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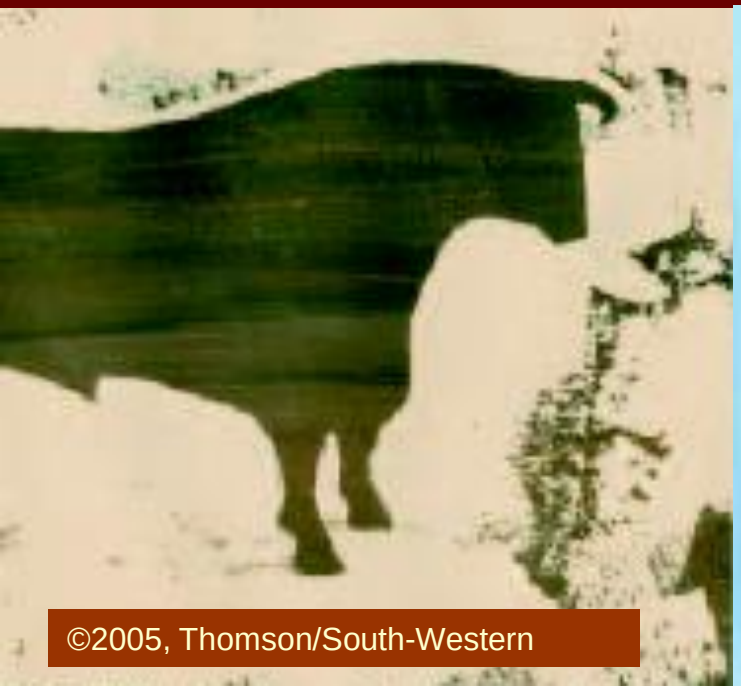
Risk Management AND INSURANCE

Risk Identification and Evaluation

Chapter 2



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Chapter Objectives

- Explain several methods for identifying risks
- Identify the important elements in risk evaluation
- Explain three different measures of variation
- Explain three different measures of central tendency
- Discuss the concepts of a probability distribution and explain the importance to risk managers
- Give examples of how risk managers might use the normal, binomial, and Poisson distributions
- Explain how the concepts of risk mapping and value at risk are used in an enterprise-wide evaluation of risk
- Explain the importance of the law of large numbers for risk management

Risk Identification

- Loss exposure
  - Potential loss that may be associated with a specific type of risk
  - Can be categorized as to whether they result from
    - Property
    - Liability
    - Life
    - Health
    - Loss from income risks

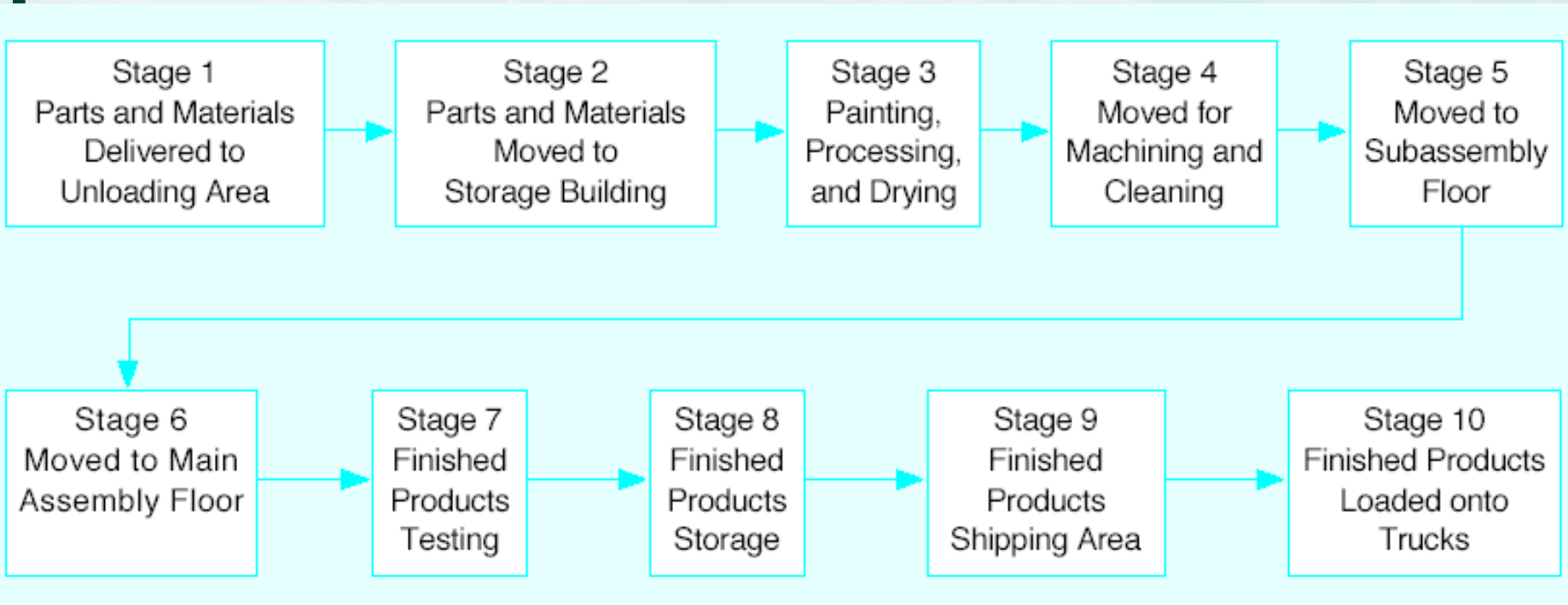
Risk Identification

- Loss exposure Checklists
  - Specifies numerous potential sources of loss from the destruction of assets and from legal liability
  - Some are designed for specific industries
    - Such as manufacturers, retailers, educational institutions, religious organizations
  - Others focus on a specific category of exposure
    - Such as real and personal property

Risk Identification

- Financial statement analysis
  - All items on a firm's balance sheet and income statement are analyzed in regard to risks that may be present
- Flowcharts
  - Allows risk managers to pinpoint areas of potential losses
  - Only through careful inspection of the entire production process can the full range of loss exposures be identified

Figure 2-1: Flowchart for a Production Process



Risk Identification

- Contract analysis
  - It is not unusual for contracts to state that some losses, if they occur, are to be borne by specific parties
  - May be found in construction contracts, sales contracts and lease agreements
  - Ideally the specification of who is to pay for various losses should be a conscious decision that is made as part of the overall contract negotiation process
    - Decision should reflect the comparative advantage of each party in managing and bearing the risk
- On-site inspections
  - During these visits, it can be helpful to talk with department managers and other employees regarding their activities
- Statistical analysis of past losses
  - Can use a risk management information system (software) to assist in performing this task
    - As these systems become more sophisticated and user friendly , it is anticipated that more businesses will be able to use statistical analysis in their risk management activities

Risk Evaluation

- Once a risk is identified, the next step is to estimate both the frequency and severity of potential losses
- Maximum probable loss
  - An estimate of the likely severity of losses that occur
- Maximum possible loss
  - An estimate of the catastrophe potential associated with a particular exposure to risk
- Most firms attempt to be precise in evaluating risks
  - Now common to use probability distributions and statistical techniques in estimating loss frequency and severity

Risk Mapping or Profiling

- Involves arraying risks in a matrix
  - With one dimension being the frequency of events and the other dimension the severity
- Each risk is marked to indicate whether it is covered by insurance or not

Statistical Concepts

- Probability
  - Long term frequency of occurrence
    - The probability is 0 for an event that is certain not to occur
    - The probability is 1 for an event that is certain to occur
  - To calculate the probability of any event, the number of times a given event occurs is divided by all possible events of that type
- Probability distribution
  - Mutually exclusive and collectively exhaustive list of all events that can result from a chance process
  - Contains the probability associated with each event

Statistical Concepts

- Measures of central tendency or location
  - Measuring the center of a probability distribution
  - Mean
    - Sum of a set of n measurements divided by n

$$\bar{x} = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n}$$

Statistical Concepts

- Median
  - Midpoint in a range of measurements
  - Half of the items are larger and half are smaller
  - Not greatly affected by extreme values
- Mode
  - Value of the variable that occurs most often in a frequency distribution

Measures of Variation or Dispersion

- Standard deviation
  - Measures how all close a group of individual measurements is to its expected value or mean
    - First determine the mean or expected value
    - Then subtract the mean from each individual value and square the result
    - Add the squared differences together and divide the sum by the total number of measurements
    - Then take the square root of that value
- Coefficient of variation
  - Standard deviation expressed as a percentage of the mean

Table 2-1: Calculating the Standard Deviation of Losses

Losses ($)	Mean Loss* ($)	Deviation from Mean ($)	Squared Deviations ($)
10	30	–20	400
20	30	–10	100
30	30	0	0
40	30	10	100
50	30	20	400
			1,000

Variance = $1{,}000 \div 5 = 200$
Standard deviation = $\sqrt{200} = \$14.14$
* Mean loss = $(\$10 + 20 + 30 + 40 + 50) \div 5 = \$30$

Loss Distributions Used in Risk Management

- To form an empirical probability distribution
  - Risk manager actually observes the events that occur
- To create a theoretical probability distribution
  - Use a mathematical formula
    - Widely used theoretical distributions include binomial, normal, Poisson

The Binomial Distribution

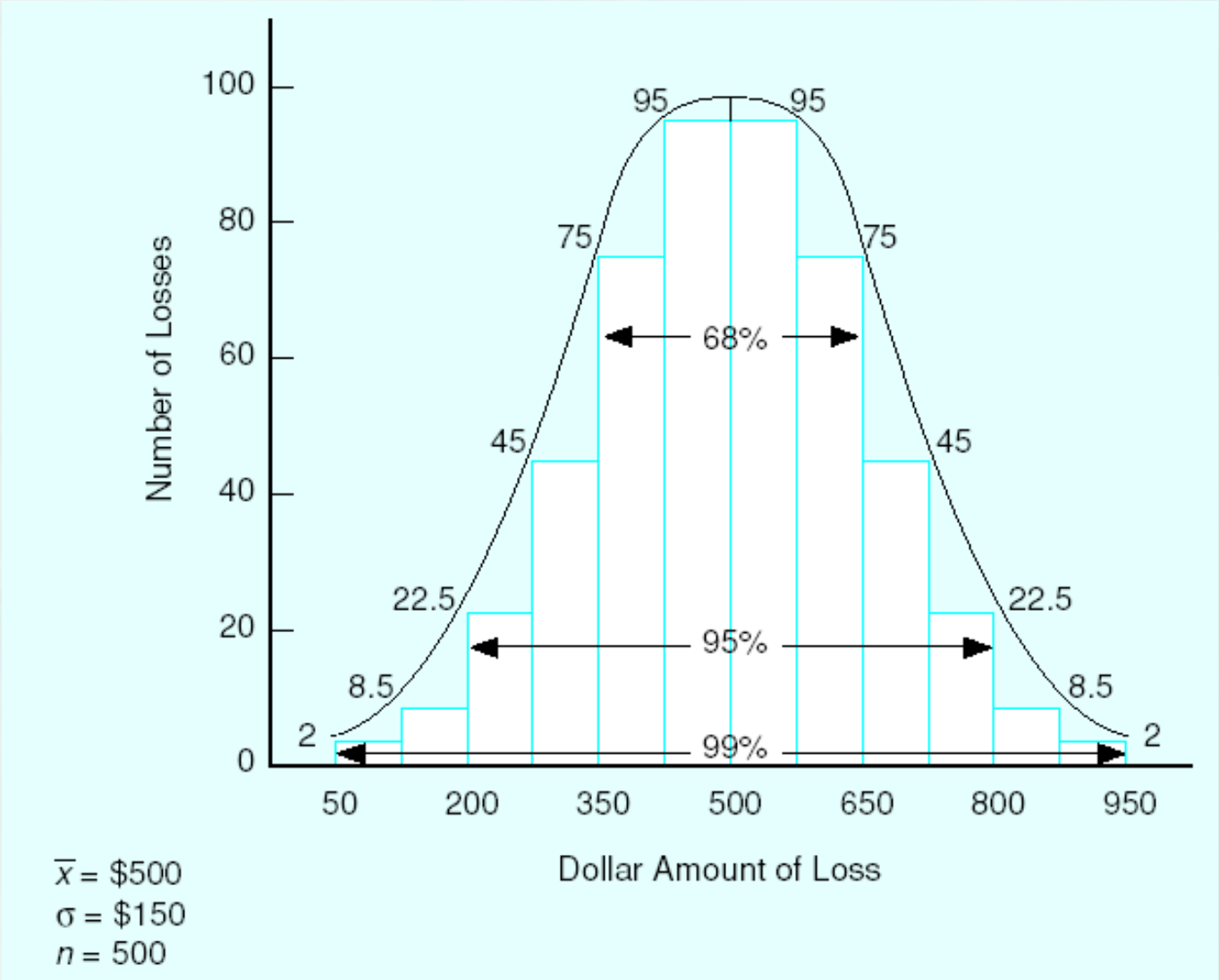
- Suppose the probability that an event will occur at any point in time is p
  - The probability q that an event will not occur can be stated as 1 – p
- One can calculate how often an event will happen with the binomial formula
  - Indicates that the probability of r events in n possible times equals

$$\frac{n!}{r!\,(n-r)!} \times p^r\, q^{n\,-\,r}$$

The Normal Distribution

- Central limit theorem
  - States that the expected results for a pool or portfolio of independent observations can be approximated by the normal distribution
    - Shown graphically in Figure 2.2
    - Perfectly bell-shaped
- If risk managers know that their loss distributions are normal
  - They can assume that these relationships hold
  - They can predict the probability of a given loss level occurring or the probability of losses being within a certain range of the mean
- Binomial distributions require variables to be discreet
  - Normal distributions can have continuous variables

Figure 2-2: Normal Probability Distribution of 500 Losses



The Poisson Distribution

- Determine the probability of an event using the following formula
  - Mean of the distribution is also its variance
    - Standard deviation is equal to the square root of m

$$p = \frac{m^r e^{-m}}{r!}$$

  - *p* = probability that an event *n* occurs
  - *r* = number of events for which the probability estimate is needed
  - *m* = mean = expected loss frequency
  - *e* = a constant, the base of the natural logarithms, equal to 2.71828

The Poisson Distribution

- As the number of exposure units increases and the probability of loss decreases
  - The binomial distribution becomes more and more like the Poisson distribution
- Most desirable when more than 50 independent exposure units exist and
  - The probability that any one item will suffer a loss is 0.1 or less

Integrated Risk Measures

- Value at risk (VAR)
  - Constructs probability distributions of the risks alone and in various combinations
    - To obtain estimates of the risk of loss at various probability levels
    - Yields a numerical statement of the maximum expected loss in a specific time and at a given probability level
    - Provides the firm with an assessment of the overall impact of risk on the firm
    - Considers correlation between different categories of risk
- Risk-adjusted return on capital
  - Attempts to allocate risk costs to the many different activities of the firm
  - Assesses how much capital would be required by the organization's various activities to keep the probability of bankruptcy below a specified level

Accuracy of Predictions

- A question of interest to risk managers
  - How many individual exposure units are necessary before a given degree of accuracy can be achieved in obtaining an actual loss frequency that is close to the expected loss frequency?
- The number of losses for particular firm must be fairly large to accurately predict future losses

Law of Large Numbers

- Degree of objective risk is meaningful only when the group is fairly large
- States that as the number of exposure units increases
  - The more likely it becomes that actual loss experience will equal probable loss experience
- Two most important applications
  - As the number of exposure units increases, the degree of risk decreases
  - Given a constant number of exposure units, as the chance of loss increases, the degree of risk decreases

Number of Exposure Units Required

- Question arises as to how much error is introduced when a group is not sufficiently large
- Required assumption
  - Each loss occurs independently of each other loss, and the probability of losses is constant from occurrence to occurrence
- Formula is based on knowledge that the normal distribution is an approximation of the binomial distribution
  - Known percentages of losses will fall within 1, 2, 3, or more standard deviations of the mean

$$N = \frac{S^2\, p(1-p)}{E^2}$$

Number of Exposure Units Required

- Value of S indicates the level of confidence that can be stated for the results
  - If S is 1
    - It is known with 68 percent confidence that losses will be as predicted
  - If S is 2
    - It is known with 95 percent confidence
- Fundamental truth about risk management
  - If the probability of loss is small a larger number of exposure units is needed for an acceptable degree of risk than is commonly recognized