates also require the use of qualitative assessments, and as a result, can vary depending on who is developing and interpreting the analysis.

In the next section, we will explore how time value of money concepts can impact risk analysis.

Review of Learning Objectives

- *Explain the different types of claim reserves and summarize the importance reserves have to a risk manager.*
- *Calculate ultimate losses for an organization.*
- *Explain the necessary data requiring adjustment prior-to-loss forecasting and calculate a loss projection.*
- *Summarize the different resources available to obtain loss development factors.*

Resources

Important concepts related to the Learning Objectives in this chapter are summarized in separate videos. Online participants can use the links to access the videos. Classroom learners can access the videos at RiskEducation.org/RAresources.

	Quantitative Analysis Forecasting
	Document: Present Value of a Dollar Tables

Section 4 Self-Quiz

Directions: Answer the following questions. Some questions may have more than one correct answer choice.

1. Which of the following statements is true about reserves? (Choose all that apply.)
   - ☐ Case reserves are loss reserves that are held for claims that have been incurred, but not reported.
   - ☐ The bulk reserve is composed of four elements: adverse development, reopened claims reserves, incurred but not reported, and reported but not recorded.
   - ☐ Companies who under-reserve their losses will eventually experience adverse development.
   - ☐ ALAE reserves are those expenses not specifically allocated or charged to a particular item.
   - ☐ Case reserves are generally set by a claims adjuster on individual claims.

2. In year X1, Company A incurred $200,000 in total losses. Given a development factor of 1.50, calculate the ultimate total losses for year X1.
   - ☐ $100,000
   - ☐ $133,333
   - ☐ $250,000
   - ☐ $300,000

3. Renisha is a risk manager for Company A. She wants to use the past five years of ultimate loss data to forecast losses for the current year (X6). What step(s) will Renisha need to take in order to accurately forecast this year's losses?
   - ☐ Collect loss data from other organizations in her industry.
   - ☐ Adjust other companies' ultimate losses for inflation.
   - ☐ Adjust Company A's total incurred losses for each year to ultimate total losses using loss development factors.
   - ☐ Index Company A's previous ultimate losses for inflation.
   - ☐ Adjust for Company A's changing exposures over time.

4. Which of the following shows the correct formula for forecasting losses?
   - ☐ (Fully developed loss rate) x (# projected exposures next period)
   - ☐ (Fully developed loss rate) x (indexed ultimate losses)
   - ☐ (Indexed ultimate losses) ÷ (revenue)
   - ☐ (Indexed Ultimate Losses) ÷ (# projected exposures next period)

5. Which of the following statements is true regarding loss forecasting using confidence intervals and linear regression? (Choose all that apply.)
   - [ ] The lower confidence interval represents the "best-case scenario," while the upper confidence interval represents the "pessimistic-case scenario."
   - [ ] In a normal distribution, the 95th percentile confidence range is estimated by calculating three standard deviations below and above the mean.
   - [ ] When r^2 is .70 or greater, linear regression is likely to yield a better result than the confidence interval approach.
   - [ ] Confidence intervals are more accurate when there is an obvious trend in the data.
   - [ ] Confidence intervals assume that loss data is right-skewed.

6. Which of the following statements are FALSE regarding resources for obtaining loss development factors (LDFs)?
   - [ ] LDFs can be generated from loss history data using a triangulation process.
   - [ ] When calculating period-to-period development, tail factors represent all additional loss data beyond the last data available.
   - [ ] Period-to-period development is calculated by starting with the oldest period and then cross-multiplying forward to the most recent year of known data.
   - [ ] A RMIS system is required for calculating development factors.
   - [ ] Payout triangles are used to show how much an organization paid by year.

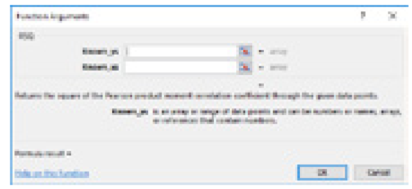
Appendix

Linear regression is easily performed in Excel using two functions. RSQ is used to determine the r^2. If there is sufficiently high r^2 to use regression, the function FORECAST.LINEAR will complete the forecast.

RSQ function:

The dependent variables are the losses, or Y. Enter the array of losses in the known Ys cell.

The independent variables are the exposures, or X. Enter the array of exposures in the known Xs cell. The result is the Coefficient of Determination, or r^2.

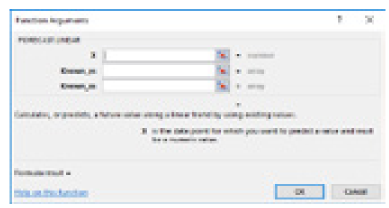


FORECAST.LINEAR function:

The budgeted or projected exposure is entered in the X cell.

The dependent variables are the losses, or Y. Enter the array of losses in the known Ys cell.

The independent variables are the exposures, or x. Enter the array of losses in the known Xs cell. The result is the forecasted value. The higher the r^2, the more reliable the prediction.



Section 5: Time Value of Money Concepts

Section Goal

The goal of this section is to understand the time value of money concept, calculate values, and make decisions according to results.

Learning Objectives

1. *Utilizing proper terminology, explain the purpose of adjusting for the time value of money.*
2. *Compare inflows and outflows by calculating present and future values.*
3. *Using time value of money calculations, make determinations on capital investment projects.*

Introduction to Time Value of Money Concepts

The average movie ticket price in 2018 was $9.14, whereas the same ticket cost only $4.69 in 1998. It would be unfair to compare the top movie in 1998, Titanic, to the top movie of 2018, Black Panther, in terms of box office revenue without first adjusting for inflation. To complete a reasonable and fair comparison, all amounts should be compared in today's dollar equivalency.

Financial decision-making involves cash inflows (benefits) and outflows (costs), with the expectation that the benefits exceed the costs. Those decisions require the analysis of the cash flows occurring at specific points in time in the future. A dollar amount at one point in time has a different value than a dollar amount at another point in time. For example, a dollar received today is worth more than a dollar received next year, simply because it can earn interest.

However, the inflows often occur later than the outflows, making the comparison of benefits and costs challenging unless the time value of money is considered. In the same way we must adjust box office sales figures to determine the top-grossing movie of all time, we must adjust claims payments and future benefits so that they are being compared after adjusting for the time value of money.

Basic Cash Management Rules

- Delay paying what you owe as long as possible without creating legal, operational, or reputation problems.
- Accelerate collecting what is owed to you as quickly as possible without creating legal, operational, or reputational problems.
- Some risk financing and insurance methods allow for the payment of costs at a later time. The longer the delay, the less it costs in current dollars.

Section Terminology

Time Value Of Money (TVOM) – the value of money over a given amount of time considering a given amount of interest

Present Value (PV) – today's value of tomorrow's cash flow

The most common TVOM calculation is to find the present value of future cash flows and then make comparisons of different alternatives based on present values. There are times when the risk manager will want to consider future values, too. In all cases, the timing and sequence of cash flows is important. For example, cash flow may be a lump sum occurring in only one future period. In other cases, cash flows are annuities, a constant amount every period for a number of periods; for example, $1000 a month for 10 years. The time value analysis is easily extended to a series of lump sums of different amounts occurring in different periods. All time value calculations have the four key variables: the number of periods (*n*), the interest rate (*i*), the future value, and the present value. If three of the variables are known, the fourth can be calculated.

Future Value (FV) or Compound Value – tomorrow's value of today's cash flow

The present value of a principal amount or single sum today can be invested at an interest rate (*i* %) for a number of periods (*n*) to earn a future value amount (FV). Compounding of interest earnings on the PV will create the FV.

The PV is invested at the beginning of the period, and interest is earned and added to the principal. During the second period, interest is earned on the total of the principal and the first year's interest earnings. In the third period, interest is earned on the total of the principal and two year's interest earnings, and so on for each additional period. This accumulation of interest on interest is called compounding.

Annuity – a stream of equal payments made over a specified period of time

Discount Rate – the organization's cost of capital (also known as the interest rate, hurdle rate, weighted average cost of capital (WACC), or the required rate of return)

The minimum acceptable return on investment is also called the **cost of capital,** and it represents to the organization a percentage rate cost of raising money to fund assets and operations. To add value to the organization, the risk management program must generate cash flows through savings or enhanced revenues that represent a rate of return that is greater than the cost of capital. For example, if the organization has a 15% cost of capital, the risk management initiatives must earn greater than a 15% rate of return to be viable.

This is also known as the hurdle rate, the weighted average cost of capital or WACC, or the required rate of return.

Present Value Factor (PV Factor) – a predetermined factor that can be used to simplify present value calculations

Present Value of an Annuity Factor (PVA Factor) – a predetermined factor that can be used to simplify present value of annuities calculations

Financial Decision-Making Concepts

Learning Objective:

1. *Utilizing proper terminology, explain the purpose of adjusting for the time value of money.*

The first important step toward learning financial decision-making concepts is to acquire an understanding of time value of money. The risk manager must be able to compare dollar amounts that occur in different time periods.

Example: Imagine that you won $10,000,00 in the lottery.

Questions:

Would you rather get $1 million per year for 10 years or $7,500,000 paid in full today?

Do you have enough information to answer this question? What other information do you need?

Quantitative Analysis:

Is there value to getting your money quicker?

How do you value the timing of cash flow?

Qualitative Analysis:

What else should you think about when making this decision?

We will come back to this question later.

Time Value of Money Concepts

Any time value of money application involves four key variables:

1. The number of periods, referred to as "*n*"
2. The interest rate, referred to as "*i* "
3. Present Value
4. Future Value
   (could be payments or single sum)

These four factors are applied directly to a fifth variable: the dollar amount of the investment or payment.

1. **The number of periods (*n*)** means the length of time the investment or payment schedule is maintained. Generally, the time interval is assumed to be once a year, but the interval may be more frequent, such as every quarter, every month, or even every day. Financial institutions often advertise that "interest is compounded daily" in describing savings accounts, meaning that the investment interval or number of periods is literally 365 times per year.

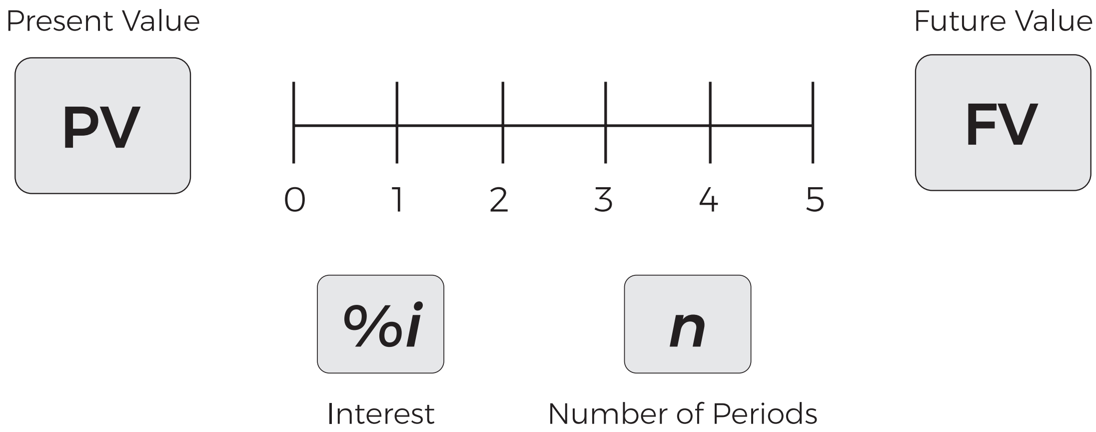
2. **The interest rate (*i*)** is the rate at which the investment will be valued. This is sometimes called the "discount rate," in keeping with the concept mentioned above that cash discounting incorporates the time value of money that discounts a future dollar to today's present value. The "discount rate" is also used to calculate future value. Interest rate may be a more precise term, but custom and practice often blurs that technical distinction. The interest rates used are assumed to be annual; therefore, when interest is to be calculated more frequently (i.e., the number of periods is increased), the interest rate must be adjusted to reflect more frequent compounding or discounting.

3. **Present Value –** Typically the value of the investment at day one or today's value of the future payments

4. **Future Value –** future payments or lump sum payments at some point in the future

These four variables can be used in TVOM calculations, such as determining present and future values.

Timeline



Knowledge Check

When your oldest child starts kindergarten, you realize that you need to start planning for the expense of college. Currently, the tuition at your alma mater is $30,000 per year. When you were a student 20 years ago, the tuition was $4,000 per year. You know you must plan to have much more than $30,000 per year. You are worried that in 13 years, the tuition will be $50,000 per year or more.

1. In terms of the tuition dollars, what is the present value of the college tuition per year?

____

2. What is your predicted future value of the college tuition?

____

3. If you plan on having a systematic plan to set aside an equal amount every year for college, what is the TVOM term for describing that savings plan?

____

4. Your investment advisor has offered you a plan that would guarantee 4% interest for 13 years. What is the TVOM term for that guaranteed rate of interest?

____

Calculating Present and Future Values

Learning Objective:

2. *Compare inflows and outflows by calculating present and future values.*

Present Value of a Single Sum

Determine the FV and PV

The future value is known (or given); the present value is what must be determined.

When we calculate a present value, we know the timing and the future value of a cash flow, the number of periods, and the interest rate per period.

When we calculate present values, we are "discounting" or reducing the future value to its present value. In effect, this is the reverse of computing the future value, where we start with a known present value and find what it increases to through investment.

In present value calculations, we start with the known future value and determine what it is worth today, or the value that we could invest today at the same interest rate over the same time to arrive at that known future value.

Future Values

The mathematical formula we use for future values is:

$$FV = PV\,(1 + i\%)^n$$

The present value is multiplied by (1 plus the interest rate) and then raised by the number of periods to calculate the future value.

Present Values

For calculating present value, we simply solve for a different unknown, the PV, because we know the FV. Using basic algebra, the FV formula becomes:

$$PV = FV\ x\ \left\{\frac{1}{(1 + i\ )^n}\right\}$$

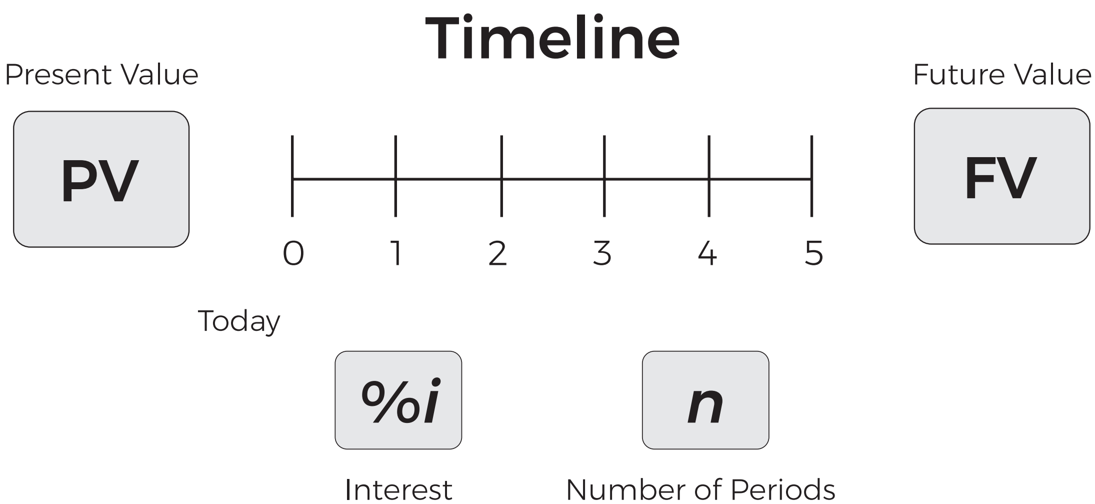
All that we have done is to divide the future value by (1 + *i*%) and raised by *n* to get the present value.

Present Value Steps

1. **Determine the number of periods (*n*) –** consider the timing of the payments (beginning of period or end of the period) when determining the number of periods.

2. **Determine the discount rate (*i*) –** usually provided by the CFO in the form of a percentage.

3. **Draw a timeline and fill in values for the four boxes.**



4. **Multiply the FV by the PV factor.**

PV of a Single Sum (PVSS)

Present value and future value are on the same time continuum; all that differs is your point of view, looking forward (compounding) or looking back (discounting).

If $FV = PV\,(1 + i\%)^n$ then

$$PV = FV \; x \left\{\frac{1}{(1+i\,)^n}\right\}$$

This factor can be found on the ***PV of $1*** table

The PV is the FV received in the nth period discounted at *i*% (per period).

Present Value of $1												
*n**	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322

Example:

You want to accumulate $20,000 at the end of 10 years.

Assuming you can earn 8%, how much must you put aside today?

Present Value

Future Value

$20,000

1. Determine the values to use in the calculation (FV, discount rate, and number of periods).

FV	$20,000
Discount rate (*i*)	8%
Number of periods (*n*)	10

2. Using the Present Value of $1 chart, find the PV factor for the given discount rate (*i*) and number of periods (*n*).

Present Value of $1												
n*	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712
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10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322

3. Multiply the future value by the discount rate.

   PV = FV x PV factor

   PV = 20,000 x 0.463

   PV = $9,260

You would need to set aside $9,260 today—at 8% interest—to have $20,000 ten years in the future.

Knowledge Check

The insurance carrier has promised to reduce the premium by $10,000 at the end of the third policy term. The CFO says the discount rate is 10%. How much is that future value worth today?

1. Determine the values to use in the calculation:

FV	
Discount rate (*i*)	
Number of periods (*n*)	

2. Using the PV of $1 table, below, find the PV factor for the given discount rate (*i*) and number of periods (*n*).)

   PV factor =_______________________

Present Value of $1												
n*	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
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3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712
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5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404
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10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322

3. Find the PV:

   PV = FV x PV factor

   PV = _________ x __________

   PV = _________

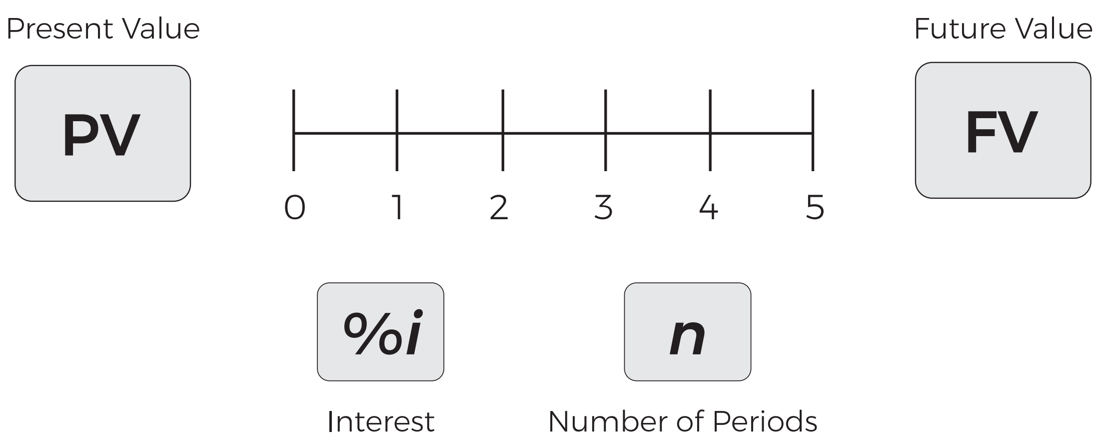
Present Value of an Annuity of Equal Payments

Cash flows in an ordinary annuity are of the same amount and occur at the end of each period for a number of periods. For example, payments received in a structured settlement are typically annuities, perhaps $5,000 a year for 20 years.

Steps:

1. **Determine the FV and PV –** the future value of a stream of equal payments is known (or given); the present value of that stream of equal payments is what must be determined.
2. **Determine the number of periods (*n*).**
3. **Determine the discount rate (*i* is usually provided by the CFO).**
4. **Draw a timeline and fill in values for the four boxes.**

Timeline



5. **Use the Present Value of an Annuity table to find the appropriate PVA factor for *i* and *n*.**

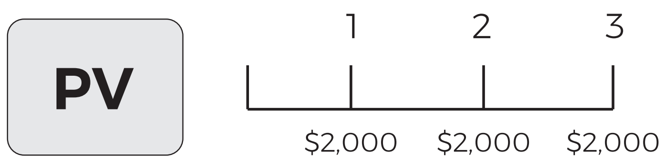
Present Value of an Annuity of $1												
n*	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605

6. **Multiply the future value by the PVA factor.**

PV = PYMT x (PVA factor of *i* and *n*)

Example: You can receive $2,000 at the end of each of the next three years. Your required rate of return is 8%. How much would the future income stream be worth today?

Present Value



1. Determine the values to use in the calculation:

PYMT	$2,000
Discount rate (*i*)	8%
Number of periods (*n*)	3

2. Using the PV of an Annuity of $1 chart, find the PVA factor for the given discount rate (*i*) and number of periods (*n*)

PV of an Annuity factor = 2.577

Present Value of an Annuity of $1												
n*	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
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5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605

3. Find the PV:

   PVA = PYMT x PVA factor

   PVA = $2,000 x 2.577

   PVA = $5154

Knowledge Check

The insurance carrier has indicated the premium will be reduced by $5,000 at the end of each of the next five policy terms. The CFO says the discount rate is 9%. How much is that premium reduction worth today?

1. Determine the values to use in the calculation:

PYMT	
Discount rate (*i*)	
Number of periods (*n*)	

2. Using the Present Value of an Annuity of $1 table, below, find the PVA factor for the given discount rate (*i*) and number of periods (*n*).
   - PV of an annuity factor =___________.

Present Value of an Annuity of $1												
n *****	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
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4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605

3. Find the PVA:

   PVA = PYMT x PVA factor

   PVA = __________

   PVA = __________

Lottery Example

Imagine that you won $10,000,000 in the lottery.

Questions:

1. Would you rather get $1 Million per year for 10 years or $7,500,000 paid in full today?
2. Do you have enough information to answer this question? What other information do you need?

Quantitative Analysis:

1. Is there value to getting your money quicker?
   - Yes. And consider the time value of money. As we previously discussed, a dollar earned today is worth more than a dollar earned next year. Therefore, the more quickly the money is obtained, the more value it will have.
2. How do you value the timing of cash flow?
   - The Present Value of Annuity can be used to value the timing of the cash flow.

Present Value of an Annuity of $1												
n*	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
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5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605
6	5.795	5.601	5.417	5.242	5.076	4.917	4.767	4.623	4.486	4.355	4.231	4.111
7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.564
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.968
9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.328
10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.650

Qualitative Analysis:

1. What else should you think about when making this decision?
   - Consider the pros and cons of taking the $1,000,000 annuity.

In the chart below, qualitative and quantitative considerations of taking the annuity are presented. On the quantitative side we use the present value of an annuity table to evaluate the choice. Using this method, we can determine that the annuity is a good choice when the interest rate is below 5%. We also see that if market interest rates are above 5%, taking the lump sum of $7,500,000 is a better option. On the qualitative side we see the factors that can influence the decision regardless of the financial benefit of the annuity.

QUANTITATIVE

Value of Annuity at Various Interest Rates:

1% = $9.4M
2% = $8.9M
3% = $8.5M
4% = $8.1M
5% = $7.7M
6% = $7.3M

As discount rate goes up, NPV goes down (Inverse relationship).

Break even between 5 and 6%

If I can earn more than 5–6% on $, then I would rather take the full $7.5M today.

QUALITATIVE

Pros of taking $1M Annuity

- ✓ Guaranteed Income
- ✓ Self Control—can't spend it all
- ✓ "Friends"

Cons of taking $1M Annuity

- ✓ What happens if I die before 10 yrs?
- ✓ What if the entity runs out of $?
- ✓ Could I have made more than 5–6% on the lump sum?

Present Value of a Series of Unequal Payments

We often make present value calculations for a series of future values, rather than just one. When the single sum amounts are not equal, we cannot treat the problem as an annuity, but as a mixed stream. For these cases, we treat each cash flow as a single sum and find the present value. After we do this for all cash flows, we add up all the present values. In all of our calculations, we continue to use rate per period and number of periods to find the present value of $1 using the Present Value of the $1 Table.

Example: Assume we have a safety program that we expect to generate after-tax savings of $13,000 in the first two years, followed by savings of $15,000 for the next two years. What is the present value of the cost savings of this program if we use a discount rate of 8%? We treat each cost saving as a future value problem as follows:

$13,000 $13,000 $15,000 $15,000

________/________/________/________/

($13,000) x (.926) = $12,038 = PV _______ $13,000 (FV) *n* = 1

($13,000) x (.857) = $11,141 = PV ________ $13,000 (FV) *n* = 2

($15,000) x (.794) = $11,910 = PV________ $15,000 (FV) *n* = 3

($15,000) x (.735) = $11,025 = PV _______ $15,000 (FV) *n*= 4

PV = $46,114.00

Steps:

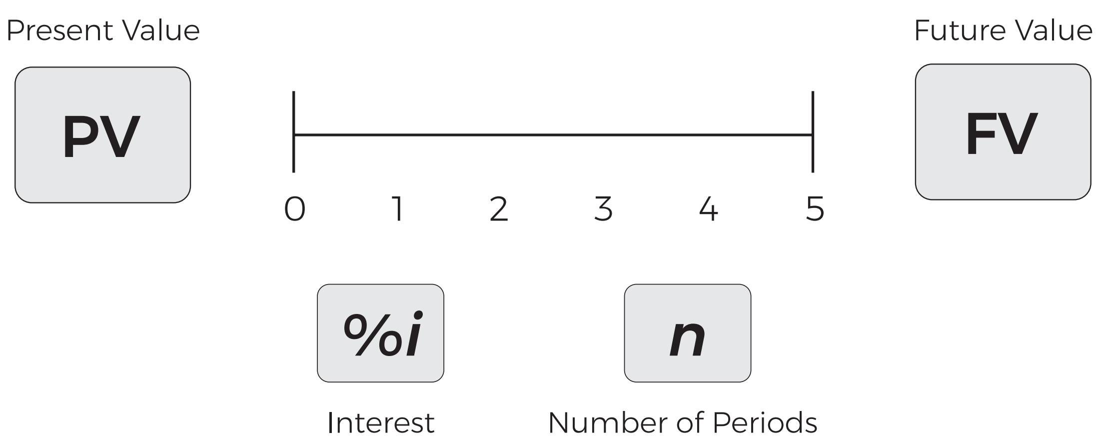
1. **Determine the FV and PV –** the future value of a stream of unequal payments is known (or given); the present value of that stream of unequal payments is what must be determined.

2. **Determine the number of periods (*n*).**

3. **Determine the discount rate (*i* is usually provided by the CFO).**

4. **Draw a timeline and fill in values for the four boxes.**

Timeline



5. **Use the PV of a Single Sum to find the FIVE appropriate PVSS factors for *i* and each *n*.**

6. **Multiply the future value by the PVSS factor for each *n*.**

Example: You can receive $1,000 at the end of the first year, $1,500 at the end of the second year, and $1,000 at the end of the third year. Assuming you can earn 8%, how much is that future flow of funds worth today?

	PV = $1,000 x .926 = $	926
+	PV = $1,500 x .857 = $	1,286
+	PV = $1,000 x .794 = $	794
	PV =	**$ 3,006**

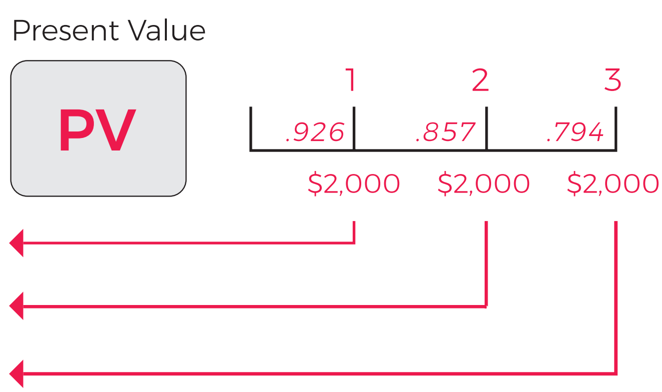
Present Value of an Annuity of Equal Payments:

Annuity Shortcut vs. Doing it the Long Way

($2,000 x 2.577 = $5,154)

Example: You can receive $2,000 at the end of the first year, the second year and at the end of the third year. Assuming you can earn 8%, how much is that future flow of funds worth today?

Calculate each year separately using the correct factor and add them together.



PV = $2,000 x .926 = $1,852 *n*=1

PV = $2,000 x .857 = $1,714 *n*=2

PV = $2,000 x .794 = $1,588 *n*=3

Total $5,154

SAME ANSWER!

Knowledge Check

The insurance carrier has indicated the premium will be reduced by $2,000 at the end of the first year, $3,000 at the end of the second year, and $4,000 at the end of the third year. The CFO says the discount rate is 9%.

1. How much is that premium reduction worth today?

n = 1	2,000	x	0.917	=	$1,834
n = 2	3,000	x	0.842	=	$2,526
n = 3	4,000	x	0.772	=	$3,088

2. How would you calculate if all payments were equal?

Present Value of an Annuity of $1												
n*	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
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3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605

Compound Sum of $1 (Future Value)

In this course, the *primary* use for Compound Sum of $1 in risk management is to easily calculate inflation rates when indexing losses to bring historical values to current values.

The Compound Sum of $1 factors at the appropriate *i* are used as the inflation factor.

Example: Because the risk manager needs to bring historical values to current values, there must be an adjustment for inflation. This can be done using ordinary multiplication or more quickly by using the factors for the appropriate *n* and *i*.

For instance, if we know the inflation is 4% a year, and there are five years of historical values to be indexed to current values, we could use ordinary multiplication as follows: 1.04 x 1.04 x 1.04 x 1.04 x 1.04 = **1.217**

The *primary* use for Compound Sum of $1 in risk management is to easily calculate inflation rates when indexing losses to bring historical values to current values.

Using the Compound Sum of $1 table, the factor for *n* = 5 and *i* = 4% is 1.217.

Compound Sum of $1					
n*	**1%**	**2%**	**3%**	**4%**	**5%**
1	1.010	1.020	1.030	1.040	1.050
2	1.020	1.040	1.061	1.082	1.103
3	1.030	1.061	1.093	1.125	1.158
4	1.041	1.082	1.126	1.170	1.216
5	1.051	1.104	1.159	1.217	1.276
6	1.062	1.126	1.194	1.265	1.340

The basic question being asked here is: What is the future value of a single sum of $1, invested today, or what will be the value of $1 at the end of a specified time period?

The present value of a principal amount or single sum today (PV) can be invested at an interest rate (*i* %) per period for a number of periods (*n*) to earn a future value amount (FV).

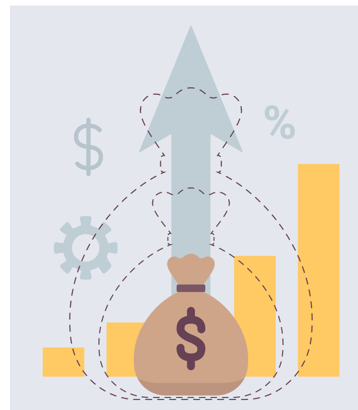
Compounding of interest earnings on the PV will create the FV. The PV is invested at the beginning of the period, and interest is earned and added to the principal. During the second period, interest is earned on the total of the principal and the first year's interest earnings. In the third period, interest is earned on the total of the principal and two year's interest earnings, and so on for each additional period. This accumulation of interest on interest is called compounding. The process is called the Future Value of a Single Sum of $1, or the Compound Sum of $1.

Evaluating Capital Investment Projects

Learning Objective:

3. *Using time value of money calculations, make determinations on capital investment projects.*

The Financial Decision Toolbox



The objective of any capital investment is to earn a net positive rate of return in excess of the cost of funds. The organization raises money at its cost of capital to finance investment outlays that add value to the organization. We will consider the most common capital investment analysis techniques used to analyze potential investment outlays. We will continue to take the cost of capital as given for now and use it for our discount rate (*i*%).

Some of our investment analysis techniques do not use the time value of money, even though we know it is not correct to compare dollar amounts in different time periods without adjusting for the time value of money.

Using time value of money concepts allows us to make sound financial decisions, but those decisions are based only on the capability of the investment to earn return greater than the cost of capital. Sometimes other factors must be considered.

Thus, we should think of our financial decision "toolbox" as having several tools, some of which are precise in their financial benefit measurement and some that address other concerns. In this section, our key focus will be on net present value and benefit cost ratios even though we present a full range of capital budgeting techniques used in practice.

Payback

Definition	Measurement of the length of time needed to recoup the cost of a capital investment—until the cash flows break even with costs
Decision Rule	Accept the project with the shortest payback.
Characteristics	1. Does not explicitly take into account TVOM 2. Conceptually simple and easy to understand

To calculate the payback, also known as the payback period, we add the cash flows for each period until we find the period where the sum of the cash flows equals the investment outlay for the project. Since the payback point seldom occurs at the beginning or end of a period, we take a simple interval average.

An example will help illustrate how the technique works.

Year	Cash Flow
X0	($7,000) Outlay
X1	2,000
X2	1,000
X3	3,000
X4	4,000
X5	3,000

The payback will be the number of years it takes to recover the $7,000.

Year	Cash Flow	Cash Flow Sum	Balance
X0	$ (7,000) Outlay	$	$
X1	2,000	2,000	($5,000)
X2	1,000	3,000	($4,000)
X3	3,000	6,000	($1,000)
X4	4,000	10,000	$3,000
X5	3,000	13,000	$6,000

Payback occurs between the third and fourth year. After the third year, we need an additional $1,000 from the fourth year to reach payback. Since we earn $4,000 in the fourth year, and we only need an added $1,000, we take ¼ of that total. So, payback occurs in 3 ¼ years.

Example: Let's compare two competing projects A & B

Data Set:

Net Expected Cash Flows

	Year	**Project A**	**Project B**
Investment Outflow	0	($100)	($200)
Cash Inflows	1	$10	$140
	2	$60	$100
	3	$80	$40

The payback will be the number of years it takes to recover the outflows.

Year	**Project A**	**Balance**	**Project B**	**Balance**
0	($100)	($100)	($200)	($200)
1	$10	($90)	$140	($60)
2	$60	($30)	$100	$40
3	$80	$50	$40	$80

Project A Payback = 2 years plus $30 / $80 = 2.4 years

Project B Payback = 1 year plus $60 / $100 = 1.6 years – Accept

Accounting Rate of Return

Definition	Measurement of the percentage return of average annual cash flows on initial investment; the ARR is the average annual cash flow divided by the initial investment.
Decision Rule	Accept the project with the highest ARR.
Characteristics	1. Does not explicitly take into account TVOM 2. Distortion because of unequal annual returns 3. Conceptually simple and easy to understand

To calculate the ARR, calculate the average annual return and divide by the initial investment. Using the net cash flows from the previous example, the average annual return is $13,000 / 5 or $2,600. Dividing $2,600 by $7,000, the initial investment results in an ARR of 37.14%. The characteristics of the ARR are essentially the same as Payback.

Year	Cash Flow
X0	($7,000) Outlay
X1	2,000
X2	1,000
X3	3,000
X4	4,000
X5	3,000

Using the net cash flows from the example, the average annual return is $13,000 / 5 or $2,600. Dividing $2,600 by $7,000, the initial investment results in an ARR of 37.14%.

2,000 + 1,000 + 3000 + 4,000 + 3,000 = 13,000

Calculate the average 13,000 / 5 = $2,600.

Divide the average by the investment.

2,600 / 7,000 = 37.14%ARR

If we are considering a competing project, which would you choose?

Outflow	Inflows
($6000)	$1400
	$1000
	$4000

The average annual return is 1400 + 1000 + 4000 = 6400 / 3 = 2133 (rounded) Divide this by the initial investment of 6000 to achieve the ARR.

2133 / 6000 = 35.55% ARR

While both projects have a favorable ARR, the project with the higher ARR is the one to accept.

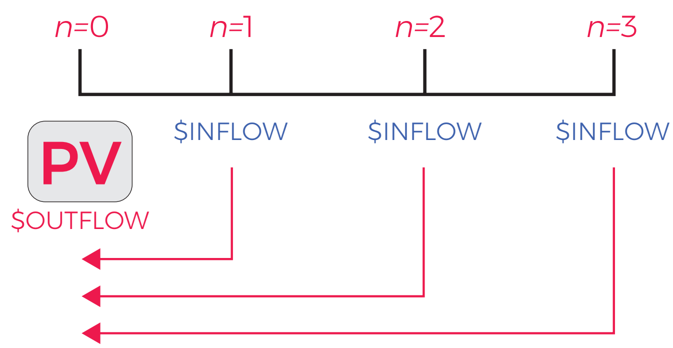
Knowledge Check

1. Calculate the ARR and payback for the following projects:

Net Expected Cash Flows			
	Year	**Project A**	**Project B**
Investment Outflow	0	($100)	($200)
Cash Inflows	1	$10	$140
	2	$60	$100
	3	$80	$40

2. Does the type of calculation (ARR vs. payback) impact which project you would select? Explain how the tools used can impact financial decisions.

Net Present Value

Definition	Measurement of the PV of future cash inflows compared to the net investment of a project, using organization's discount rate as *i*.
Decision Rule	Accept the project if the PV of the cash inflows minus outflows is greater or equal to zero. **NPV = PV inflows – PV outflows ≥ 0**
Characteristics	1. Considers TVOM 2. Assumptions of value of cash flows, discount rate, and time periods Present Value 

The net present value uses time value of money appropriately and holds projects to a standard based on the cost of capital discount rate. It is a preferred technique for making investment decisions in almost every case.

The net present value requires a discount rate for the present value calculation. In practice, the discount rate should be the organization's cost of capital. Since we will illustrate the cost of capital calculation later, for now we will assume the cost of capital is 10%. The data in our example represents a series of unequal single sums that we bring back to a single present value.

Example:

Net Expected Cash Flows		
Year	**Project A**	**Project B**
0	($100)	($200)
1	$10	$140
2	$60	$100
3	$80	$40

We can find the present value of each cash flow and add all the present values to get the total present value of benefits from the project. We get our present value factors from the Present Value of $1 table. The calculation using time value factors appears below.

Project A NPV: (discount rate is 10%)					
n	**Cash Inflows**	**X**	**PV Factor**	**=**	**PV**
1	10	X	.909	=	9.09
2	60	X	.826	=	49.56
3	80	X	.751	=	60.08
					118.73
	Less Initial Investment				(100.00)
	NPV				18.73

Project B NPV: (discount rate is 10%)					
n	**Cash Inflows**	**X**	**PV Factor**	**=**	**PV**
1	140	X	.909	=	127.26
2	100	X	.826	=	82.60
3	40	X	.751	=	30.04
					239.90
					(200.00)
					39.90

Decision rule: Accept if NPV is ≥ 0.

Both projects are acceptable because NPV ≥ 0.

Tip: For most organizations, capital is a scarce resource and there are always competing uses. Net Present Value allows us to select projects that have a return greater than the cost of capital, but when there are two or more capital investment projects and insufficient capital to fund both, the decision-makers must ration out the scarce capital to those investment opportunities that promise the greatest return. This requires a new tool, the Benefit/Cost ratio.

Benefit/Cost Ratio

Definition	Measurement of discounted values of inflows divided by the net investment. Used in comparing the NPV of various projects.
Decision Rule	Accept the project if BCR is greater than or equal to 1. When choosing between mutually exclusive projects, accept the project with the highest BCR.
Characteristics	1. Considers TVOM 2. Allows ranking of projects in order of effective use of capital 3. Facilitates capital rationing decisions 4. Allows for decision-making between competing projects with positive NPVs, but different investment requirements

The Benefit/Cost ratio uses the same information as the NPV, but it gives us a measure of dollar benefits per dollar spent. If a company is rationing capital, only those projects with the "biggest bang for the buck" receive funding. Any time we are evaluating mutually exclusive projects or face capital rationing, we should consider using Benefit/Cost ratio procedure.

Using the NPV data we developed for the projects above, we can calculate the Benefit Cost Ratios by dividing the NPV by the initial investment.

Example:

Project A NPV: (discount rate is 10%)						
n	**Cash Inflows**	**X**	**PV Factor**	**=**	**PV**
1	10	X	.909	=	9.09
2	60	X	.826	=	49.56
3	80	X	.751	=	60.08
					118.73
	Less Initial Investment				(100.00)
	NPV				18.73

Project B NPV: (discount rate is 10%)					
n	**Cash Inflows**	**X**	**PV Factor**	**=**	**PV**
1	140	X	.909	=	127.26
2	100	X	.826	=	82.60
3	40	X	.751	=	30.04
					239.90
					(200.00)
					39.90

Project A BCR = 118.73 / 100 = 1.1873   Project B BCR = $239.90 / $200 = 1.1995

Decision rule: if BCR > 1, accept the project.

Tip: By itself, a Benefit/Cost ratio will give the same result as NPV. However, when choosing between mutually exclusive projects, we should accept the project with the highest Benefit/Cost ratio.

If capital is limited or rationed, select Project B. If no capital rationing, both are acceptable, but B should be undertaken first.

Internal Rate of Return

Definition	Discount rate where PV of outflows equals the PV of inflows. NPV=$0
Decision Rule	Accept the project if the IRR is greater than or equal to the cost of capital.
Characteristics	1. Requires specialized financial software to compute 2. Assumptions of reinvestment *i* and timing 3. Multiple IRRs due to positive and negative cash flows

The internal rate of return (IRR) is the discount rate that makes the present value of benefits equal to the present value of costs (NPV = 0). The calculation for the IRR is complicated, since the only way to find the IRR is a trial-and-error approach. This is laborious by hand, but a financial spreadsheet function or financial calculator makes the process easy.

For our purposes, it is most important to understand the logic of the IRR. Calculating the IRR requires a financial calculator, but we need to know how to use the IRR. 0nce we have an IRR value, we accept a project if the IRR is greater than the organization's cost of capital. The logic is that the IRR represents the anticipated return on the project, and if the return on the project exceeds the cost of funding the project, the project adds value.

The IRR is popular and normally appears in any investment project evaluation. In most cases, a good project meets all the other investment criteria, including payback, NPV, and Benefit/Cost ratio standards. Nevertheless, there are times when we might prefer to use the Benefit/Cost ratio or the NPV instead of the IRR because of the characteristics inherent with the IRR.

Multiple Roots for the IRR – When the net cash flows have a change in signs (positive inflow, negative outflow), we get more than one possible solution for the IRR. We have as many IRR values as we have roots to the solution to the zero NPV calculation, and we have a root for every change in signs of the cash flows. This is disturbing because we get more than one answer for our IRR calculation.

Reinvestment Rate Assumption – For the NPV and Benefit/Cost calculations, we are assuming that cash flows are reinvested at the cost of capital when the cash flows come back to the organization. This is reasonable, since projects would already be taken if their rates of return exceed the cost of capital. The IRR calculations assume that the cash flows are reinvested at the IRR.

Additional Considerations

Projects with Different Lives: NPV to least common multiple

Since alternative competing projects often have different lives, it is consistent to evaluate them based on the least common lifespan multiple. For example, if a sprinkler system has an expected life of 20 years (the costs of the sprinklers and expected savings will last 20 years) versus a smoke alarm system that has an expected life of 10 years, the projects can be evaluated on the basis of 20 years, the least common multiplier.

Projects with Infinite Life:

Some projects have an "infinite life," or a life that for NPV purposes, extends far beyond the usefulness of the calculation. Since the NPV factors decrease with time, the factors for extended time periods have much less impact on the NPV than the earlier years. For example, the NPV of a fire-resistant building versus that of an ordinary construction building would be considered to have "infinite life" cash flows.

Validity of Assumptions: interest rates do not remain static

The cost of capital, known as the required rate of return or "hurdle rate," the rate that all projects are required to return as a minimum, can and do change with the organization over time. For example, an estimate of the hurdle rate can be initially estimated for a 20 year project, many years into that project the company may have higher/lower estimate for ongoing projects.

Inflation will also impact the projected hurdle rate utilized, but it is difficult and dangerous to forecast.

Examples of Gamesmanship: "Working the Numbers"

- Everyone knows the minimum acceptable rate of return on investment is 20% so all projects miraculously come in at least at 20%.
- Senior management knows middle management will be overly optimistic in forecasts, so senior management reduces their estimates by 20%.
- Middle management knows what senior management does, so they add an extra 25%.
- All projects miraculously come in at 25% or more.

Knowledge Check

You are the risk manager for a nonprofit organization that is tax exempt under IRC 503(c)(3). You are considering purchasing safety equipment at a cost of $100,000. Your insurance broker has obtained an estimate of premium savings from the underwriter for the next five years (assuming that exposures and premiums remain the same) of $27,000 a year. The CFO says the organization's cost of capital is 10%.

1. Assume all premiums are paid at the end of the year. Should you purchase the equipment?

Yes **No**

n = 5

i = 1 0%

PV of payments 1–5: ______________

Less cost ______________

NPV ______________

2. Now assume all premiums are paid at the beginning of the year. Should you purchase the equipment?

Yes **No**

n = 4

i = 10%

PV of first payment ______________

PV of payments 2–5: ______________

Total benefit (discounted) ______________

Less cost ______________

NPV ______________

Summary

The first important step in financial decision-making is to acquire an understanding of time value of money. Financial decisions require the analysis of dollar cash flows occurring at specific points in time in the future. A dollar amount at one point in time has a different value than a dollar amount at another point in time. For example, a dollar received today is worth more than a dollar received next year simply because it can earn interest.

In order to understand how time impacts the value of money, it is essential to understand how to calculate present and future values, both for single sums and for annuities.

By understanding cash flows and the impact of interest or discount rates, the risk manager can present well-reasoned proposals for risk management initiatives and investments. The risk manager has a variety of tools that can account for TVOM when evaluating capital investment projects. In the next section, we will dive deeper into the practical application of TVOM calculations as they are used in financial decision making.

Review of Learning Objectives

- *The participant will use proper terminology to explain the purpose of adjusting for the time value of money.*
- *The participant will be able to compare inflows and outflows by calculating present and future values.*
- *The participant will use time value of money calculations to make determinations on capital investment projects.*

Resources

Important concepts related to the Learning Objectives in this chapter are summarized in separate videos. Online participants can use the links to access the videos. Classroom learners can access the videos at RiskEducation.org/RAresources.

▶	TVOM Concepts and Risk Management Decisions
📄	Document: Present Value of a Dollar Tables

Section 5 Self-Quiz

Directions: Match the definition or description on the right with the term or phrase on the left.

A. Annuity **B.** Present Value **C.** Future Value **D.** Discount Rate **E.** Payback **F.** Accounting Rate of Return **G.** Net Present Value **H.** Benefit/Cost Ratio **I.** Internal Rate of Return	______ Calculated using the mathematical expression FV / (1 + *i*%)*n*
	______ Measurement of the PV of future cash inflows compared to the net investment of a project, using organization's discount rate as *i*
	______ A stream of equal payments made over a specified period of time
	______ Measurement of the length of time needed to recoup the cost of a capital investment (when flows break even with costs)
	______ Created as a result of compounded interest earnings on the present value
	______ Measurement of discounted values of inflows divided by the net investment using in comparing the NPV of various projects
	______ Discount rate where PV of outflows equals the PV of inflows NPV = $0
	______ The average annual cash flow divided by the initial investment
	______ The organization's cost of capital; also known as WACC

Directions: Select the BEST answer choice for each question. Use the tables, if needed, to help you calculate your answers.

Present Value of $1

*n**	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567

Present Value of an Annuity of $1

*n**	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605

1. The insurance carrier has promised to reduce the premium by $10,000 at the end of the fifth policy term. The CFO says the discount rate is 9%. How much is that future value worth today?
   - ☐ $3,890
   - ☐ $3,791
   - ☐ $6,210
   - ☐ $6,500

2. The insurance carrier has indicated the premium will be reduced by $1,000 at the end of the first year, $3,000 at the end of the second year, and $5,000 at the end of the third year. The CFO says the discount rate is 8%. How much is that premium reduction worth today?
   - ☐ $7,146
   - ☐ $7,467
   - ☐ $19,160
   - ☐ $23,193

3. The insurance carrier has indicated the premium will be reduced by $6,000 at the end of each of the next three policy terms. The CFO says the discount rate is 10%. How much is that premium reduction worth today?
   - ☐ $3,726
   - ☐ $4,506
   - ☐ $14,922
   - ☐ $22,746

Directions: For each project description below, indicate whether you should accept or reject the project.

1. Project A: BCR of 0.954.

   Accept **Reject**

2. Project B: BCR of 1.38

   Accept **Reject**

3. Project D: PV inflows = 897,321; PV Outflows = 543,210

   Accept **Reject**

Section 6: Risk Analysis Applications

Section Goal

In this section, we will examine real-world applications of risk analysis, with a focus on net present value cost-benefit analysis.

Learning Objectives

1. *Explain the importance and purpose of a net present value cost-benefit analysis to a risk management program.*
2. *Understand the steps required to calculate a net present value cost-benefit analysis when making investments in equipment and training.*
3. *Understand how to calculate a net present value cost-benefit analysis for decisions related to risk financing options.*
4. *Understand the issues related to quantitative and qualitative analyses.*

Introduction to Risk Analysis Applications

In the previous sections, we have reviewed a variety of qualitative and quantitative tools used in Risk Analysis. In this section, we will examine real-world applications of risk analysis, with a focus on present value cost-benefit analysis. We will consider scenarios from the perspective of Mary Olsen, the risk manager for DCRI, a chain of distribution centers. She has various risk management team member including her brokers, Rachel and Ralph, and her CEO, Sarah Parker. In this section we will analyze a variety of choices Mary must make and the processes she will use. We will walk through Mary's processes in applying NPV cost-benefit analysis to make crucial risk management decisions. You will then have an opportunity to practice your own skills in making NPV cost-benefit analysis calculations that will better support risk management decisions.

Review of Analytical Techniques

Learning Objective

1. *Explain the importance and purpose of a net present value cost-benefit analysis to a risk management program.*

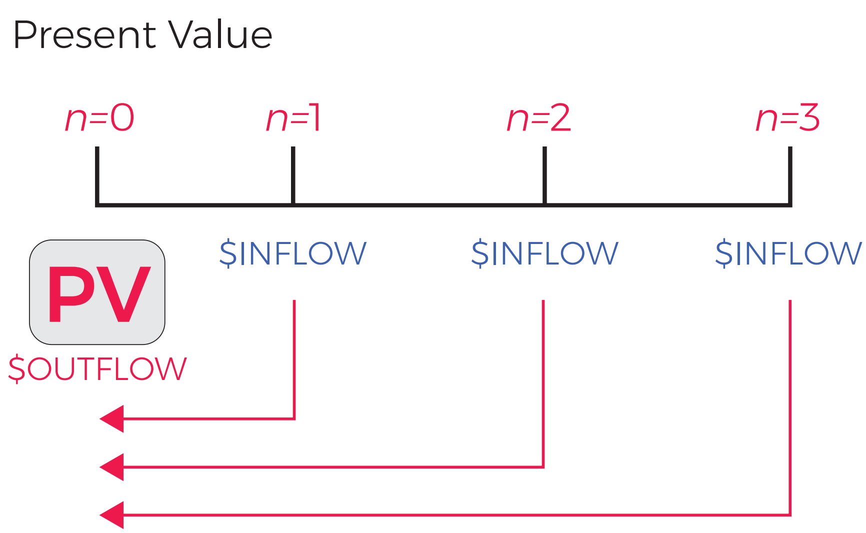
Important Risk Management Applications

Risk managers hold a great responsibility as key decision-makers with respect to investments. Risk managers are responsible for decisions related to investments in equipment and training, as well as risk financing options. For example, a risk manager at a hospital may need to decide whether to invest in patient transfer equipment or whether to replace obsolete personal protective equipment that is still functioning adequately. Naturally, the goal with any financial investment is to earn a net positive return that exceeds the cost of funds.

Purpose of NPV Cost-Benefit Analysis in Risk Management Programs

In the previous section, we introduced a number of tools that are part of the "Financial Decision Toolbox." In this section, we will focus more closely on one tool: the **net present value (NPV) cost-benefit analysis.** The purpose of the NPV cost-benefit analysis is to evaluate a project or option by determining if the present value (PV) of expected *inflows* exceeds the PV of expected *outflows*. Risk managers typically accept projects if the PV of cash inflows minus outflows is greater than or equal to zero. This table from Section 5 reviews basic characteristics of an NPV cost-benefit analysis.

Net Present Value

Definition	Measurement of the PV of future cash inflows compared to the net investment of a project, using organization's discount rate as *i*.
Decision Rule	Accept the project if the PV of the cash inflows minus outflows is greater or equal to zero. **NPV = PV inflows - PV outflows ≥ 0**
Characteristics	Considers TVOM  Assumptions of value of cash flows, discount rate, and time periods

A good decision adds more in present value benefits than it adds in present value costs. Put another way, an investment must earn a higher rate of return than the rate paid to raise money to finance that investment.

All business activities, including risk management, must be justified in terms of value added. The basic method of justifying a business decision involves a calculation of its benefits and costs. Staffing, risk retention, risk transfer, safety programs, life safety initiatives, and all other related risk management activities require financing. Now that we understand the importance of NPV cost-benefit analysis to risk management organizations, we can dive deeper into the steps needed to conduct this type of analysis.

Cash inflows:

- Premium reductions — A reduction in a cash expense has the same effect as an increase in revenues.
- Tax reductions — A reduction in tax has the same effect as an increase in revenues.
- Loss payment reductions resulting from investment in safety equipment or training — A reduction in loss payments has the same effect as an increase in revenues.
- Non-cash expenses, (ex. depreciation) have the same effect as an increase in revenue; the expense deduction lowers tax but there is no reduction in cash from the expense itself.

Cash outflows:

- Cost of safety equipment
- Cost of training
- Retained losses paid
- Premiums paid

Depreciation:

- Depreciation is an accounting concept (generally for tax management) that allows for the for a non-cash expense to reduce income, and therefore tax obligations.
- Spreading out the cost over the useful life of an asset

Knowledge Check

XYZ Corporation is considering investing in a new third-party training program for its management staff. Though the cost of the program is significant, reviews indicate that it has helped similar organizations to reduce the frequency and severity of employment practices liability claims.

1. Explain how an NPV cost-benefit analysis might be used in this situation to determine whether this program is a good fit for XYZ Corp.

2. Name at least one potential inflow and one potential outflow that the risk manager should evaluate.

Calculating NPV Cost-Benefit Analysis for Equipment and Training Investment Decisions

Learning Objective:

2. *Understand the steps required to calculate a net present value cost-benefit analysis when making investments in equipment and training.*

NPV cost-benefit analysis is an invaluable tool for risk managers when making decisions around investing in equipment or training. Following these steps will provide risk managers with data on present value inflows versus present value outflows in order to determine whether or not an investment is expected to see a positive return.

Steps in the Process When Selecting Investment Options

1. Determine cash outflows, such as:
   - Cost of safety equipment.
   - Cost of training and professional fees.
   - Paid losses and related expenses or premiums.

2. Determine cash inflows, such as:
   - Premium reductions (reduction in premiums has the same effect as an increase in revenues).
   - Tax reductions (reduction in taxes has the same effect as an increase in revenues).
   - Loss savings specifically tied to safety equipment or training investments.
   - Non-cash expenses (ex. depreciation) – have the same effect as an increase in revenue; the expense deduction lowers tax but there is no reduction in cash from the expense itself.

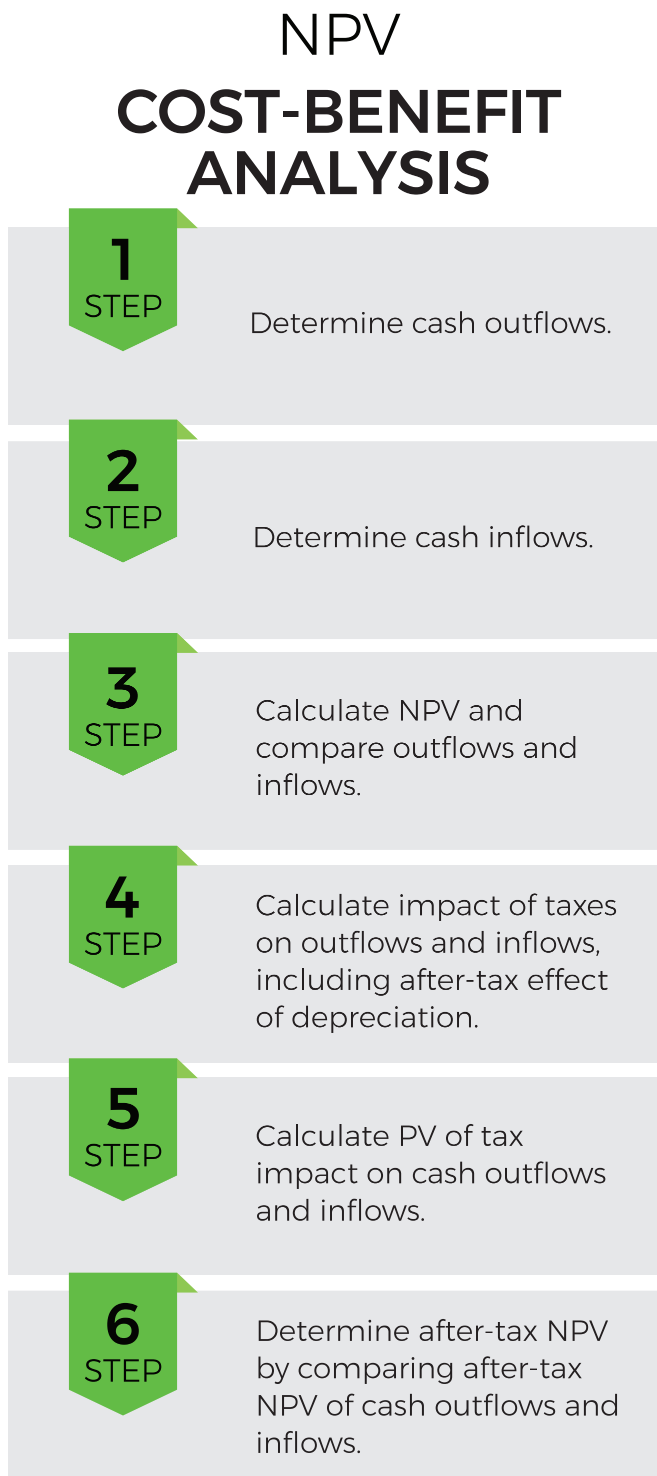
3. Calculate NPV using the organization's discount rate (WACC or CFO's prerogative) and compare PV of cash outflows to PV of cash inflows.

4. Calculate the impact of taxes on cash outflows and inflows including the after-tax effect of depreciation.

5. Calculate the PV of tax impact on cash outflows and inflows.

6. Determine after-tax NPV by comparing after-tax PV of cash outflows and inflows.

Now we will take a look at an example of how a risk manager can employ this process when making a decision on whether or not to invest in equipment.



Example: Net Present Value Cost-Benefit Analysis: Investment in Equipment

Mary Olsen, the risk manager for a chain of distribution centers, is concerned about the cost of injuries to the employees working on the receiving dock and in storage areas caused by improper lifting techniques. She thinks she has finally discovered a way to address the issue. The problem, as is often the case, is that the solution will cost a great deal of money.

An external safety consultant suggested that her company introduce the use of new high-tech lifting devices. Since these devices cost from $10,000 to $25,000 each, Mary agreed to try two units on a three-month trial basis at the Lake Tahoe location. The initial results seemed to be quite positive. The consultant and the manufacturer's rep for the lifting units estimated a total cost of $300,000 to properly outfit all locations. The consultant projected a reduction in losses of 20% from the current level once the units are in place and the staff is trained in their use. Mary is assured the installation, training, and improvement in results can happen overnight. The expected life of the machines is five years. Mary decides to calculate the financial cost-benefit effects of purchasing the lifting devices.

Mary developed the loss data for those five years for these types of losses and determined average expected losses of $500,414. She expects a reduction in the losses by 20%, regardless of size or frequency, in keeping with the representations made by the loss consultant and manufacturer's rep.

Working with her brokers, Rachel and Ralph, Mary learned the current premium allocated to that particular exposure is $400,000 annually.

Mary is preparing to make an analysis of this option, but she realizes she does not have adequate information.

Important Considerations:

What discount rate should she use?

What pattern of premium reduction might she expect, assuming the reduction of losses occurs as suggested?

What are the depreciation charges and effect of taxes?

Mary knows Sarah Parker, the CFO, should have this information. Sarah asks Mary to make the analysis using three discount rates (12%, 15% and 20%), a tax rate of 40%, and the straight-line depreciation method.

Mary knows that 100% of the costs will be incurred immediately. She assumes, for simplicity in analysis, that savings, when they occur, will be received at the beginning of the appropriate year as well. Also, she assumes the tax savings will be received at the beginning of each appropriate year.

Rachel and Ralph tell Mary that the current insurance market for this class of business is "tough". Underwriters will not reduce the premium this year, particularly since the last year was a loser. The underwriter feels that if the suggested improvement actually occurs, premiums will be reduced 10% the second year, then an additional 20% each of the next two years. No additional credit is likely in the fifth year, but a substantial premium reduction should have occurred by then, and premiums should be stable.

When she completed her analysis, Mary gave a copy of the report to Sarah, the CFO.

INSURANCE SAVINGS CALCULATIONS			
Year	**Estimated Prem. Reduction (off prior year)**	**Estimated Projected Premium $**	**Estimated Dollar Savings $**
X6	0%	400,000	-
X7	10%	360,000	**40,000**
X8	20%	288,000	**112,000**
X9	20%	230,400	**169,600**
X10	0%	230,400	**169,600**
		Total Savings	**491,200**

Calculations

X7 X7 estimated premium reduction x X6 estimated projected premium = estimated dollar savings

10% x $400,000 = $40,000

X6 estimated projected premium – X7 estimated dollar savings = X7 estimated projected premium

$400,000 – $40,000 = $360,000

X8 [X8 estimated premium reduction x X7 estimated projected premium] + previous savings = estimated dollar savings in X8

[20% x $360,000] + $40,000 = $112,000X7 estimated projected premium – [20% of X7 estimated projected premium] = X8 estimated projected premium

$360,000 – [20% x $360,000] = $288,000

X9 [X9 estimated premium reduction x X8 estimated projected premium] + previous savings = X9 estimated dollar savings

[20% x $288,000] + $112,000 = $169,600

X8 estimated projected premium – [20% of X8 estimated projected premium] = X9 estimated projected premium

$288,000 – [20% x $288,000] = $230,400

X10 [X10 estimated premium reduction x X9 estimated projected premium] + previous savings = X10 estimated dollar savings

[0% x $230,400] + $169,600 = $169,600

X9 estimated projected premium – [0% of X9 estimated projected premium] = X10 estimated projected premium

$230,400 – [0% x $230,400] = $230,400

Total insurance savings: $491,200.

Present Value Factors for Future Calculations			
n	12%	15%	20%
1	0.893	0.870	0.833
2	0.797	0.756	0.694
3	0.712	0.658	0.579
4	0.636	0.572	0.482

NET PRESENT VALUE CALCULATIONS Discount Rate = 12%						
Year	**Cost of Lifts ($)**	**PV of Lifts ($)**	**Insurance Savings $**	**Discount Factor**	**PV of Insurance Savings $**	**NPV ($)**
X6	(300,000)	(300,000)	-		-	
X7			40,000	0.893	35,720	
X8			112,000	0.797	89,264	
X9			169,600	0.712	120,755	
X10			169,600	0.636	107,866	
Total		(300,000)			353,605	53,605

X7 Insurance savings x discount factor = PV insurance savings

$40,000 x 0.893 = $35,720

X8 Insurance savings x discount factor = PV insurance savings

$112,000 x 0.797 = $89,264

X9 Insurance savings x discount factor = PV insurance savings

$169,600 x 0.712 = $120,755

X10 Insurance savings x discount factor = PV insurance savings

$169,600 x 0.636 = $107,866

Total PV of Insurance Savings: $353,605.

Net Present Value

NPV = sum of PV of the lifts and PV of insurance savings

($300,000) + $353,605 = $53,605

Since the savings in insurance premiums is greater than the cost of the lifts resulting in a positive NPV, the project should be accepted.

TAXATION CALCULATIONS				
(Assume Straight-line Depreciation) Tax Rate = 40% Discount Rate = 12% Depreciation of Lifts				
Year	**Depreciation of Lifts ($)**	**Tax Savings $**	**Discount Factor**	**PV @12% ($)**
X6	60,000	24,000		24,000
X7	60,000	24,000	0.893	21,432
X8	60,000	24,000	0.797	19,128
X9	60,000	24,000	0.712	17,088
X10	60,000	24,000	0.636	15,264
Total				96,912

Insurance Saving	
PV insurance savings	$ 353,605
Tax on the PV insurance savings	(141,442)
After-tax PV insurance savings	$ 212,163

After-tax NPV		
After-tax NPV =	PV of lifts + PV tax savings + after-tax PV insurance savings	
Outflows:	PV of lifts	$ (300,000)
Inflows:	PV of tax savings (depreciation)	96,912
	After-tax PV of insurance savings	212,163
Total Inflows:		$ 309,075
After-tax NPV		$ 9,075

NET PRESENT VALUE (NPV) CALCULATIONS
Discount Rate = 15%

Year	Cost of Lifts ($)	PV of Lifts	Insurance Savings $	Discount Factor	PV of Insurance Savings $	NPV ($)
X6	(300,000)	(300,000)				
X7			40,000	0.870	34,800	
X8			112,000	0.756	84,672	
X9			169,600	0.658	111,597	
X10			169,600	0.572	97,011	
Total		(300,000)			328,080	28,080

X7 Insurance savings x discount factor = PV insurance savings

$40,000 x 0.870 = $34,800

X8 Insurance savings x discount factor = PV insurance savings

$112,000 x 0.756 = $84,672

X9 Insurance savings x discount factor = PV insurance savings

$169,600 x 0.658 = $111,597X

X11 Insurance savings x discount factor = PV insurance savings

$169,600 x 0.572 = $97,011

Net Present Value

NPV = sum of PV of the lifts and PV of insurance savings

$(300,000) + $328,080 = $28,080

Since the savings in insurance premiums is greater than the cost of the lifts resulting in a positive NPV, the project should be accepted.

TAXATION CALCULATIONS				
(Assume Straight-line Depreciation) Tax Rate = 40% Discount Rate = 15% Depreciation of Lifts				
Year	**Depreciation of Lifts ($)**	**Tax Savings $**	**Discount Factor**	**PV @ 15% ($)**
X6	60,000	24,000		24,000
X7	60,000	24,000	0.870	20,880
X8	60,000	24,000	0.756	18,144
X9	60,000	24,000	0.658	15,792
X10	60,000	24,000	0.572	13,728
Total				92,544

Insurance Savings

PV insurance savings	$ 328,080
Tax on the PV insurance savings	(131,232)
After-tax PV insurance savings	$ 196,848

After-tax NPV

After-tax NPV =	PV of lifts + PV tax savings + after-tax PV insurance savings	
Outflows:	PV of lifts	$ (300,000)
Inflows:	PV of tax savings (depreciation)	92,544
	After-tax PV of insurance savings	196,848
Total Inflows:		$ 289,392
After-tax NPV		$ (10,608)

NET PRESENT VALUE (NPV) CALCULATIONS Discount Rate = 20%						
Year	**Cost of Lifts ($)**	**PV of Lifts ($)**	**Insurance Savings ($)**	**Discount Factor**	**PV of Insurance Savings ($)**	**NPV ($)**
X6	(300,000)	(300,000)	-		-	
X7			40,000	0.833	33,320	
X8			112,000	0.694	77,728	
X9			169,600	0.579	98,198	
X10			169,600	0.482	81,747	
Totals		(300,000)			290,993	(9,007)

X7 Insurance savings x discount factor = PV insurance savings

$40,000 x 0.833 = $33,320 X 8

X8 Insurance savings x discount factor = PV insurance savings

$112,000 x 0.694 = $77,728 X 9

X9 Insurance savings x discount factor = PV insurance savings

$169,600 x 0.579 = $98,198 X 10

X10 Insurance savings x discount factor = PV insurance savings

$169,600 x 0.482 = $81,747

Net Present Value

NPV = sum of PV of the lifts and PV of insurance savings

$(300,000) + $290,993 = $(9,007)

Since the savings in insurance premiums are less than the cost of the lifts resulting in a negative NPV, it is a project that should not be accepted.

TAXATION CALCULATIONS				
(Assume Straight-line Depreciation) Tax Rate = 40% Discount Rate = 20% Depreciation of Lifts				
Year	**Depreciation of Lifts ($)**	**Tax Savings ($)**	**Discount Factor**	**PV @ 20% ($)**
X6	60,000	24,000		24,000
X7	60,000	24,000	0.833	19,992
X8	60,000	24,000	0.694	16,656
X9	60,000	24,000	0.579	13,896
X10	60,000	24,000	0.482	11,568
Total				86,112

Insurance Savings	
PV insurance savings	$ 290,993
Tax on the PV insurance savings	(116,397)
After-tax PV insurance savings	$ 174,596

After-Tax NPV

After-tax NPV = PV of lifts + PV tax savings + after-tax PV insurance savings

Outflows:		
	PV of lifts	$ (300,000)
Inflows:		
	PV of tax savings (depreciation)	86,112
	After-tax PV of insurance savings	174,596
Total Inflows:		$ 260,708
After-tax NPV		$ (39,292)

Recap of Previous Pages

Discount Rate	Non-Taxable Entity NPV ($)	Taxable Entity NPV ($)
12%	53,605	9,075
15%	28,080	(10,608)
20%	(9,007)	(39,292)

After reviewing the report together, Mary and Sarah come to the conclusion that as a taxable entity, only the 12% discount rate makes sense because it has a positive NPV.

Effect of Discount Rates and Taxation

As this example demonstrates, a higher discount rate will result in a lower NPV, while a lower discount rate will result in a higher NPV. In short, *as the discount rate increases, NPV decreases.* Non-taxable entities will have higher NPV than taxable entities, regardless of the discount rate.

Knowledge Check

Directions: For each step in the process, describe one example of how Mary carried out the step.

NPV COST-BENEFIT ANALYSIS

1 STEP	Determine cash outflows	1.
2 STEP	Determine cash inflows	2.
3 STEP	Calculate NPV and compare outflows and inflows	3.
4 STEP	Calculate impact of taxes on outflows and inflows, including after-tax effect of depreciation	4.
5 STEP	Calculate PV of tax impact on cash outflows and inflows	5.
6 STEP	Determine after-tax NPV by comparing after-tax NPV of cash outflows and inflows	6.

Calculating NPV Cost-Benefit Analysis for Risk Financing Decisions

Learning Objective:

3. *Understand how to calculate a net present value cost-benefit analysis for decisions related to risk financing options.*

Risk financing decisions require different considerations than decisions around whether to invest in training or equipment. As a result, the steps in the process for conducting an NPV cost-benefit analysis for risk financing differ from those for investment in equipment and training. When conducting an NPV cost-benefit analysis to select risk financing options, risk managers must consider both qualitative and quantitative factors.

Steps in the Process When Selecting Risk Financing Options

1. Develop losses through triangulation using the organization's own data, or using industry factors. Decisions can be based on a combination and weighting of both types of data.

2. Forecast or project losses using the following methods:
   - Trend losses (index for inflation).
   - Develop loss rates using exposures.
   - Forecast losses, using average loss rates or regression.
   - Consider using ranges based on confidence intervals or high-low estimates.
   - Consider capping losses to the budgeted retention.

3. Determine payout pattern of projected losses using the organization's own data as well as industry factors. Decisions will be based on a combination and weighting of both types of data.

4. Calculate and compare the NPV of each option.

Approaches to Analysis

Analysis can be conducted either externally or internally. When the analysis is conducted using an external approach, the organization will outsource the actual work of completing the steps listed above. It is important, in this case, that the risk manager still understands both the process and the results. Analysis can also be conducted internally using Excel or specific software applications (e.g. @Risk, or Instant Actuary).

Now we will once again take a look at how DCRI's risk manager, Mary, uses an NPV cost-benefit analysis to make a risk financing decision.

Net Present Value Cost-Benefit Analysis: Risk Financing Options

Mary, the risk manager, is provided with two renewal options for her upcoming Worker's Compensation program renewal.

Option 1: A guaranteed cost program with a flat fee of $1,000,000.

Option 2: A $100,000 deductible program with a premium (covering insurer expenses, claims handling, loss control, and reinsurance) of $200,000.

She will be responsible to pay all losses under $100,000. Mary used the last five years of DCRI loss experience and exposures to calculate a projection. After consulting with the Human Resources department, she learned that the payroll (exposures) was expected to increase by 9% for the next year. Compare the two options from a quantitative and qualitative perspective.

I. Quantitative Considerations

Risk Financing Analysis Loss History		
Year	**Frequency (a)**	**Total Limited Incurred* ($) (b)**
X1	156	125,986
X2	115	469,091
X3	148	386,550
X4	192	291,555
X5	138	357,171

Step 1: Develop Losses

The first step is to develop the retained losses below the deductible (Limited Incurred) using a Loss Development Factor (LDF) (this accounts for IBNR losses). The total incurred losses are multiplied by the LDF to calculate ultimate total losses.

Risk Financing Analysis Calculate Ultimate Total Losses				
Year	**Freq. (a)**	**Total Incurred ($) (b)**	**Development Factor (c)**	**Ultimate Total Loss ($) (b x c) (d)**
X1	156	125,986	1.00	125,986
X2	115	469,091	1.11	520,691
X3	148	386,550	1.30	502,515
X4	192	291,555	1.57	457,741
X5	138	357,171	2.51	896,499

Note: Development factors were provided but can be calculated by triangulation (example in Section 4).

Step 2: Forecast Losses

At the time of the collection of the loss data, the value of each dollar of loss in each period of time is different. The purchasing power of a dollar today may not be the same as the value of a dollar when the loss report was created, and probably will not be the same as when the loss occurred. The data must be adjusted to reflect current prices. A price index provides an adjustment factor based on inflation rates for each year, beginning with a given year of losses. The product of multiplying the ultimate total losses by the inflation factor in called the indexed ultimate total loss.

The oldest data requires the most adjustment, since prices have changed more over time. The rule of thumb, related to inflation index numbers, is that the highest index factor applies to the oldest data.

Risk Financing Analysis: Index for Inflation						
Year	**Freq. (a)**	**Total Incurred $ (b)**	**Development Factor (c)**	**Ultimate Total Loss $ (b x c) (d)**	**Inflation Index Factor* (e)**	**Indexed Ultimate Total Loss $ (d x e) (f)**
X1	156	125,986	1.00	125,986	1.762	221,987
X2	115	469,091	1.11	520,691	1.574	819,568
X3	148	386,550	1.30	502,515	1.405	706,034
X4	192	291,555	1.57	457,741	1.254	574,007
X5	138	357,171	2.51	896,499	1.120	1,004,079

* A 12% inflation rate is used because of the high rate of inflation on medical costs. This rate would vary based on geographical location.

Step 2 *(continued)*:

Risk Financing Analysis Indexed Ultimate Total Loss Rate								
Year	**Freq. (a)**	**Total Incurred $ (b)**	**Dev. Factor (c)**	**Ultimate Total Loss $ (b x c) (d)**	**Inflation Index Factor (e)**	**Indexed Ultimate Total Loss $ (d x e) (f)**	**Exposure (Payroll $) (g)**	**Indexed Ultimate Total Loss Rate* (f / g) (h)**
X1	156	125,986	1.00	125,986	1.762	221,987	12,350,000	0.0180
X2	115	469,091	1.11	520,691	1.574	819,568	13,910,000	0.0589
X3	148	386,550	1.30	502,515	1.405	706,034	15,204,000	0.0464
X4	192	291,555	1.57	457,741	1.254	574,007	17,112,000	0.0335
X5	138	357,171	2.51	896,499	1.120	1,004,079	18,080,000	0.0555

* Indexed ultimate total loss rate = the cost in losses per $1 in payroll, adjusted for inflation

Regression Analysis for Indexed Ultimate Loss Rates
Forecast Losses Using Regression

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.46699555
R Square	0.218084843
Adjusted R Square	-0.042553542
Standard Error	0.01718157
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000247009	0.000247009	0.836733403	0.427783647
Residual	3	0.000885619	0.000295206		
Total	4	0.001132628			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	0.03254	0.013308787	2.445001265	0.092088622	-0.009814538
X Variable 1	0.00497	0.005433289	0.914731329	0.427783647	-0.012321168

r^2 = 0.218 is too low to use the regression for forecasting. In this instance, mean loss rate, and possibly confidence intervals, should be used instead.

Step 2 (*continued*):

Average of Indexed Ultimate Total Loss Rates

(0.0180 + 0.0589 + 0.0464 + 0.0335 + 0.0555) ÷ 5 = 0.0425

Projected payroll = $18,080,000 x 1.09 = $19,707,200
(1.09 represents expected increase in payroll)

Projected losses for X6 are approximately:
$19,707,200 X 0.0425 = $837,556

Risk Financing Analysis Project Losses for X6			
Year	**Indexed Ultimate Total Loss $ (f)**	**Exposure (Payroll $) (g)**	**Indexed Ultimate Total Loss Rate (f / g) (h)**
X1	221,987	12,350,000	0.0180
X2	819,568	13,910,000	0.0589
X3	706,034	15,204,000	0.0464
X4	574,007	17,112,000	0.0335
X5	1,004,079	18,080,000	0.0555
(Projection) X6	837,556	19,707,200	0.0425

Our forecast of total dollar losses requires a calculation of an loss rate (# losses/exposure) from our fully developed losses data and our exposure data. 0ur goal is to create the loss rate data and construct our forecast of the X6 losses based on the expected exposure (payroll).

In many cases, we are interested in this loss rate forecast alone, since it reveals how many accidents or losses the insured has per exposure unit, and loss control measures are aimed at lowering the TCOR (total cost of risk).

Step 3: Determine payout pattern of projected losses.

Paid Claims $ (in thousands)					
Year	**12**	**24**	**36**	**48**	**60**
X1	15	41	47	67	75
X2	140	234	304	469	
X3	93	186	205		
X4	63	141			
X5	143				

Age-to-Age Development Factors				
Year	**12–24**	**24–36**	**36–48**	**48–60**
X1	2.73	1.15	1.43	1.12
X2	1.67	1.30	1.54	
X3	2.00	1.10		
X4	2.24			
X5				
Total	8.64	3.55	2.97	1.12
Averages	2.16	1.18	1.48	1.12

Age-to-Age Development Factors					
Year	**12–24**	**24–36**	**36–48**	**48–60**	**60+**
Totals	8.64	3.55	2.97	1.12	
Average	2.16	1.18	1.48	1.12	1.00
Paid Development to Ultimate Factor	4.23	1.96	1.66	1.12	1.00

Paid LDF	% Ult. Payout	Payout Pattern
4.23	24%	24%
1.96	51%	27%
1.66	60%	9%
1.12	89%	29%
1.00	100%	11%

Note: We use paid loss development factors, not incurred loss development factors, for projecting payout ratios.

Step 4: Calculate and compare NPV of each option.

Risk Financing Analysis NPV of Payout Options					
Projected Losses ($) (a)	**Payout Periods (months) (b)**	**Est. Payout % (c)**	**Projected Payout per Period ($) (a x c) (d)**	**12% Discount Factor (e)**	**Discounted Payout $ (d x e) (f)**
837,556	12	24%	201,013	0.893	179,505
	24	27%	226,140	0.797	180,234
	36	9%	75,380	0.712	53,671
	48	29%	242,891	0.636	154,479
	60	11%	92,131	0.567	52,238
Total		**100%**	**837,556**		**620,126**

Guaranteed Cost Program: $1,000,000

Deductible Program: $200,000 (premium) + $620,126 (discounted losses) = $820,126

Based on the quantitative data, which program should Mary choose and why?

Based on these calculations we see that the deductible program is less expensive than the guaranteed cost program. If the data used for the analysis is correct, Mary should choose the deductible program.

II. Qualitative Considerations

In addition to the quantitative data, Mary also has several qualitative considerations when deciding which option to choose. These include the following:

- Would it benefit the organization to have a certain payment of a fixed premium on a specific date versus uncertain possible future payments, dates, and amounts?
- Has Mary collected enough information to make an informed decision?
- Can Mary identify trends over a given period, such as changes in exposures or loss rates?
- How do the ultimate total losses compare to the ultimate total losses plus the confidence interval?
- Does the company have the ability and willingness to pay the policy premium and any additional costs?
- Are there other non-financial factors to consider, such as the impact on reputation and goodwill if a decision is made to close a facility and lay off 100 workers, or the loss of stakeholder confidence if a new product line is launched and it does not generate the revenue expected?

When deciding on the best policy, Mary will have to take this qualitative data into account alongside the quantitative data. Depending on the organization's preferences and appetite for risk, qualitative considerations can sometimes outweigh quantitative when making the final decision.

Knowledge Check

Directions: Answer the questions and complete the necessary calculations using the information provided.

Scenario 1: Incurred losses (valued as of 12/31/X5), including reserves for loss adjustment expenses, are as follows:

01/01/X3–12/31/X3 $67,000

01/01/X4–12/31/X4 $49,000

01/01/X5–12/31/X5 $41,000

Revenues have been stable. Frequency has been relatively consistent.

1. Are you satisfied that losses are improving? Explain.

____

2. Development factors (to ultimate total loss) are 1.2, 1.4, and 1.8 for three years. Compute developed losses, and enter your answers in the worksheet provided.

3. Adjust the losses for inflation (based on 5% annually) to reflect X6 dollars, and enter your answers in the worksheet provided.

Worksheet

Year	Loss $	x Dev	= Ultimate Total Loss $	x Index	= Indexed Ultimate Total Loss $
X3					
X4					
X5					
X6					

Knowledge Check *(continued)*

Scenario 2: Total projected losses for next year are $82,000, assuming operations are the same as in the past.

You believe you can install various safety measures, e.g., new machine guards, strips on floors for traction, and new ergonomic computer tables, which will significantly reduce losses.

The cost of these measures is $50,000 (assume this is paid immediately). Assume losses less than $1,000 per occurrence will be reduced to $10,000 annually for each of the next three years, which is much lower than in the past.

As a result, consider a $1,000 deductible program. Presume the deductible losses are remitted to the carrier after an average of one year's use of funds (assume 100% losses paid in each policy year).

The insurance program will change as follows, assuming loss improvement occurs as expected. Over time, less frequency should also result in less severity.

X6	Deductible credit of $15,000
X7	Deductible credit of $15,000 and experience credit of $15,000
X8	Deductible credit of $15,000 and experience credit of $20,000

1. Calculate the combined results of both introducing loss control measures and accepting a deductible. Assume a 10% cost of capital (discount rate).

Inflows:	$	Discount Factor	PV $ of Inflows
X6 (current)			
X7			
X8			
Total			

Outflows:	$	Discount Factor	PV $ of Outflows
X6 (current)			
X7			
X8			
X9			
Total			

NPV____

Knowledge Check *(continued)*

Scenario 3: DCRI's automobile liability program is renewing in several months. The current fleet of 206 vehicles consists of private passenger autos (100), limousines (52), vans (30), and SUVs (24).

The following data is from premium audits and loss reports:

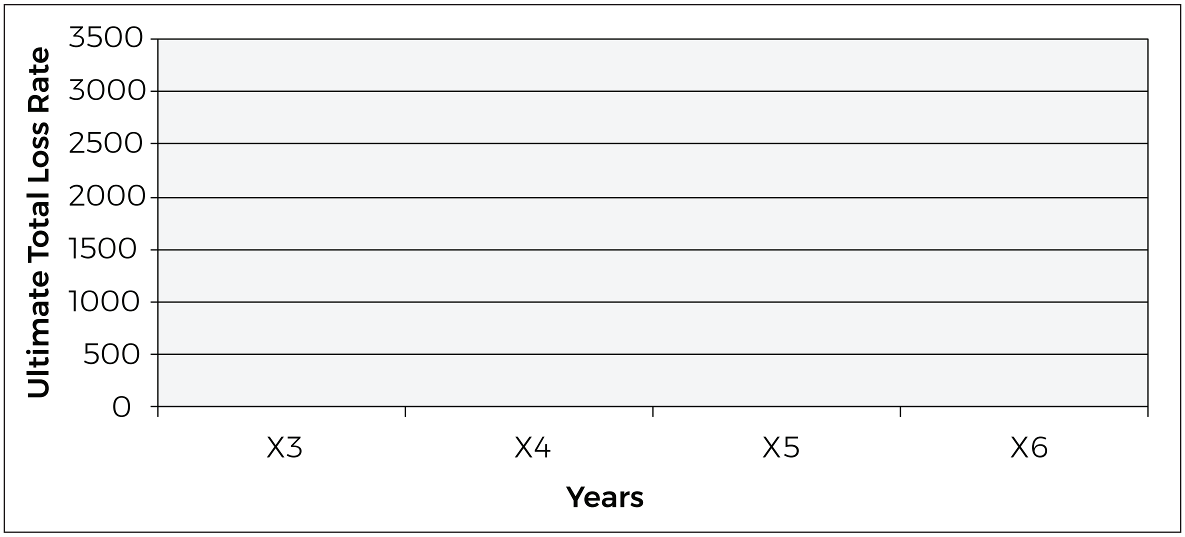
Year	# of Units	Total Incurred Liability Losses ($)	# of Losses
X3	140	250,000	13
X4	145	277,000	15
X5	163	224,000	20
X6	206		

Mary, the risk manager, calls Lucas Pacioli, the actuary with whom she has a business relationship, and Lucas gives her the loss development factors of 1.1, 1.3, and 2.0 for severity and an index (inflation) factor of 4% each year.

1. How should Mary develop the indexed ultimate total loss rate projected for the coming year (year X6)?

Year	Freq	Total Incurred	Dev. Factor	Ultimate Total Loss $	Inflation Index Factor	Indexed Ultimate Total Loss $	Exposure Units	Indexed Ultimate Total Loss Rate
X3								
X4								
X5								
X6								

2. How would Mary develop indexed ultimate total losses projected for year X6? Fill in the graph below, and explain the steps Mary would take to develop losses.



Knowledge Check *(continued)*

Scenario 4: Mary has received two renewal quotes.

Year	Indexed Ultimate Total Loss $	Exposure (Payroll $)	Indexed Ultimate Total Loss Rate (f / g)
	(f)	**(g)**	**(h)**
X1	221,987	12,350,000	0.0180
X2	819,568	13,910,000	0.0589
X3	706,034	15,204,000	0.0464
X4	574,007	17,112,000	0.0335
X5	1,004,079	18,080,000	0.0555
(Projection) X6	837,556	19,707,200	0.0425

Quote 1 is for a fully insured (guaranteed cost) plan. The premium is $950,000, payable the first of the month in 12 equal installments.

Quote 2 is for a deductible plan having a $25,000 deductible per loss with no aggregate. The underwriter believes of the $837,556 of total losses expected in X6, that $217,500 will fall within the deductible range. The premium for this deductible plan is $625,000 and is to be paid in 12 equal installments. The projected payout of losses within the deductible is as follows:

0–12 mos.	12–24 mos.	24–36 mos.	36–48 mos.	48–60 mos.
$52,200	$58,725	$19,575	$63,075	$23,925

Mary makes the assumption that the payout is made at year-end of each year.

Sarah, the CFO, advised Mary that the discount rate she should use is 12%.

Tips:

- Consider using the PV of an annuity when calculating the discounted payment streams.
- Assume the annual 12% discount rate will translate to a monthly discount rate of 1%.

1. Which quote should Mary accept and why? Check the box for the best quote plan and explain your reasoning.

Worksheet for Quote #1

Premium first month		÷		=		
11 following months		x		=		
Total discounted payments						

☐ Fully Insured Plan (Quote 1)

Worksheet for Quote #2

Premium first month		x		=		
11 following months		x		=		
Total Discounted Payments						
Losses (assuming payout made at year end)						
Paid 0–12 months		x		=		
Paid 12–24 months		x		=		
Paid 24–36 months		x		=		
Paid 36–48 months		x		=		
Paid 48–60 months		x		=		
Total Discounted Paid Losses						
Total						

☐ Deductible Plan (Quote 2):

Issues Related to Quantitative and Qualitative Analyses

Learning Objective

4. *Understand the issues related to quantitative and qualitative analyses.*

Throughout this course, we have studied both quantitative and qualitative assessment methods in-depth. Both types of analyses can yield data and information that is crucial for risk management decision-making. However, it is important to remember that no method of risk analysis is "foolproof." There are a number of important issues to consider when performing both qualitative and quantitative risk analyses.

Quantitative Analysis

Loss Projections

When calculating loss projections, it is essential to remember that raw, undeveloped numbers can be very misleading. As such, it is crucial to follow traditional, acceptable methods for developing loss projections, including adjusting all data for inflation. Even when these methods are employed correctly, data is not guaranteed to be accurate. For example, case reserves can be inaccurate. Since development factors are critical, it is essential for risk managers to keep in mind the inaccuracies or insufficiencies that can exist, including:

- Internal data that is inaccurate or insufficient to generate any reasonable degree of statistical confidence.
- Changes to operations or third-party administrators can result in inaccurate data.
- External data may include inaccuracies such as:
  - — Incorrect industry
  - — Incorrect classifications
  - — Organization may be "better" or "worse than the industry average

Issues of Credibility

Both mechanical and subjective methods of quantitative analysis may be subject to issues of credibility. The quality of the data is essential to a proper analysis.

Cash Discounting

When performing cash discounting calculations, the choice of discount rate is critical. Flow assumptions are also crucial. Interest rates are not static and affect both inflow and outflow.

Financial Transfer and Retention Modeling

It is important to remember that quantitative analysis in risk management is as much art as it is science. There are numerous factors to consider in decision-making, such as whether the organization prefers to take a financial or attitude-driven approach. Customized models of financial transfer and retention modeling are best, but they can be very expensive.

Qualitative Analysis

Though it might seem logical that all financial and risk management decisions should be based on solid, quantifiable data, there are many instances in which qualitative analysis outweighs quantitative. For example, an organization's leadership may value corporate citizenship over quantitative results. Additionally, management may have their own biases with respect to risk. Organizations have varying degrees of risk tolerance or risk aversions. In the end, the organization's financial statements may not support the final conclusion due to qualitative considerations.

In summary, risk managers must take precautions to ensure the integrity and quality of data, as well as to be aware of organizational factors that may impact financial decision-making.

Knowledge Check

Mary is planning to conduct a full-scale quantitative and qualitative analysis to determine how her company should finance the risk created by offering delivery service withing a 30-mile geographic radius. The cost of the service would be based on distance, weight of the merchandise, and the purchase price.

1. Name three potential issues Mary should keep in mind with respect to data and explain how they might impact her analysis.

    a) ______________________________

    b) ______________________________

    c) ______________________________

Summary

Sections 1–5 of this course introduced numerous qualitative and quantitative tools for risk analysis. In this section, we explored the practical application of these tools, specifically how to employ the use of NPV cost-benefit analyses in risk management decision-making.

In order to conduct an NPV cost-benefit analysis for decisions related to investment in equipment or training, risk managers should follow these steps:

1. Determine cash outflows.
2. Determine cash inflows.
3. Calculate NPV using the organization's discount rate (WACC or CFO's prerogative) and compare PV of cash outflows to PV of cash inflows.
4. Calculate the impact of taxes on cash outflows and inflows including the after-tax effect of depreciation.
5. Calculate the PV of tax impact on cash outflows and inflows.
6. Determine after-tax NPV by comparing after-tax PV of cash outflows and inflows.

To conduct an NPV cost-benefit analysis for risk financing decisions, risk managers should follow these steps:

1. Develop losses.
2. Forecast or project losses.
3. Determine payout pattern of projected losses using the organizations own data as well as industry factors.
4. Calculate and compare the NPV of each option.

Finally, risk managers should always be aware of the numerous challenges relating to obtaining reliable, credible quantitative data in their decision-making process. Often, assumptions are made when conducting NPV analyses and loss projections that have a significant impact on the results. From a qualitative perspective, management may have their own biases with respect to risk tolerance and risk aversions. Risk management decisions ultimately rely on both quantitative and qualitative evaluation for decisions facing the program.

Review of Learning Objectives

- *Explain the importance and purpose of a net present value cost-benefit analysis to a risk management program.*
- *Understand the steps required to calculate a net present value cost-benefit analysis when making investments in equipment and training.*
- *Understand how to calculate a net present value cost-benefit analysis for decisions related to risk financing options.*
- *Understand the issues related to quantitative and qualitative analyses.*

Resources

Important concepts related to the Learning Objectives in this chapter are summarized in separate videos. Online participants can use the links to access the videos. Classroom learners can access the videos at RiskEducation.org/RAresources.

Document: Present Value of a Dollar Tables

Section 6 Self-Quiz

Directions: List the steps of conducting an NPV cost-benefit analysis when investing in equipment or training.

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

____

6. ______________________________

____

Directions: Use the word bank to fill-in-the blanks. Terms will be used only once, and not all terms will be used.

capping	**NPV**	**cost-benefit analysis**	**forecast**
after-tax	**inflation**	**loss rates**	**confidence intervals**
industry	**regression**	**payout pattern**	**triangulation**

Steps in the process when selecting risk financing options:

1. Develop losses through ______________________ using the organization's own data, as well as using ______________________ factors.

2. ______________________ losses using the following methods:

3. Trend losses (index for ______________________).

4. Develop ______________________ using exposures.

5. Forecast losses, using average loss rates or ______________________.

6. Consider using ranges based on ______________________ or high-low estimates.

7. Consider ______________________ losses.

8. Determine ______________________ of projected losses using the organization's own data as well as ______________________ factors.

9. Calculate and compare the ______________________ of each option.

Appendix

Preparing for the Final Exam

For many learners, test preparation is stressful. Please keep in mind that the most important measure of your knowledge will be witnessed in your service to your organization. Think of a test as a tool. Use it to come to an understanding of what you know, how it affects your work, and what more you would like to know to have even greater success in the workplace.

The testing period for the Final Exam is 2 ½ hours long. The test itself is composed of 17–21 short-answer questions for a total of 200 possible points. Questions appear in the order of presentation of the topics.

Remain aware of the time as you take the test. Pace yourself and be aware that unanswered questions are considered incorrect.

Study Techniques

There are some techniques you can use to help you prepare for the end-of-course test. Apply the same techniques to each chapter in your learning guide.

1. Review the Section Goal.
2. Review each Learning Objective.
3. Change each header and subhead into a question. Then answer the question. For example,

   Header: Components of a Formal Training Plan

   Question: What are the components of a formal training plan?
4. Review each diagram, graph, and table. Interpret what you see. Ask yourself how it relates to a specific Learning Objective.
5. Check your answers to each Check-In. Correct your original answers, if necessary.
6. Check your answers to each Knowledge Check. Consider ways to improve your original answers.
7. Re-read the summary at the end of each section.
8. Check your answers to each question in the Self-Quizzes at the end of each section. Correct your original answers, if necessary.
9. Review any comments, highlights, or notes you made in each section.

10. Rewrite important ideas in your own words. Find ways to connect those ideas to your own work experiences.

11. Make flash cards to help you review important vocabulary.

Sample Test Questions

1. Freddy Temple, the risk manager of a growing restaurant chain, has heard that a competitor just changed insurance brokers. Freddy wishes to look into selecting a different broker, but the current account executive is the nephew of a Board member. Provide three reasons Freddy might give to the CEO to justify selecting another broker.

Sample Answers:

1) It gives the appearance of a conflict of interest—nepotism
2) There is a potential for confidential information to be shared/divulged
3) The broker may have little incentive to recommend the most cost effective policy as it might affect his commission

2. Your CEO is interested in how an effective risk management program can have a positive impact on the organization. Please explain four positive impacts of an effective risk management program.

Sample Answers (any four):

a. It raises awareness of the importance of risk management and promotes understanding and acceptance of risk management policies and procedures throughout the organization
b. It supports managerial objectives:
   - Improves planning and budgeting
   - Reduces frequency and severity of incidents, accidents, losses and claims
   - Projects future losses
   - Increases awareness of indirect losses
c. It improves morale and productivity among the work force.
d. It improves quality, processes, and technology.
e. It increases profitability (reduced costs or increased revenues):
   - Reduces claims management and legal costs
   - Optimizes cost of risk
   - Protects cash flow, assets and financial statements
f. It protects the organization's reputation and brand.

3. Ben Volio, the risk manager of Verona Markets, has accumulated a number of years of loss data related to his workers compensation exposures. He plans to use measures of

statistical central tendency to determine the likely number of workers compensation losses the organization will face in the typical year.

A. Identify and briefly describe two measures of statistical central tendency (based on normal distributions) that Ben should use.

Sample Answers (any two):

- Mean average, or arithmetic mean, or sum of all values divided by the number of observations (any of the underlined terms)
- Median 50th percentile or half the values lie below and half the values lie above or middle value (any of the underlined terms)
- Mode observation occurring most often or observation occurring most frequently (any of the underlined terms)

B. Using the following values, calculate the two measures of statistical central tendency you listed above. Give the name of the measure of statistical central tendency and show your calculations.

Values: 1 4 2 1 1 7 5 3

Sample Answers (any two):

- Mean: Sum = 24, 24 ÷ 8 = 3
- Median: 1, 1, 1, 2, 3, 4, 5, 7 = 2.5
- Mode: 1, 1, 1, 2, 3, 4, 5, 7 = 1

Glossary of Terms

accounting rate of return (ARR) measurement of the percentage return of average annual cash flows on initial investment; the ARR is the average annual cash flow divided by the initial investment

annuity a stream of periodic payments made over a specified period of time

benefit/cost ratio (BCR) measurement of discounted values of inflows divided by the net investment using in comparing the NPV of various projects

catastrophe modeling a computerized system that generates a very large set of simulated events to estimate the likelihood, magnitude or intensity, location, degree of damage, and ultimately, insured and uninsured losses arising from a catastrophe event such as a hurricane, earthquake, tornado, flood, wildfire, winter storm, terrorism, war, pandemics, or cyberattack

causality the relationship between one variable and another variable in which the second variable is a direct consequence of the first. However, correlation between two variables does not necessarily imply causality

coefficient of determination r^2 is a descriptive measure of the strength of the regression relationship or how well the regression line fits the data; it measures the percentage of the variation in the dependent variable explained by the regression

correlation measure of the strength of a linear relationship between two variables

delphi method a series of surveys/questionnaires used to form a consensus opinion on the anticipated impact of a risk

discount rate the organization's cost of capital; also known as the hurdle rate, the weighted average cost of capital or WACC, or the required rate of return

Empirical Rule states that nearly all values will lie within three standard deviations of the mean in a normal distribution

financial capacity the organization's ability to fund projects, activities, etc.

future value (FV) or compound value tomorrow's value of today's cash flow

heat mapping a visual representation of complex sets that uses colors to concisely indicate patterns or groupings, thus making the data more actionable

histograms a graphical representation of the distribution of data that is used to illustrate the spread of numerical data

Ishikawa diagram (fishbone diagram) a systematic method used to determine underlying and contributing causes of losses

Law of Large Numbers in statistics, as the sample size increases, the average of the sample gets closer to the average of the whole population

left skew negative skew

linear regression a statistical technique of modeling the relationship between variables by fitting the “best” line to a scatter of dots

loss development the process by which data is adjusted to account for lag time to settle claims, recognize Incurred But Not Reported Losses (IBNR) and index for inflation

loss development factor used to adjust (multiply) known claims to determine the anticipated value for claims over a specific time period

mean the sum of all observations divided by the number of observations (also known as the average or arithmetic mean)

median the midpoint of the observations ranked in order of value; half the observations lie below and half above the middle value (also known as the 50th percentile); if an even number of observations, the median is the average of the middle two

mode the observation that occurs most often in the sample; the highest frequency. There may be none, one or more than one mode. The population mode is the observation that has the highest probability of occurring.

outlier an extreme value that is much higher or lower than the other values in the data set

net present value (NPV) a measurement of the PV of future cash inflows compared to the net investment of a project, using organization’s discount rate as ***i***

payback a measurement of the length of time needed to recoup the cost of a capital investment

population the entire group of observations

predictive analytics use of statistical techniques ranging from data mining and modeling through analyzing current and historical facts and transactions to make predictions of future unknown events

present value (PV) today’s value of a tomorrow’s cash flow

present value factor (PV Factor) predetermined factor that can be used to simplify present value calculations

present value of an annuity factor (PVA Factor) predetermined factor that can be used to simplify present value of annuities calculations

qualitative analysis the analysis of loss exposures that cannot be measured precisely, including non-monetary considerations such as the organization’s reputation and brand image

quantitative analysis the use of widely accepted statistical methods to calculate numerical values for risks and loss exposures

range the difference between the largest and smallest values

right skew positive skew

risk analysis the assessment of the potential impact of various exposures on an organization; it is an essential part of the risk management process

risk mapping a visual analytical tool from which all risks of an organization can be identified, and their potential impact can be understood

risk modeling the use of relevant historical data and past behaviors to find correlations and extrapolate data to predict future losses based on assumptions as determined by experts

risk register another risk analysis method that prioritizes risks based on a scale of anticipated potential impact

root cause analysis a systematic method to drill down to the root cause of an incident

sample a subset of a larger group having the same characteristics of the group

skewness the measure of the degree of asymmetry or distortion from a symmetrical bell curve of a frequency distribution

standard deviation of a population of losses the amount of variation or dispersion in a set of data values

time value of money (TVOM) the value of money over a given amount of time considering a given amount of interest

triangulation a study of the historical changes over time in frequency, severity, and payout patterns