New FE Textbook Vol.2
IT Strategy & Management

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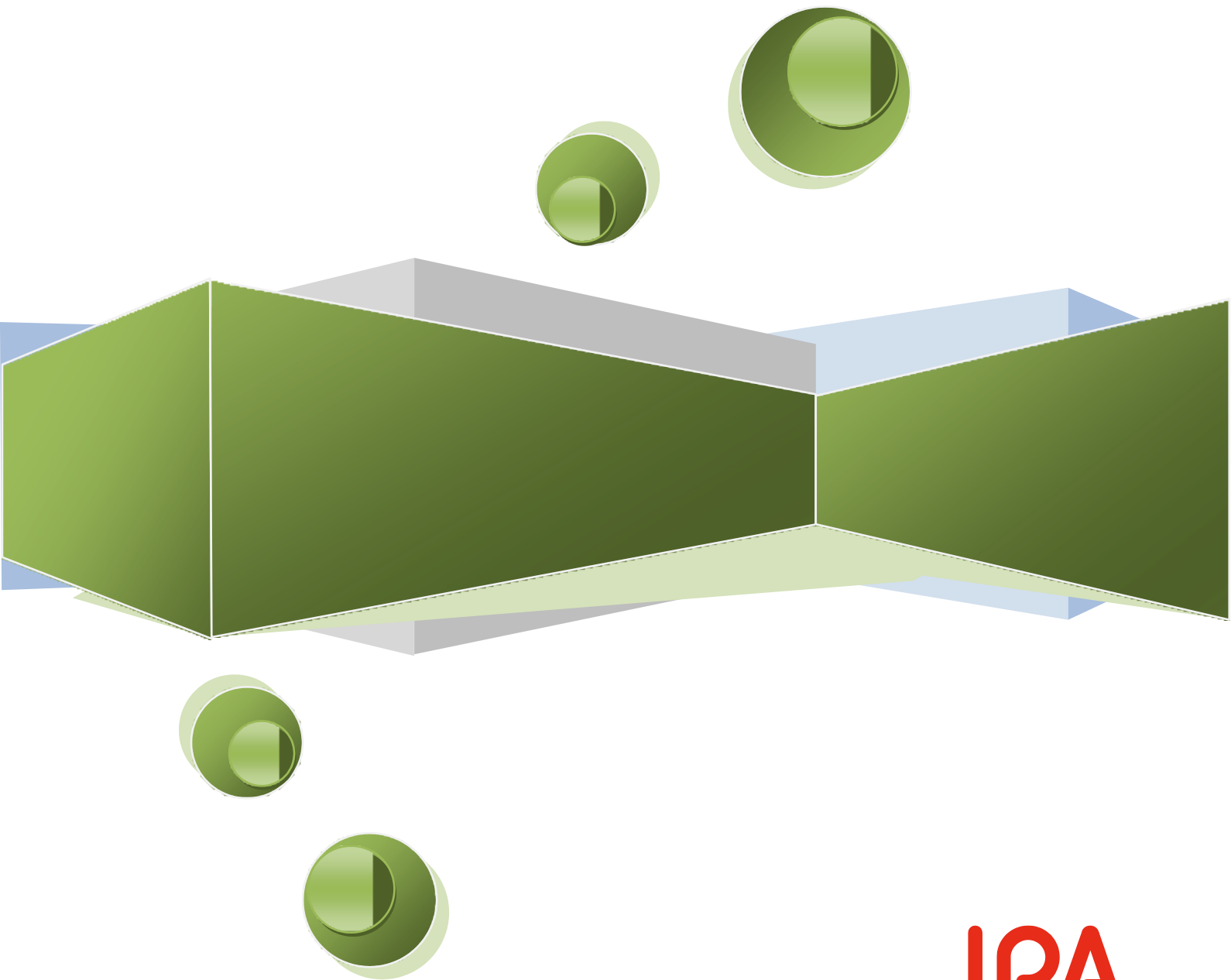
IT Strategy and Management

Introduction

1 Computers Within Companies

The activities of companies today are supported by a diverse range of information systems that make use of computer-based IT technologies. This is further described below through several typical examples of the information systems used within corporate activities.

(1) Business Management System

Business management system is an information system for the efficient management of corporate activities, customers, product/service quality, and other aspects of business, with the aim of stable corporate management.

Conventionally, business management system has comprised a jumble of systems supporting individual business operations. However, from the viewpoint of effectively utilizing management resources (people, things, money, and information), the concept is created for which ERP (Enterprise Resource Planning) for the integrated management of overall corporate activities is used. Therefore, these resources are now subject to unified management under ERP packages, and integrated business management system is now used to optimize management resources and boost management efficiency.

(2) Business System

This is a general name for the information systems that are used in areas of business. Business system includes distribution, financial, sales, and other diverse systems.

- Distribution information system

  This is a system that supports distribution overall, from transport planning and monitoring for goods to actual transportation.

- Financial information system

  This is a system for performing financial work in banks and other institutions. It includes systems to support administrative work in shops, in addition to financial transactions.

- POS (Point Of Sales) system

  This is a system for managing information concerning product sales. It reads product bar codes at store registers and is used in product sales management and in assessing sales trends.

- SFA (Sales Force Automation)

  This is a support system for effectively carrying out sales activities and raising productivity. It provides functions for unified management of customer information and standardization of sales processes, among other functions.

- Card system

  This is a system for the use of a variety of cards, including cash cards, credit cards, electronic money, and commuter passes.

This business system includes software (i.e., business package) that is sold commercially for use in the business field, and software that is developed within companies (or through outsourcing) for their own business operations.

(3) Engineering System

This is a general name for systems to support the production of industrial products. Engineering system includes a variety of systems, from systems for administrative processing that manages production information to control-related systems for industrial machinery and robots.

- CIM (Computer Integrated Manufacturing) system

  This is a system to enhance productivity in manufacturing or other industries by sharing and managing information ranging from product manufacturing to sales. This system, including business management system, is now positioned as a system to integrate and manage aspects ranging from business strategy to production.
- FA (Factory Automation)

  This is a general name for systems aimed at promoting computer-based automation in factories and increasing work productivity.
- FMS (Flexible Manufacturing System)

  This is an automated production system that integrates and controls manufacturing processes, ranging from management of resources to management of processes.
- FMC (Flexible Manufacturing Cell)

  "Cell" here refers to a unit of processing and assembly in manufacturing processes. FMC is a general name for systems that perform automated control of cells by using computers.

The information system above is not adopted in disordered fashion. The adopting companies establish business strategies for achieving company goals on the basis of their management principles and then adopt systems according to their concrete information systems strategies.
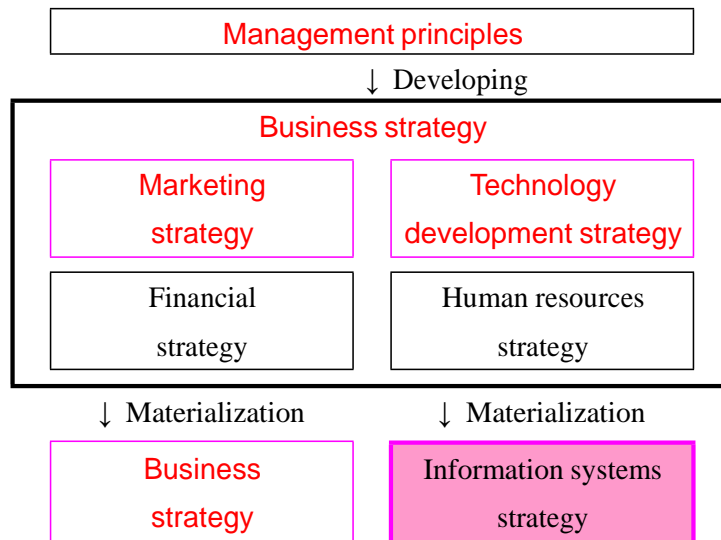
Here, it should be noted that the figure above is a generalized depiction, and that the relationships among business strategies can differ somewhat according to a given company's thinking and definitions.

2 The World Surrounding Companies and the Structure of this Textbook

Companies create a large number of strategies and use a variety of information systems to achieve those strategies as we discussed so far.

In this textbook, readers will learn about the world surrounding companies from the viewpoint of information processing engineers, as follows:

"Chapter 1 Corporate and Legal Affairs"
The first step toward understanding the world surrounding companies is to learn what a company is. Readers will learn about the corporate accounting and management science used within corporate activities, along with various related laws and regulations.

"Chapter 2 Business Strategy"
Readers will learn about methods for developing business strategies for achieving objectives (i.e., business objectives) as a company. Readers will also learn about business industries (i.e., industries related to the information systems used in business fields, and business industries using information systems).

"Chapter 3 Information Systems Strategy"
Readers will learn about methods for developing information systems strategies that make business strategies concrete. Readers will also learn about information system planning for the development of individual computerization plans for each information system adopted, on the basis of information systems strategy.

"Chapter 4 Development Technology"
Readers will learn about information system development technologies. Specifically, readers will learn about system development technologies for constructing systems overall, and software development methods for developing the software components of systems.

"Chapter 5 Project Management"
Readers will learn about the methods and technologies used in project management, which aims to achieve success in work or projects (e.g. system development) launched irregularly to achieve specified objectives.

"Chapter 6 Service Management"
Readers will learn about methods and technologies of service management for the stable and effective operations of information systems and for the maintenance and improvement of service quality.

"Chapter 7 System Audit and Internal Control"

Readers will learn about system audit to inspect and evaluate whether information systems are appropriately operated and managed. Readers will also learn about internal control, by which a company itself sets rules for the appropriate execution of work, and establishes and operates inspection systems.

3 The Relationship Between the ITEE and this Textbook

The ITEE (Information Technology Engineers Examination) is a national examination that is implemented by the IPA (Information Technology Promotion Agency, Japan) as a guidepost for the training of human resources in the information processing industry. Under a 2008 revision to the examination system, the ITEE has been mapped to Levels 1 through 3 of the Common Career/Skills Framework, with level determined upon success in the examination.

Level	Name of examination	Targeted human resources
Level 1	IT Passport Examination	Persons with basic knowledge of the information technology that should be common to professionals
Level 2	Fundamental Information Technology Engineer Examination	Persons who possess the necessary basic knowledge and skills for becoming advanced IT professionals, and also have acquired practical capabilities for making use of them.
Level 3	Applied Information Technology Engineer Examination	Persons who possess the necessary applied knowledge and skills, and also have established a direction, for becoming advanced IT professionals

This textbook is structured to allow learning with a focus on strategy and management related fields within the scope of the morning questions in the Fundamental Information Technology Engineer Examination of the ITEE. The following is the correspondence relationship between the Chapters of this textbook and the question areas of the Fundamental Information Technology Engineer Examination.

IT Strategy and Management		Question areas of the Fundamental Information Technology Engineer Examination
Chapter 1	Corporate and Legal Affairs	1 Basic Theory (Basic Theory [Applied Mathematics, etc.])
		9 Corporate and Legal Affairs (Corporate Activities)
		9 Corporate and Legal Affairs (Legal Affairs)
Chapter 2	Business Strategy	8 Business Strategy (Business Strategy Management)
		8 Business Strategy (Technological Strategy Management)
		8 Business Strategy (Business Industry)
Chapter 3	Information Systems Strategy	7 System Strategy (System Strategy)
		7 System Strategy (System Planning)
Chapter 4	Development Technology	4 Development Technology (System Development Technology)
		4 Development Technology (Software Development Management Techniques)
Chapter 5	Project Management	5 Project Management (Project Management)
Chapter 6	Service Management	6 Service Management (Service Management)
Chapter 7	System Audit and Internal Control	6 Service Management (System Audit)

Areas that are within the scope of morning questions but that are not covered in this textbook can be studied in "IT Fundamentals," published by our company.

The following is the correspondence relationship between the Chapters of "IT Fundamentals" and the question areas of the Fundamental Information Technology Engineer Examination.

IT Fundamentals		Question areas of the Fundamental Information Technology Engineer Examination
Chapter 1	Hardware	1 Basic Theory (Basic Theory [Discrete Mathematics, etc.])
		2 Computer System (Computer Component)
		2 Computer System (Hardware)
Chapter 2	Information Processing System	2 Computer System (System Component)
		3 Technology Element (Human interface)
		3. Technology Element (Multimedia)
Chapter 3	Software	2 Computer System (Software)
Chapter 4	Database	3 Technology Element (Database)
Chapter 5	Network	3 Technology Element (Network)

| Chapter 6 | Security | 3 Technology Element (Security) |
| Chapter 7 | Data Structure and Algorithm | 1 Basic Theory (Algorithm and Programming) |

This textbook is organized, as noted above, so as to allow mastery of the morning question areas of the Fundamental Information Technology Engineer Examination, when used together with "IT Fundamentals."

Moreover, since this textbook corresponds to Level 2 of the Common Career/Skills Framework, its study contents include the question areas of the Level 1 IT Passport Examination. The IT Passport Examination is an examination for all who have acquired the fundamental knowledge required of persons using IT.

With the use of this textbook and "IT Fundamentals," it is possible to take the IT Passport Examination and the Fundamental Information Technology Engineer Examination in order. We hope that this textbook will be of use in improving the reader's skills, with the aim of acquiring the desired qualifications.

Chapter 1
Corporate and Legal Affairs

1 Corporate Activities

Corporate activities are the business tasks and all other activities that are performed by a company according to the company's goals and policies. This section describes the nature of corporate activities, which are primarily focused on the purpose of those corporate activities.

1 - 1 Purpose of Corporate Activities

Corporate activities are activities that are conducted according to a company's corporate philosophy (management philosophy) which indicates the fundamental concept of all corporate courses of action (i.e., the views, reason for existence, action policies, values, etc. that influence the management of a company). The purpose of corporate activities is to increase profits and enable a company to semi-permanently continue to exist under healthy management.

[Basic flow of corporate activities]
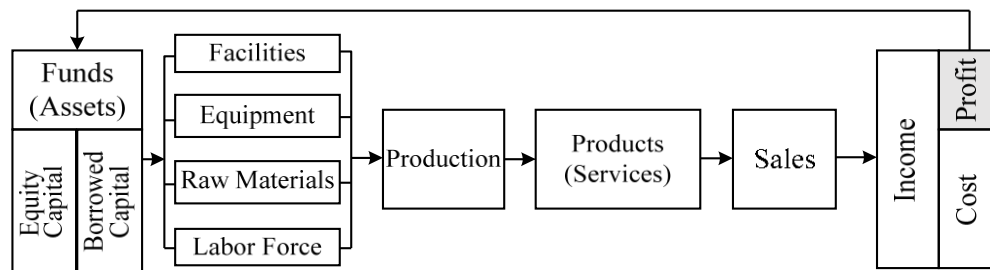
1) Prepare the funds that are required for production activities and sales activities.
2) Use the prepared funds to produce products (or services).
3) Pay out costs (e.g., employee wages, cost of sales) from the income that is acquired through sales of the products (or services). This results in a profit (or loss).
4) If it is profitable, distribute dividends to investors and use the remaining profit to maintain the company (e.g., as capital for the next fiscal year's corporate activities).

Companies that can smoothly execute these corporate activities are those that are organic organizations with the following multifaceted characteristics.

Characteristic	Content
Economic function	Performing commercial activities, such as the production, provision, and sale of goods and services.
Separation of ownership from management	Financiers (or owners) and managers/employees are separated.
Independence from market	The decision to continue corporate activities is left up to the company itself.
Collaboration system	Corporate activities are conducted by an organization that consists of multiple people who are cooperating together towards a common goal.

A company which has both multifaceted and organic characteristics successfully repeats the PDCA cycle (Plan, Do, Check, and Act) and plans for expansion in response to the present age and environment.

Another important purpose of corporate activities is contribution to society. Companies exist to gain profit, but companies that do not act in the interests of society cannot stand the test of time. The contribution to society as part of corporate activities leads to an increase in corporate value (and in turn, maintaining the company's existence).

The following are some concepts that are related to corporate activities for the contribution to society.

- CSR (Corporate Social Responsibility)

  CSR refers to the responsibilities of a company in response to requests that are received from citizens, local communities, or the current social climate through their corporate activities. Companies must take responsibility for the effects that their decisions and activities have on society and the environment.

  - Green IT

    Green IT refers to the promotion of energy conservation in today's whole modern IT-based society and the approach to the conservation of the global environment by reducing the energy that is consumed by computers, peripheral devices, network devices, and other IT-related devices and products, in addition to the efficient use of resources and other means.

  - CI (Corporate Identity)

    CI is a concept in which the existential value and significance of a company is clearly defined through CSR or other means in order to create awareness of the corporate brand.

- Corporate governance

Corporate governance covers the acts that are taken by a company in order to promote wholesome management practices for the purpose of earning the trust of the market and customers. It involves monitoring whether management has the ability and desire to meet the goals of the company and whether the company maintains accountability for its decisions and actions.

- Disclosure

    Disclosure is the act of publicizing the business and financial state of a company. Some disclosure is required by law, while other types of disclosure are left up to the discretion of the company. The latter type of disclosure is sometimes also referred to as IR (Investor Relations) because it acts as the provision of information for investors to base their investment decisions on. The broad definition of disclosure also includes information about products and the environment other than the business situation, and therefore can sometimes be considered as part of CSR.

- Going concern (Continuous Business Entities)

    This refers to the underlying prerequisite concept for any company that "the company can continue its corporate activities indefinitely and continue to meet its social responsibilities/missions." As long as this prerequisite is in place, investors can invest in the company and customers can use the services that are provided by the company.

    - BCP (Business Continuity Plan)

        This refers broadly to the plan of action and policies that are designed to avoid in advance or quickly recover from any damages that may result in a risk of an interruption of vital business activities, such as a disaster or failure. BCP also includes business impact analysis, which determines policies, such as the maximum allowed amount of business stoppage time upon analysis of the losses and the effects of an interruption of business activities.

1 - 2　Corporate Organizational Structure

1-2-1　Corporation Forms

Corporation forms represent the relationship between equity participants and corporations. Corporation forms are classified as described below, on the basis of whether equity participants are individuals, private entities, or public entities and the scope of equity participants' responsibilities.

- **Public enterprise** (First sector)

This refers to a company which is funded by countries or local public entities. In the fields of highly public business, this type of company is established for the purpose of enhancing public profit.

- **Private enterprise** (Second sector)

This refers to a company which is funded by individuals or private entities. This classification is further divided into individual proprietorship which is funded by a single individual, and incorporated enterprise (i.e., joint venture) which is funded by two or more equity participants. Incorporated enterprises are further classified as described below, in accordance with the Companies Act of Japan.

  - **Limited partnership** (Ownership and management are the same.)

  This classification encompasses the following three types of enterprises: **general partnership company** in which all employees are members with unlimited liability, **limited partnership company** which consists of both members with limited liability and members with unlimited liability, and **limited liability company** in which all employees are members with limited liability. The limited liability company is also referred to as "Japanese style LLC (Limited Liability Company)." There are also LLP (Limited Liability Partnership) which acts as an entity rather than as a corporation. The LLP system shows promise for business deployment in areas, such as academic-industrial alliances.

  - **Stock company** (Ownership and management are separated.)

  This company is established by one or more founders and acquires funds by issuing stock (i.e., stock certificates). Stock can be bought and sold privately, or listed on a securities exchange where it can be traded freely on the securities market through an **IPO (Initial Public Offering)**. Equity participants in this type of company are called **stockholders** and have limited liability.

    - **Stockholders' meeting**

    This is the highest decision-making body that establishes the basic policy rules for a stock company. Stockholders can attend stockholders' meetings and can exercise voting rights on the basis of the amount of stock in the company they hold.

    - **Board of directors**

    This is an organization where the chief executive officers, who acts as the external representative of the company, take the lead. It establishes important rules for how the company conducts business. The board of directors can also select outside directors not within their own organization.

    - **Auditor**

An auditor performs audits of accounting or the execution of operations by directors, and presents the results of those audits at stockholders' meetings. Large companies are required to have an auditor in place at all times.

- Mixed enterprise (Third sector)

  This refers to a company which is funded by "countries or local public entities" and "individuals or private entities."

- Other corporations (Fourth sector)

  This classification includes entities such as foundations that are established by individuals or private entities that do not distribute profits.

1-2-2 Corporate Hierarchy Structure

A corporate hierarchy structure represents the relationships between employees in a common corporation.

Corporate hierarchy structure
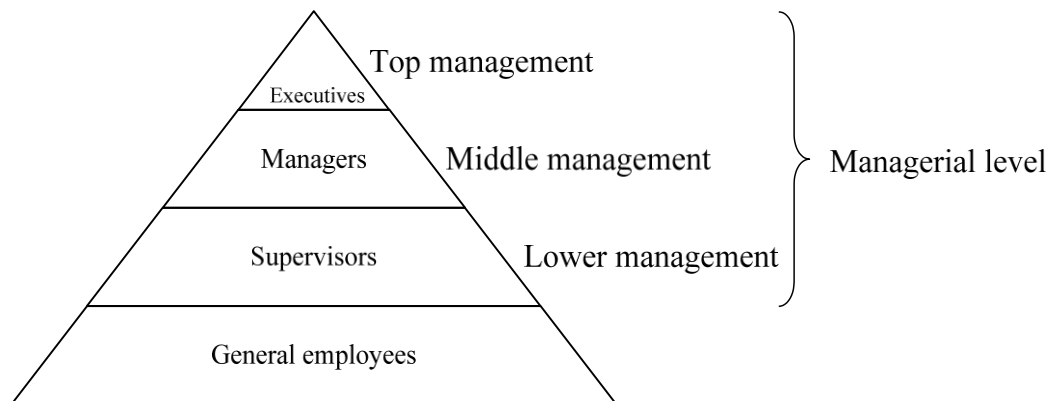
- Executive tier (Top management)

  This tier consists primarily of the people who make up the board of directors, such as the president, vice-president, and executive managing directors. The executives determine the overall direction of the company and make important company decisions.

- Management tier (Middle management)

  This tier consists primarily of middle management positions, such as department managers and section chiefs. These employees determine plans of action to achieve concrete goals from the intentions of the executive tier, and manage those in the supervisor tier and below.

- Supervisor tier (Lower management)

  This tier consists of on-site supervisors, such as assistant managers and chiefs.

These employees make concrete plans to meet specified goals and manage/direct actions to carry out those plans. They also supervise those in the general employee tier.

- General employee tier (Staff members)

  General employees are the on-site staff members who carry out business activities based on the direction of the management and supervisor tiers.

In the United States and many other countries, the following titles may be given to executives and management positions to further clarify their positions. These titles are also currently often used in Japan.

Abbreviation	Title
CEO	Chief Executive Officer
COO	Chief Operating Officer
CIO	Chief Information Officer
CFO	Chief Financial Officer
CISO	Chief Information Security Officer
CCO	Chief Compliance Officer
CCO	Chief Customer Officer

The CIO (Chief Information Officer) is a particularly important executive officer because they are in charge of information strategy planning and execution, including company-wide information management and information systems control. The CIO is also responsible for promoting the effective use of information systems (or services).

1-2-3 Management Organization

The management organization (corporate organization) is the organization form to conduct corporate activities. There are two concepts of management organization structures: vertical and horizontal.

- Hierarchical organization (Vertical structure)

  In a hierarchical organization, relationships are structured in a supervision-reporting structure (i.e., management-subordinates). Top-level management are at the top of the hierarchy, with all other tiers, such as departments, sections, and supervisors below. Therefore, this type of structure is also known as a pyramid organization. Generally, one manager is in direct supervision of multiple subordinates. However, the number of subordinates (span of control) he or she can directly supervise is said to be only five

> or six people.
> • Functional organization (Horizontal structure)
> In a functional organization, departments are divided up on the basis of specializations
> and roles, such as accounting, sales, or general affairs.

Most companies consist of a combination of these two types of organizational structures. Among these types of organizations, a flat management organization which utilizes an extremely small amount of middle management is known as flat organization.

In addition to the above management organizations, some companies may utilize a different organizational structure on the basis of their management policies and business objectives. The section below lists a variety of management organizations that are specialized for specific objectives.

(1) Line and staff organization

A line and staff organization is a management organization which consists of a line department in charge of tasks, such as production and sales, and a staff department which is in charge of tasks, such as general affairs and accounting. In this type of organization, the staff department follows (i.e., advices, supports) the line department which is in charge of directly performing business activities.
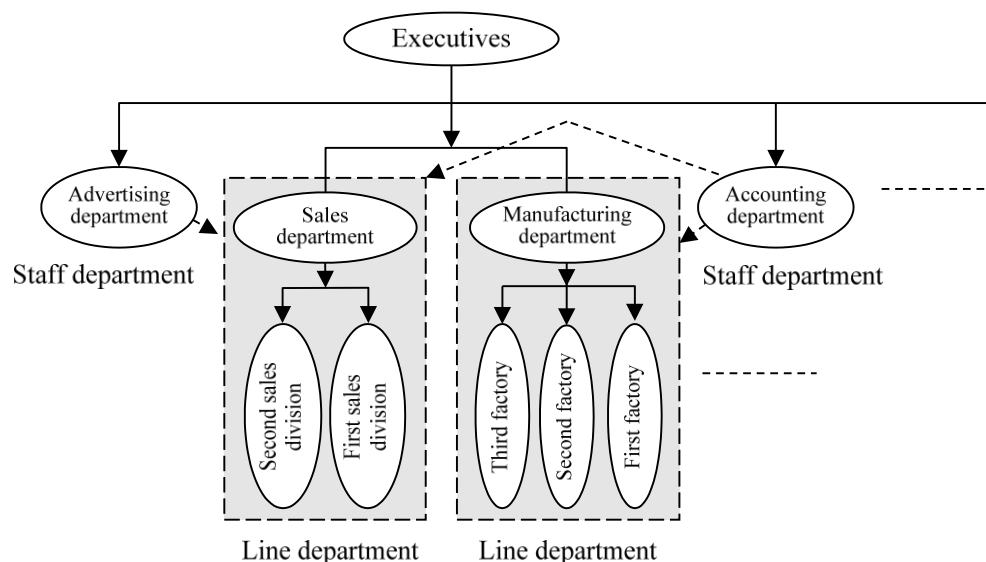
Figure 1-1　Line and staff organization

(2) Project organization

A project organization is a management organization that is formed temporarily as a group

of specialists from each department in order to resolve a specific problem (or reach a specific goal). It is a flexible type of organization which operates independently from all other standard organizations, with a pre-determined objective, period, budget, and set of resources.

(3) Matrix organization

A matrix organization is a management organization that establishes an exchange between project and functional organizations in order to flexibly respond to changes in the business environment. However, members of this type of organization must maintain a high level of responsibility and be flexible to adapt because there will be an overlap of permissions and responsibilities with other organizations. This may lead to a collapse of the "centralization of command."
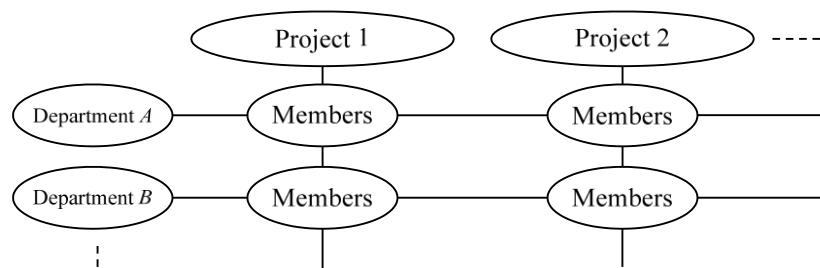
Figure 1-2   Matrix organization

(4) Divisional organization

A divisional organization is a management organization that divides manufacturing, sales, and other departments up into organizational units (i.e., divisions) such as by product, client, region, or project. Each of these divisions has its own responsibility for profit and has its own decision-making authority. Executives are committed solely to top management.

• In-house company system
  This is a management organization which incorporates independent accounting system to treat business divisions as independent, autonomous in-house companies. This type of organization is generally used to separate the core business activities of a corporation into a separate, autonomously managed entity. By integrating development, manufacturing, sales, and all other divisions into a single company, this provides greater organizational structure and improved environmental adaptation. However, this fragments the shared management resources of the overall company and makes company-wide optimizations more difficult to implement.
• In-house venture organization
  In this type of management organization, a new business activity or project is started

and executed as a semi-independent business. Full rights and responsibilities for the success of the business endeavor are given to the founder(s). This type of organization is used to deploy a venture business for a new product or service that is still managed by the parent corporation.

1 - 3 Business Management

Business management is the act of managing a company overall to ensure that corporate activities are conducted smoothly in order to achieve the company's goal that was established on the basis of the company's corporate philosophy (business objectives). Business management requires the procurement and optimal distribution of management resources.

Management item	Target managerial resource	
Human resource management	People	Human resources such as full-time or part-time staff members
Asset management	Things	Physical resources such as raw materials, machinery, or buildings
Financial management	Money	Financial resources such as capital and debt
Information management	Information	A wide range of information resources related to people, things, and money

Business management is performed via the PDCA cycle: Plan (i.e., establishment of a management plan), Do (i.e., implementation of the management plan), Check (i.e., inspection and evaluation of the status of current activities), and Act (i.e., improvement of known issues). Furthermore, TQM (Total Quality Management) must also be integrated to improve management quality along with company-wide risk management to maintain and improve corporate value. In the risk management, risk identification, analysis, and evaluation are performed. A BCP (Business Continuity Plan) is planned against risks that cause the interruption of business activities. The ISO TC (Technical Committee) ISO/TC 223 standardizes BCMS (Business Continuity Management System) that support BCM (Business Continuity Management) for continuing corporate activities in standards such as ISO 22301 "Societal security — Business continuity management systems — Requirements."

In today's society, much emphasis is also put on human resource management for "human." The following types of abilities are desired in human resources.

Ability	Overview
Leadership	The ability to lead and instruct people
Communication	The ability to convey desires, emotions, and thoughts to other people
Negotiation	The ability to conduct a dialogue of negotiation and trade with others
Technical Writing	The ability to write technical documents
Presentation	The ability to guide others to understanding and agreement through the presentation of information
Conflict Management	The ability to reduce or eliminate conflict through proper management
Logical Thinking	The ability to think in a logical and coherent manner
Brainstorming	The ability to generate novel, exciting ideas
Computer Literacy	The ability to make full use of computer systems

Motivation, or the will to achieve a certain goal or objective, is also an important element that is considered in human resources. Motivation management includes ideas, such as the hygiene theory which proposes that motivation is not promoted by simply eliminating dissatisfaction (i.e., hygiene factor) that causes a decrease in motivation and the XY theory which proposes that people hold opposing theories in the "control by direction theory X" and the "self-control theory Y."

The following explains some human resource development (or training) and management methods.

- OJT (On the Job Training)

  OJT is the education and training that are received while actual business activities are performed. Conversely, there is the training that is received while actual business activities are not performed, and it is called Off-JT (Off the Job Training).
- Case study/Role-playing/Debate/In-basket

  Case study aims to analyze and systematize problems on the basis of the past examples. Role-playing is used to experience simulated business activities. Debate involves discussions between two groups: for and against. In-basket involves processing a large number of issues that are put in the "in-basket" within a specific time period. These activities are education and training methods that can all be conducted by an individual or a group.
- e-Learning

  E-Learning is an education method that utilizes computers and other information devices for learning.
- Competency

Competency is the behavioral characteristics of employees who achieve a high level of performance. The quality of all employees has the potential to be raised by modeling this behavior and using it as a standard of evaluation for other employees.

- CDP (Career Development Plan)

CDP is a system that takes into account the specialization, workplace experience, and level of skill acquisition, and then creates a future plan for each individual with the aim of fulfilling the plan.

- Work-life balance

Work-life balance is a concept that emphasizes a proper balance between work and personal life.

- Mental health

Mental health is a concept that provides counseling and other services to limit and prevent negative psychological effects because of work-related stress and other factors.

- MBO (Management By Objective)

MBO is an objective-based management system in which the progress made towards objectives that is set by each individual employee is measured, evaluated, and managed in order to improve abilities and skills.

- Work-sharing

Work-sharing is a system in which a limited bracket of employment is shared by multiple workers through different combinations of work opportunities, working hours, and wages.

- Discretionary labor system

The discretionary labor system is a system in which actual working hours are left up to the discretion of the workers, and wages are paid out on the basis of the deemed working hours.

Business management also includes tasks that are related to changes in the business environment, such as globalization that spans across different countries or expansion into new business activities. Recent years have revealed a large number of changes in the business environment, from the change of internal environment where more employees work in satellite offices away from the head office and work from home or small offices in SOHO (Small Office Home Office) environments via telecommuting, to the change of external environment where investments are made only in corporations that fulfill their CSR (Corporate Social Responsibilities) in light of the dissemination of SRI (Socially Responsible Investments).

2　Corporate Accounting

Corporate accounting consists of financial accounting and management accounting. Financial accounting is performed in accordance with the Commercial Code, the Corporation Tax Act, and the Securities and Exchange Act which applies to organizations, such as publicly listed companies. Management accounting provides and manages information that is used to help executives in decision-making.

2 - 1　Financial Accounting

Financial accounting records and calculates business activities on the basis of commercial code and tax laws, and reports that information to stockholders, creditors, nations, and other entities.

2-1-1　Mechanism of Closing Accounts

Since corporate activities are conducted indefinitely, the accounting processing for a corporation is performed for a fixed period (from any desired date) known as a fiscal year (i.e., accounting term). In Japan, many companies operate on a fiscal year that starts from April 1 and ends on March 31 of the next calendar year. Closing accounts is the process of authoring financial statements (e.g., balance sheets, income statements (or P/L statement)) on the basis of accounting standards after the last day (i.e., account closing date) of the fiscal year and finalizing profit and loss. The accounting standards include IFRS (International Financial Reporting Standards) that is established as an international standard by the IASB (International Accounting Standards Board).

> **Workflow from transaction records (or journal book) to closing accounts**
>
> Journal book → General ledger → Trial balance sheet → Work sheet → Financial statements
>
> 1) Record all transactions that are conducted during the fiscal year in order of time in a journal book.
> 2) Organize the contents of the journal book by account title, and transfer that information into the general ledger.
> 3) Create a trial balance sheet to confirm that the information is transferred correctly.
> 4) Apply the closing account adjustment information that is performed on the account closing date to the trial balance sheet, and create a work sheet.
> 5) Create the financial statements (e.g., balance sheets, income statements (or P/L
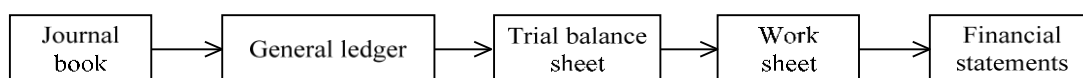
statement)) from the work sheet.

The items applicable for closing accounts are any of those that are related to a change in assets, liabilities, net assets, income, and cost. Corporate activities which are only contract-based do not apply. However, any uniquely held "goodwill" assets with intangible value are evaluated as a monetary value amount and are therefore applicable for closing accounts. Publicly traded companies must create an earnings summary (i.e., advance earnings report) and submit that information to the securities exchange according to the common forms of the securities exchange when it publicizes its closing of accounts.

The consolidated accounting system was introduced in the year 2000, which treats parent companies, subsidiaries, and all other related companies as a single organization, and therefore, must perform closing accounts for the entire organization as a whole. In such cases, the equity method may also be employed in which the financial status of companies in which a firm holds a significant investment is applied to the earnings report even though those companies are not considered consolidated subsidiaries.

2-1-2 Financial Statements

(1) B/S (Balance Sheet)

B/S (Balance sheet) is a financial statement that is intended to clearly indicate the financial situation of a company at a specific point in time (e.g., normally the end of a fiscal period) by showing assets, liabilities, and net assets.

[Balance sheet structure]
The left side (debit) shows assets, while the right side (credit) shows liabilities and net assets (capital).

Debit	Credit
Assets	Liabilities
	Net Assets (Capital)

• Assets
  These are the rights (or claims) that a company can obtain cash in the future.
  • Current assets: These are cash on hand, bank deposits, accounts receivable, and other forms of assets that can be converted to cash in a short period of time.
  • Fixed assets: These are tangible fixed assets, such as buildings and

machinery, and intangible fixed assets, such as intellectual property rights and software.

- Deferred assets: These are costs that have the potential to create profit, such as research and development cost.

- Liabilities (borrowed capital)

These are debts that must be paid by the company sometime in the future.

- Current liabilities: These are payments (i.e., trade account payable) for products and other short-term payment costs.

- Fixed liabilities: These are company-issued bonds, long-term debts from a financial institution, etc.

- Reserves: These are money in reserves for specific expenditures or losses.

- Net assets (equity capital, capital stock)

These are the amounts after subtracting total liabilities from total assets.

- Capital: This is funds for running the company.

- Legal reserves: These are the amounts of reserves that are required to be saved according to the Companies Act.

- Remainder: This is the amount of net assets that exceeds the amount of capital (i.e., legal capital).

A balance sheet is named as it is called so because the total on the debit side (i.e., assets) must be the same total on the credit side (i.e., liabilities, net assets). Therefore, the following equalities must always be completed.

Balance sheet equality	Assets = Liabilities + Net assets = Borrowed capital + Equity capital
Net assets equality	Net assets = Assets − Liabilities

The amount of profit (i.e, current period net profit) and loss (i.e., current period net loss) can also be determined by comparing the balance sheets for the previous and current periods.

Accurate asset management is important to account for all assets that are owned by the company in order to create accurate and correct balance sheets. The following concepts are applied in asset management.

(i) Depreciation

Value of buildings and equipment goes down in the course of being used. The reduction amount of value (i.e., depreciation) is included in a cost, and the amount is subtracted from the acquisition cost of those assets in order to perform the depreciation. Depreciation cost (i.e., the amount of depreciation) can be calculated by using the following methods.

- Straight-line method

  In the straight-line method, the salvage value is subtracted from the acquisition cost, and then the amount of difference is divided by the number of years of useful life. The depreciation cost is fixed for all fiscal years. This method is most often used for buildings and other intangible fixed assets.

  $$\text{Depreciation cost} = \frac{\text{Acquisition cost} - \text{Salvage value}}{\text{Number of years of useful life}}$$

- Fixed-rate method

  In the fixed-rate method, the non-depreciated balance at the end of each period is multiplied by a fixed depreciation ratio. The depreciation cost is highest for the first fiscal year, and gradually decreases over time.

  $\text{Depreciation cost} = \text{End of period non-depreciated balance} \times \text{Depreciation ratio}$

(ii) Lease contract

This is a long-term contract for borrowed devices, equipment, or other assets from a leasing company. If such a contract is canceled during the contract period, a penalty must be paid, and all maintenance costs for leased equipment are paid for by the borrower. In many cases, it is possible to purchase the leased equipment at the end of the leasing period for a discounted price. At one time, assets that were borrowed by leasing were not included in balance sheets (off-balance), but this rule was changed because there were cases of abusing it, and now these assets must be included in balance sheet calculations. There is also a rental contract which has less restrictions than lease contract. Rental contract is a short-term borrowing contract (generally around one year) which allows mid-term cancellation. Maintenance costs for borrowed equipment are also covered by the rental company.

(iii) Inventory valuation

This is the assessment of the value of inventory (e.g., products, services) at the time of closing account. Inventory can be converted into cash through sales, so it is counted within current assets.

- First-in first-out method

  In the first-in first-out method, the inventory unit price is calculated by treating products that are purchased first as sold first.

- Periodic average method

  In the periodic average method, the inventory unit price is determined by dividing the total purchase amount by the total quantity of items purchased.

- Moving average method

  In the moving average method, the following expression is used to calculate the inventory unit price every time a product is purchased.

$$\text{Inventory unit price} = \frac{\text{Inventory amount} + \text{Purchased amount}}{\text{Inventory quantity} + \text{Purchased quantity}}$$

- Final acquisition cost method (Final purchase cost method)

  In the final acquisition cost method, the unit price of the last product purchased is used as the inventory unit price.

(2) Income statement (or Profit and Loss (P/L) statement)

An income statement (or Profit and Loss (P/L) statement) is a financial statement that shows "cost/profit and income" or "cost and income/loss" to clarify a company's business performance over a specified period (normally the fiscal year).

[Income Statement (Balance form) structure]

The left side (debit) shows cost while the right side (credit) shows income. If income is greater than total costs, the debit side shows profits. If the opposite is true, the credit side shows loss.

Debit	Credit
Cost	Income
Profit	

Debit	Credit
Cost	Income
	Loss

- Cost

  This is the cost (e.g., cost of sales, payroll) that was required to conduct corporate activities plus the costs (e.g., interest on payments, fees) outside of corporate activities.

- Income

  This is the operating income (e.g., sales, revenue) that is obtained through corporate activities plus other income (e.g., interest received, dividends) that is obtained

> through other means.
> • Profit and loss
> This is the difference between income and cost. This represents the operating performance of a company over a specified period.

The following expressions are completed because the total debit and credit must also the same on income statements.

Income statement equality	If there is a profit	Income = Cost + Profit
	If there is a loss	Cost = Income + Loss

Costs must be recorded accurately in order to correctly create an income statement. Cost of sales (i.e., the selling cost for products) that is the cost for obtaining operating income is calculated differently for product sales (i.e., commercial bookkeeping) and for manufacturing (i.e., industrial bookkeeping).

> • For product sales
> Cost of sales   = Beginning of period goods inventory
>   + Current period amount of goods purchased
>   − End of period goods inventory
> • For manufacturing
> Manufacturing cost   = Current period material cost
>   + Current period labor cost + Current period expenses
> Product manufacturing cost = Beginning of period work in progress inventory
>   + Current period manufacturing cost
>   − End of period work in progress inventory
> Cost of sales   = Beginning of period product inventory
>   + Current period product manufacturing cost
>   − End of period product inventory

In order to calculate cost of sales, inventory asset management is important. If the purchase unit price varies even amongst the same types of products, the inventory unit price must be calculated by using a method, such as the first-in first-out method, periodic average method, moving average method, or final acquisition cost method (Final purchase cost method).

There are two types of costs: direct costs which are directly related to specific business activities or products, and indirect costs (or overhead costs) which are indirectly related. However, there is no need to distinguish between these two types of costs when overall costs

are considered.

Income statements can also be formatted as a report form as well as a balance form. Report form income statements are not formatted by debit and credit, but instead the income, cost, and profit/loss are listed in order from the top for each category.

Classification (Account title)	Explanation
Sales (Operating income)	The amount of sales of products and/or services
Cost of sales (Cost)	The cost of raw materials, manufacturing costs, or purchase costs for products and/or services
Gross profit or gross loss	The profit (or loss) from only sales of products and/or services [Sales − Cost of sales]
Selling, general and administration expense	Sales expenses, such as advertising costs, and overall company administration costs
Operating profit or operating loss	Profit (or loss) that is obtained from the results of operating activities [Gross profit − Selling, general and administration expense]
Non-operating income	Income from non-operating activities, such as interest received or dividends
Non-operating expense	Any non-operating activity costs, such as interest expense.
Current profit or current loss	Profit (or loss) that is obtained from the results of corporate business activities [Operating profit + Non-operating income − Non-operating expenses]
Extraordinary profit	Profit from exceptional sources (e.g., sale of fixed assets) other than normal business activities
Extraordinary loss	Loss because of reasons (e.g. natural disasters) other than normal operating activities
Net profit before tax for current period or net loss before tax for current period	Profit (or loss) that is obtained as the final result of business activities [Current profit + Extraordinary profit − Extraordinary loss]
Corporate tax and other taxes	Total taxes, such as a corporate tax and a residential tax
Net profit for current period or net loss for current period	The amount of profit (or loss) that is left in-hand [Net profit before tax for current period − Corporate tax and other taxes]
Retained earnings carried forward to next period	Profit (i.e., earnings retained) after appropriation of profits (e.g., stockholder dividends, executive bonuses, earned surplus reserves, voluntary reserves) from the net profit for the current period

Example: Calculate each profit from the following income statement (report form).

Unit: million yen

Income statement	
I. Sales	980
II. Cost of sales	650
Gross profit	☐
III. Selling, general and administration expense	210
Operating profit	☐
IV. Non-operating income	60
V. Non-operating expense	80
Current profit	☐

• Gross profit

$= \text{Sales} - \text{Cost of sales}$

$= 980 - 650$

$= 330$

• Operating profit

$= \text{Gross profit}$

$\quad - \text{Selling, general and administration expense}$

$= 330 - 210$

$= 120$

• Current profit

$= \text{Operating profit} + \text{Non-operating income} - \text{Non-operating expense}$

$= 120 + 60 - 80$

$= 100$

(3) Other financial statements

In addition to balance sheets and income statements, there are also the following types of financial statements.

(i) Cash flow statement

This is a financial statement that represents a balance of accounts for funds (i.e., cash) during the accounting period in the following three activity classifications: operating activities, investment activities, and financial activities. Since this represents cash flow, if cash (even from borrowed money) increases, cash flow increases.

• Cash flow accounting

This is a method of accounting which focuses on changes in the amount of cash (e.g., cash on hand, and deposits). Even though balance sheets and income statements show a profit, there could be cases of insufficient cash for payments depending on when deposits are received or other factors. This type of situation can be avoided by using cash flow accounting to keep an eye on cash flow.

• Cash flow management

This is a management method which focuses on cash flow. This management method focuses on how much cash can be obtained, not on assets and profit on the balance sheets and income statements

> • Cash management
>
> This is a management method which involves drafting a fund plan for procuring fund in consideration of the timing of income and cost so that there will always be enough fund on hand.

(ii) Statements of shareholders' equity

This is a financial statement which shows the amount of change in net assets (e.g., capital stock) on the balance sheet. This type of statement is created to determine changes in net assets during an accounting period. Net assets are classified into capital stock, valuation and conversion difference, share options, and minority interests, and then specified along with the amount of change in each of these types.

(iii) Consolidated financial statement

This is a financial statement which is created when consolidated accounting is used. The consolidated accounting treats parent companies, subsidiaries, and all other related companies as a single organization, and therefore, must close accounts for the entire organization as a whole. They include financial statements, such as consolidated balance sheets, consolidated income statements, consolidated cash flow statements, and consolidated statements of shareholders' equity.

(iv) Appropriation statement

This is a financial statement which shows information, such as current period unappropriated profit, appropriation of profit amount, or surplus profit carried forward to the following period.

(v) Annual securities report

This is a report which discloses financial conditions and other relevant data in order to aid in making fair investment decisions.

2-2 Management Accounting

Management accounting is a method of accounting in which financial and income calculations are performed and managed separately for departments and products in order to facilitate the decision-making (e.g., reviewing corporate activities, establishing management planning) of top management.

2-2-1 Business Analysis

Business analysis is performed to make business decisions by understanding of processes that is required from recording transaction information (i.e., slips) to creating closing account documents, and to read the results of corporate activities in the form of closing account documents.
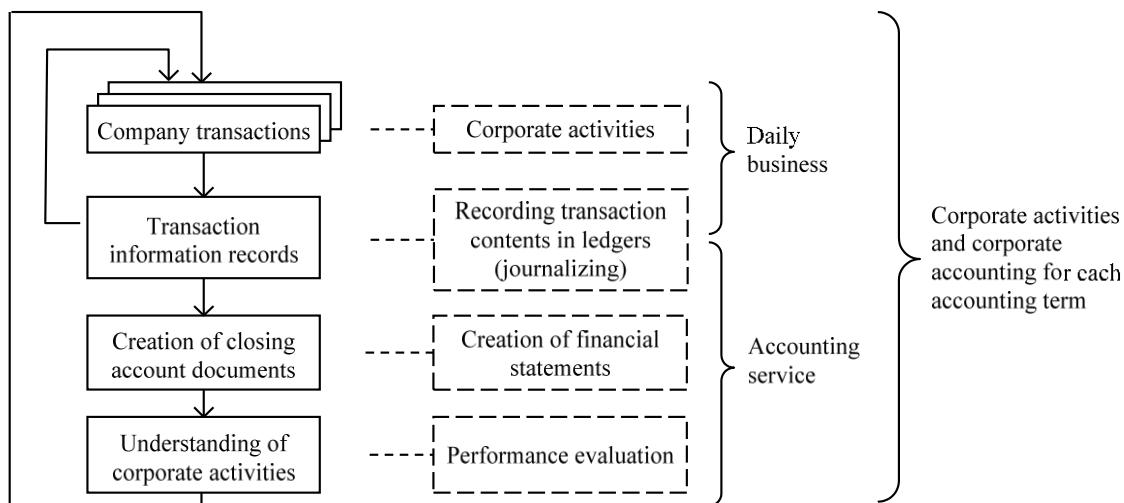
Figure 1-3   Flow of transaction information

(1)   Financial indicator

A financial indicator is an index which is represented as a relationship (i.e., ratio) between account titles on closing account documents that are used in business analysis. Some examples of financial indicators are as follows:

(i)   Income indicator (net profit indicator)

This is a financial indicator that is used to analyze how efficiently a company is gaining income from an income perspective. Some examples of income indicators are: ROE (Return On Equity), ROA (Return On Assets), ratio of gross profit to net sales (gross profit ratio), ratio of costs to net sales, total capital turnover, and total asset turnover. All of these indicators represent the operational efficiency of capital that was invested into the business activities of a company, and are also used as rough indication for ability to pay dividends.

• ROE (Return On Equity)	• ROA (Return On Assets)
This is the ratio of net profit for current period to equity capital.	This is the ratio of net profit for current period to total assets (= borrowed capital + equity capital = total capital).
$$ROE = \frac{\text{Net profit for current period}}{\text{Equity capital}}$$	$$ROA = \frac{\text{Net profit for current period}}{\text{Total assets}}$$

(ii) Profitability indicator

This is a financial indicator that indicates an investment effect, such as ROI (Return On Investment). It is a type of income indicator, and is often used in economic efficiency calculations (or economical efficiency analysis) and in determining payout periods.

> • ROI (Return On Investment)
> This is the ratio of profit to an investment amount.
> $$ROI = \frac{\text{Profit}}{\text{Investment amount}}$$

(iii) Safety indicator

This is a financial index that is used to analyze if the asset management is sufficient for business activities, if there is sufficient paying ability, and other financial conditions. This is also known as a liquidity index. Some examples of safety indicators are equity to total assets, current ratio, quick ratio, and debt ratio.

• Equity to Total Assets	• Current ratio
This indicates long-term/latent paying ability. The higher this ratio, the safer the operation of the company.	This indicates current paying ability. The higher this ratio, the more cash flow the company has, and therefore, the operation of the company is safe.
$$\text{Equity to total assets} = \frac{\text{Equity capital}}{\text{Total capital}}$$	$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

(2)   Economic efficiency calculation (Economical efficiency analysis)

Economic efficiency calculation (economical efficiency analysis) is a form of business analysis which involves selection of the most economical plan amongst multiple candidate

plans at the time of decision-making. In the course of business management, plans must be drafted for production, sales, and logistics, human resources, quality and technical improvement, capital investment, and other important business decisions. Economic efficiency calculation clarifies the objective and targets of comparison, and is used to analyze the relationships between income and cost for each plan in terms of cash flow to investigate the changes in profits.

- ROI method (Return On Investment method)

  This is a method of making decisions on the basis of ROI (Return On Investment).
- PBP method (PayBack Period method)

  This is a method of making decisions on the basis of the length of payout periods.
- NPV method (Net Present Value method)

  This is a method of making decisions on the basis of a comparison of the investment amount and the current value of payback amount.
- IRR method (Internal Rate of Return method)

  This is a method of making decisions on the basis of the discount rate at which the net present value of the payback amount and the investment amount are equal.

2-2-2 Break-even Point Analysis

Break-even point analysis is a method of analysis which is used to determine the break-even point, when operating profit is zero and there is no profit or loss. This data is useful for profit planning and other planning. However, opportunity loss (e.g., sales lost because of out of stock) is not counted in the loss that is mentioned here.

(1) Profit planning

Profit planning refers to business activity planning in order to set profit goals that are required in a specific future period and achieve those goals. Break-even point analysis is an especially effective method for short-term profit planning. It is necessary to understand how costs change in response to changes in factors, such as sales or production, and then establish an optimal profit plan.

(2) Direct cost accounting

Direct cost accounting is a method of cost control that is used in profit planning. In direct cost accounting, a cost is classified and controlled as follows:

- **Fixed cost**

  This is a constant cost that is incurred without relation to factors, such as sales or production quantity. This cost is required to maintain sales or production activities. It is incurred even if the sales amount and production quantity are all zeros. For example, fixed cost includes a rental fee, an insurance premium, a tax and due, a depreciation cost, and such other cost.

- **Variable cost**

  This is a cost that increases or decreases in response to factors, such as sales or production quantity. For example, variable cost includes a direct material cost, a packing/shipping cost, a sales commission, a packaging cost, a percentage pay and such other cost.
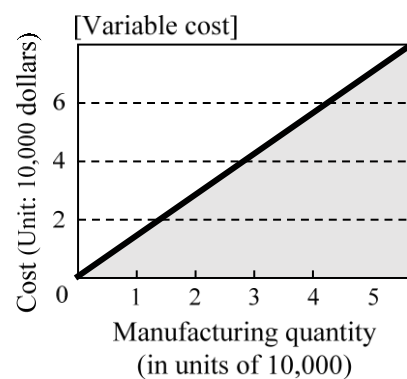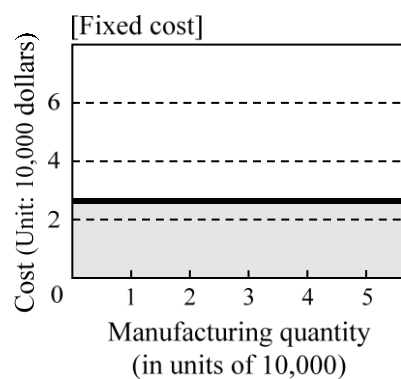
The ratio of fixed cost to sales is the **fixed cost ratio**. The ratio of variable cost to sales is the **variable cost ratio**.

$$\text{Fixed cost ratio} = \frac{\text{Fixed cost}}{\text{Sales}} \qquad \text{Variable cost ratio} = \frac{\text{Variable cost}}{\text{Sales}}$$

(3) Marginal profit (Contribution margin)

Marginal profit (**contribution margin**) is the amount of profit (i.e., profit + fixed cost) that can recover fixed cost. The ratio of marginal profit to sales is called the marginal profit ratio. The sum of the marginal profit ratio and variable cost ratio must equal 1 (100%).

$$\text{Marginal profit} = \text{Sales} - \text{Variable cost}$$
$$= \text{Operating profit} + \text{Fixed cost} \Rightarrow \text{Operating profit} = \text{Marginal profit} - \text{Fixed cost}$$
$$\text{Marginal profit ratio} = \frac{\text{Marginal profit}}{\text{Sales}} = 1 - \frac{\text{Variable cost}}{\text{Sales}}$$
$$\Rightarrow \text{Marginal profit ratio} + \text{Variable cost ratio} = 1$$

(4) Break-even point sales

Break-even point sales refers to the volume of sales at the break-even point. Break-even point sales can be calculated by using the following expression if the fixed cost, variable cost, and sales volume are known.

$$\text{Break-even point sales} = \cfrac{\text{Fixed cost}}{1 - \cfrac{\text{Variable cost}}{\text{Sales}}} = \frac{\text{Fixed cost}}{1 - \text{Variable cost ratio}}$$

$$= \frac{\text{Fixed cost}}{\text{Marginal profit ratio}}$$

For example, with the fixed cost of $45K, the variable cost of $36K, and the sales of $90K, the break-even point sales can be calculated as follows:

Break-even point sales = $45K ÷ (1 − $36K ÷ $90K) = $75K

Break-even point sales can also be calculated by using a profit chart (or break-even point chart) other than using formulas. A profit chart is a chart that shows the relationship between sales and cost/profit.
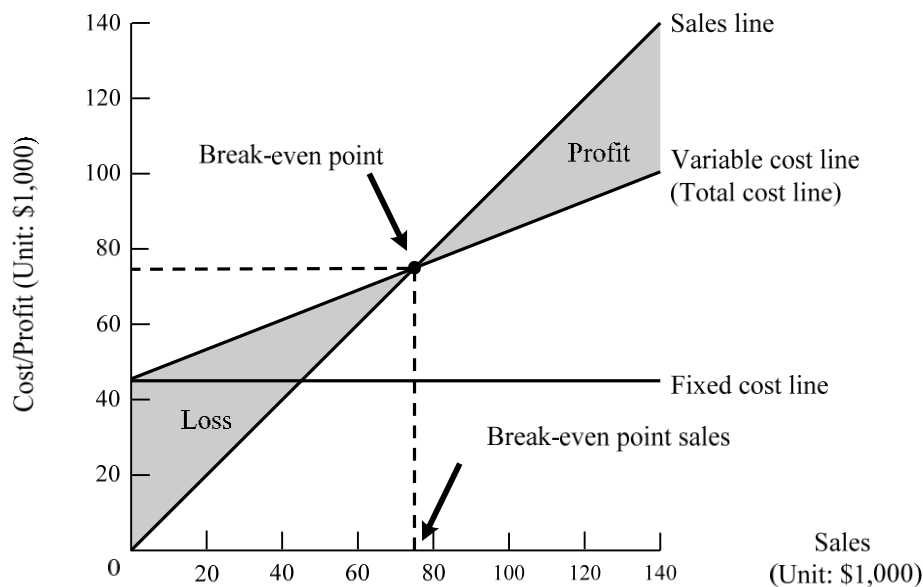
Figure 1-4　Profit chart

3 Management Science

Management science is an academic field which uses mathematics to determine the optimal methods or numeric values that are required to solve specific problems and to support business management. This section explains the applied mathematics that form the basic methodologies of management science, and after that, some of the most common management science methods.

3-1 Applied Mathematics

3-1-1 Set

A set is a collection of elements (e.g., numbers, things, or events) that meet the conditions listed below. For example, a collection of "30 year old Japanese people" can be a set, but a collection of "young people" is not called a set.

[Conditions for a set]
When an element is taken out from a set, it must be clearly identifiable as an element of that set.

The event that becomes an element in the set can be of the following types:

- Whole event: All possible events
- Elementary event: Each single event which will occur in actual situations
- Complementary event: An event wherein its negative (i.e., negation of the event) will take place)
- Exclusive event: An event which cannot occur simultaneously with another event

For example, the following whole event U represents the spots of a dice when the dice is thrown, and is defined as follows:

$$U = \{1, 2, 3, 4, 5, 6\}$$

The event E which represents an odd spot when the dice is thrown, and the complimentary events $\overline{E}$ are defined as shown below. In this case, the event E and the complimentary event $\overline{E}$ are mutually exclusive.

$$E = \{1, 3, 5\} \qquad \overline{E} = \{2, 4, 6\}$$

Venn diagram can be used as shown in Figure 1-5 to demonstrate the relationship between

events. In this example, the elementary events {1, 2, 3, 4, 5, 6} make up the elements of the set.
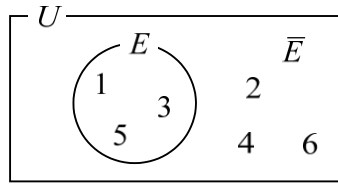
Figure 1-5　Venn diagram

Here, there is a set of nine cards with the number 1 through 9 on them. If a universal set is *U*, the set *A* of "numbers that are multiples of 2"and the set *B* of "numbers that are multiples of 3" can be represented in the following Venn diagram.
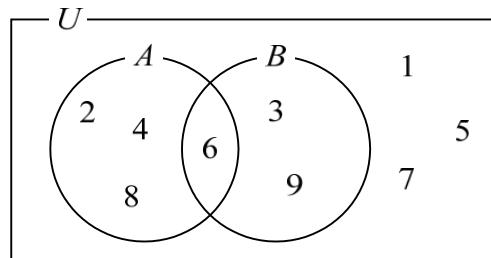
Figure 1-6　Venn diagram for card set

If the elements of each set are taken out from the Venn diagram in Figure 1-6, each set is defined as follows:

$U = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$
$A = \{2, 4, 6, 8\}$
$B = \{3, 6, 9\}$

A set of equal elements in two different sets is called a product set (intersection set). A product set is represented by the "∩" (AND) symbol.

$A \cap B = \{6\}$
Note: The set of numbers that are at once a multiple of 2 and a multiple of 3.

On the other hand, the set of elements that are included in either of two sets is known as a union set. A union set is represented by the "∪" (OR) symbol.

$A \cup B = \{2, 3, 4, 6, 8, 9\}$
Note: The set of numbers that are a multiple of 2 or a multiple of 3.

The elements {1, 5, 7} are not in set *A* nor set *B*. This means that {1, 5, 7} is a result of the difference which the union set $A \cup B$ is subtracted from the universal set *U*. This type of set, which is determined by the difference between two sets, is known as a difference set and is represented by the symbol "–". The set of elements {1, 5, 7} can be represented as follows:

> $U - (A \cup B) = \{1, 5, 7\}$
>
> Note: The set of numbers that are not a multiple of 2 nor a multiple of 3.

Since *U* is the universal set, the set of elements {1, 5, 7} can also be regarded as the negation of the union set $A \cup B$ for the universal set. The set of elements that are not included in a specific set is known as the complement set, and is represented by the symbol "‾".

> $\overline{A \cup B} = \{1, 5, 7\}$

The symbols ("$\cap$", "$\cup$", and "‾") which have been used at so far in this section are called set operators. These set operations are summarized by using a Venn diagram as follows:
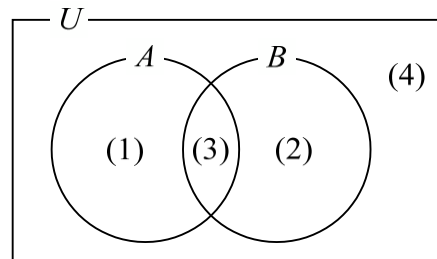
(1)   ··· *A* AND "NOT *B*"   => $A \cap \overline{B}$
(2)   ··· "NOT *A*" AND *B*   => $\overline{A} \cap B$
(3)   ··· *A* AND *B*   => $A \cap B$
(4)   ··· "NOT *A*" AND "NOT *B*"   => $\overline{A} \cap \overline{B}$
          NOT "*A* OR *B*"   => $\overline{A \cup B} = U - (A \cup B)$

When (4) above is focused on, it can be said that "the product set of the negation of set *A* and the negation of set *B* ($\overline{A} \cap \overline{B}$) is the same as the negation of the union set of set *A* and set *B* ($\overline{A \cup B}$)."

This is known as De Morgan's laws, and can be summarized as below.

$$\overline{A \cup B} \quad = \quad \overline{A} \cap \overline{B}$$ Note: The complement set of the union set is equal to the product set of the complement set.

$$\overline{A \cap B} \quad = \quad \overline{A} \cup \overline{B}$$ Note: The complement set of the product set is equal to the union set of the complement set.

(1) through (4) above are subsets of the universal set U. A subset is a set that is part of a larger set. This concept can also be applied to other types of sets other than universal sets.

[Examples of subsets]
- (1) is a subset of set A.
- (3) $A \cap B$ is a subset of set $A \cup B$.

3-1-2 Proposition

A proposition is a sentence which can be uniquely determined as either True (i.e., correct) or False (i.e., incorrect).

"I am Japanese." ⋯ This is a proposition. (The statement can be determined as either true or false.)

"I am pretty." ⋯ This is not a proposition. (The definition of "pretty" is unclear, so this statement cannot be clearly determined as true or false.)

Propositional logic is a concept which analyzes relationships among multiple propositions and deduces new propositions (i.e., compound proposition) by other propositions with the use of join operations ($\neg$: negation, $\rightarrow$: if, then).
Propositional logic is explained with the use of the following two propositions (P and Q) as examples.

Proposition P: It is raining.
Proposition Q: I am putting up an umbrella.

The following four relationships can be derived from the two propositions P and Q.

Relationship	Expression	Meaning
Implication	$P \rightarrow Q$	If P, then Q. (If it is raining, then I am putting up an umbrella.)
Converse	$Q \rightarrow P$	If Q, then P.

		(If I am putting up an umbrella, then it is raining.)
Reverse	$\lnot P \to \lnot Q$	If not *P*, then not *Q*. (If it is not raining, then I am not putting up an umbrella.)
Contraposition	$\lnot Q \to \lnot P$	If not *Q*, then not *P*. (If I am not putting up an umbrella, then it is not raining.)

In this example, the statement of the contraposition is the only one where the fact of the true or false matches the implication ($P \to Q$) regardless of the true or false values of the individual propositions *P* and *Q*.

In propositional logic, the propositions themselves are not considered for analysis. For a concept of analysis of propositions as subjects and predicates, a predicate logic is used.
Inference is used in both propositional logic and predicate logic. Inference is the process of extracting a new principle from an established event (i.e., fact), and has the following methods:

• Deduction inference
  If $X \to Y$ and $Y \to Z$, then it is inferred that $X \to Z$. This is a common concept that is known as syllogism.

$X \to Y$	Tama is a cat.	=>	$X \to Z$	Tama says meow.
$Y \to Z$	Cat says meow.			

• Inductive Inference
  If $X1 \to Y$ and $X2 \to Y$, then it is inferred that $X \{X1, X2, \cdots\} \to Y$. This is a concept of generalizing an individual event.

$X1 \to Y$	The cat in my house says meow.	=>	$X \to Y$	Cat says meow.
$X2 \to Y$	The neighbor's cat says meow.			

A relational model is a model that is devised from set theory and predicate logic. Propositional logic and predicate logic are also used in relational databases which use relational models.

3-1-3 Probability

Probability is the ratio of the number of times the specific event (elementary event) occurs to the number of times the whole event occurs. (This type of probability is referred to as mathematical probability.)

The number of times the whole event occurs or the number of times the specific event occurs is known as the number of cases. If it is impossible to count the number of cases, it can be calculated by using one of the following two methods.

> • Permutation
>
> This is the number of cases in which r items are taken in order from a total of n items. This is represented as $_n\mathrm{P}_r$.
>
> $$_n\mathrm{P}_r = \frac{n!}{(n-r)!} = n \times (n-1) \times \cdots \times (n-r+1)$$
>
> Note: $n!$ is the factorial of n, and is represented as
> $$(n \times (n-1) \times (n-2) \times \cdots \times 3 \times 2 \times 1).$$
>
> • Combination
>
> This is the number of cases in which r items are taken at random from a total of n items. This is represented as $_n\mathrm{C}_r$.
>
> $$_n\mathrm{C}_r = \frac{_n\mathrm{P}_r}{r!} = \frac{n!}{(n-r)!\,r!}$$

(1) The probability of rolling a 1 in a single dice throw

When a dice is thrown, there are six cases as a whole event. Only one of those cases is a 1, so the probability of rolling a 1 is 1/6.

(2) The probability of rolling a 1 or a 2 in a single dice throw

There are two cases to roll a 1 or a 2 in a single dice throw, so the probability is 2/6 (= 1/3).

It can also be calculated by using the addition theorem, which states that "the probability of occurrence of two exclusive events can be calculated by the sum of the probabilities of the two events ($P(A \cup B) = P(A) + P(B)$)". Since the cases of rolling a 1 or a 2 are exclusive events, this probability can simply be calculated by adding the probability (i.e., 1/6) of rolling a 1 to the probability (i.e., 1/6) of rolling a 2. Thus, the result is $(1/6) + (1/6) = 2/6 = 1/3$.

The following expression can be used in order to find the probability of two non-exclusive events: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.

(3) The probability of rolling a 1, and a 2 in order in a two dice throws

When a dice is thrown twice, there are $6 \times 6 = 36$ cases as a whole event. Then, there is only one case to roll a 1 on the first roll and a 2 on the second roll, so the probability of rolling a 1 and a 2 in order is 1/36.

It can also be calculated by using the multiplication theorem, which states that "the probability of one event that occurs only after another event has occurred can be calculated by the product of the probabilities of occurrence of the two events ($P(A \cap B) = P(A) \times P(B)$)". In this example, this probability can be calculated by multiplying the probability (i.e., 1/6) of rolling a 1 on the first roll by the probability (i.e., 1/6) of rolling a 2 on the second roll, and the result is $(1/6) \times (1/6) = 1/36$.

As with the dice in this example, when the probability process in which a past event (i.e., rolling a 1 on the first roll) does not affect the probability of the next event (i.e., rolling a 2 on the second roll), this is known as a Markov process. (Generally, a Markov process in which the next event is determined only by the current status is known as a simple Markov process.)

Example: If two cards are drawn from a deck of eight cards that represent the numbers 1 through 8, what is the probability that both cards are even?

[Solution 1: Calculate the probability from the number of cases.]
1) Calculate the total number of combinations when two cards are drawn from the eight card deck.
$$_8C_2 = \frac{8!}{(8-2)!2!} = \frac{8\times7\times6\times5\times4\times3\times2\times1}{6\times5\times4\times3\times2\times1\times2\times1} = 28$$

2) Calculate the total number of combinations when both cards are even.
Six combinations: $(2, 4), (2, 6), (2, 8), (4, 6), (4, 8), (6, 8)$

3) Calculate the probability.
$$\text{Probability} = \frac{\text{Number of specific event combinations}}{\text{Number of whole event combinations}} = \frac{6}{28} = \frac{3}{14}$$

[Solution 2: Calculate the probability by using the multiplication theorem.]
1) Calculate the probability of drawing an even card from the eight card deck.
$\Rightarrow$ There are a total of four even cards, so the probability is $4/8 = 1/2$.

2) Calculate the probability of drawing an even card from the remaining seven cards.
$\Rightarrow$ There are a total of three even cards, so the probability is 3/7.

3) Calculate the probability by using the multiplication theorem.
$$\text{Probability} = \text{Probability of (1)} \times \text{Probability of (2)} = \frac{1}{2} \times \frac{3}{7} = \frac{3}{14}$$

There is also the concept of expected value in relation to probability. The expected value is a mean that is determined from the probability of an occurrence of an event when the benefit or loss is known for the possible occurrence of that event.

> Expected value = Σ(Benefit/Loss of event × Probability of occurrence)
>   Note: Σ means summation.

For example, the following calculation can be used to calculate the expected value when a dice is rolled one time.

$$\text{Dice roll expected value} = 1 \times \frac{1}{6} + 2 \times \frac{1}{6} + 3 \times \frac{1}{6} + 4 \times \frac{1}{6} + 5 \times \frac{1}{6} + 6 \times \frac{1}{6} = 3.5$$

Example: Calculate the expected value of prize winnings when a lottery is drawn.	Winnings expected value

Example: Calculate the expected value of prize winnings when a lottery is drawn.

Prize	Winnings	Number of tickets
1st	$10,000	1
2nd	$5,000	5
3rd	$1,000	20
Lose	$0	24
Total lottery tickets		50

Winnings expected value
= Σ(Winnings × Probability of winning)
= $10,000 × 1/50
  + $5,000 × 5/50
    + $1,000 × 20/50
      + $0 × 24/50
= $200 + $500 + $400 + $0
= $1,100

3-1-4 Statistics

Statistics is a mathematical technique that is used to find patterns in large sets of data.

In natural, economic, and social phenomena, each set of data may seem random at first glance, but in some cases there may be a specific trend or pattern. For example, the probability (i.e., mathematical probability) of rolling a 1 in a single dice throw is 1/6. However, if the dice is rolled 10 times, it may not be possible to get a single 1 in real. However, the more times the dice is rolled, the closer the probability will approach 1/6. (This is called statistical probability or empirical probability.) Statistics is a method of finding patterns through repeated measurements and/or observations.

In statistics, the entire set of target data is called the population, and a survey of this data is called a complete survey. A portion of a population is called a sample, and sampling data from a population for surveying is called a sample survey. Generally, statistics is used to determine certain characteristics (e.g., trends, patterns) from a sample survey and to estimate

the characteristics of a population.

(1) Frequency distribution

Frequency distribution refers to the distribution status of the frequency (i.e., the number of observation values in a set of measurement data) between intervals. Frequency distributions are often represented in a frequency distribution table or a histogram.

[Observation Values]

Number	1	2	3	4	5	6	7	8	9	10
Score	75	88	95	65	75	62	86	72	62	75

[Frequency distribution table]

Class	Frequency
60 to 69	3
70 to 79	4
80 to 89	2
90 to 100	1

[Histogram]
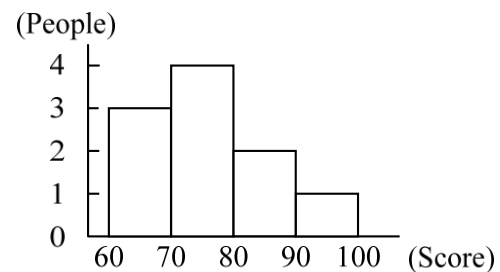
(i) Representative value

This is a value that represents a characteristic of the observation values (e.g., overall trend, pattern). The following are types of representative values:

Name	Meaning
Average (or Mean)	The value that is obtained by dividing the total of all observation values by the number of observation values
Mode	The observation value with the most occurrences
Median	The middle value (i.e., the observation value that lies in the middle of the data set when it is lined up in order from smallest to largest) If there are an even number of observation values, the median is the average of the two center observation values.
Range	The range of the observation values This can be calculated by "the largest observation value − the smallest observation value."

Examples: Calculate the representative values for the following observation values.

Observation Values	60	62	62	62	64	66	66	68	70	70

- Average = (60 + 62 + 62 +62 + 64 + 66 + 66 + 68 + 70 + 70) ÷ 10 = 65
- Mode = 62   (62 appears the most in the set with 3 occurrences.)
- Median = (64 + 66) ÷ 2 = 65
- Range = 70 − 60 = 10

(ii) Dispersion

This is a value that represents the degree of scatter (i.e., degree of dispersion) in a set of observation values. The types of dispersion are listed below. For all of these types, the higher the number, the higher the scatter, and the lower the number, the closer all observation values are to the average.

Name	Meaning
Variance	Σ(Deviation of observation values from the average)^2 ÷ Number of observation values Note: Σ means summation.
Standard deviation	The square root ($\sqrt{\ }$) of the variance Deviation value can be calculated from the standard deviation by using the expression below. The deviation value is a value which is standardized so that the average can be β, and the standard deviation can be α. In such as exams, these deviation values are commonly written as, for example, $\alpha = 10, \beta = 50$. $$\text{Deviation value} = \frac{\text{Observation value} - \text{Average}}{\text{Standard deviation}} \times \alpha + \beta$$

Examples: Calculate the variance and standard deviation from two sets of observation values, both of which have an average of 80.

Observation values X	74	76	78	80	80	80	82	82	84	84

Observation values Y	60	66	72	78	80	84	88	90	90	92

[Observation values X]

- Variance $= \{(74-80)^2 + (76-80)^2 + (78-80)^2 + (80-80)^2$
  $+ (80-80)^2 + (80-80)^2 + (82-80)^2 + (82-80)^2$
  $+ (84-80)^2 + (84-80)^2\} \div 10 = 9.6$

- Standard deviation $= \sqrt{9.6} = 3.098\cdots \approx 3.1$

[Observation values Y]

- Variance $= \{(60-80)^2 + (66-80)^2 + (72-80)^2 + (78-80)^2$
  $+ (80-80)^2 + (84-80)^2 + (88-80)^2 + (90-80)^2$
  $+ (90-80)^2 + (92-80)^2\} \div 10 = 108.8$

- Standard deviation $= \sqrt{108.8} = 10.430\cdots \approx 10.4$

(2) Correlation

Correlation is a relationship between two variates in which changes in one variate cause changes in the other. The correlation between two sets of observation values is generally analyzed by using a scatter diagram.

- Correlation analysis

  Correlation analysis is a method of statistical analysis which uses a correlation coefficient to find the degree of correlation between observation values. Correlation coefficients range between 1 and -1. The closer the correlation coefficient is to 1, the stronger the positive correlation. The closer the correlation coefficient is to -1, the stronger the negative correlation. The closer to 0, the weaker the correlation.
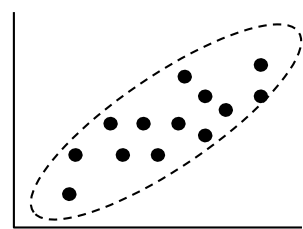
  Strong positive correlation   Weak negative correlation
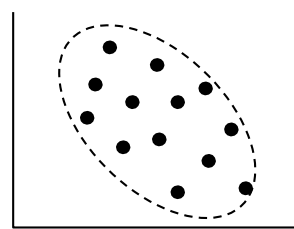
- Regression Analysis

Regression analysis is a statistical technique for estimating one of data x and y, which are correlated with each other, from the other. In particular, the regression model is called a regression line, which is represented by the linear equation $y = a\,x + b$.

$y = a\,x + b$
a: slope
b: y-intercept
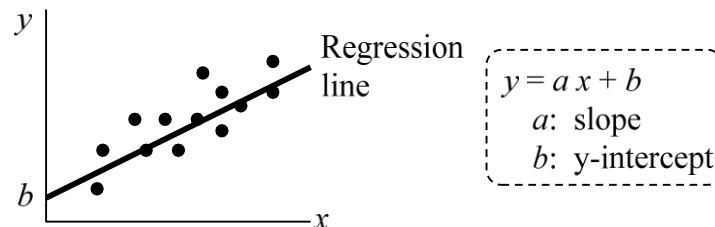
(3) Probability distribution

Probability distribution is the distribution status of a variable x, which has a set probability to be a certain value on the basis of the results of the trials. There are two types of probability variables: discrete probability variables which have scattered values, and continuous probability variables which must be within a continuous range.

The following are the three most common types of probability distribution:

• Normal distribution	• Poisson distribution	• Exponential distribution
This is a probability distribution for continuous probability variables.	This is a probability distribution for discrete probability variables.	This is a probability distribution for continuous probability variables.
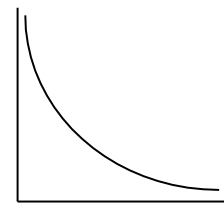
For continuous probability variables, the most commonly used probability distribution is the normal distribution. Normal distributions are written as $N(\mu,\ \sigma^2)$, where N is the normal distribution, μ is the average, and σ^2 is the variance. (σ is the standard deviation.) Under a normal distribution, probability characteristics are determined by the average μ and the deviation σ^2, and the graph of this type of distribution is a bilaterally symmetric bell curve around the average μ.
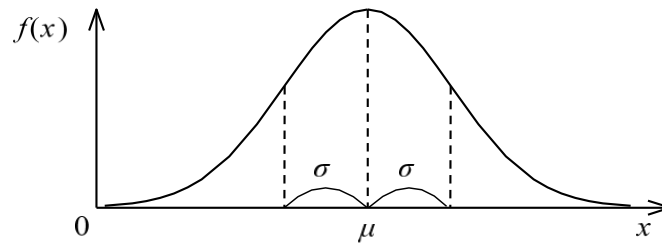
When the average or deviation of a population is estimated or determined, it is complicated to use the probability variable x as-is in those calculations. It is often easier to find the deviation value u, which is standardized to ensure that the probability variable x has an average of 0 and a standard deviation of 1, and utilize the value of u that follows a standard normal distribution $N(0, 1^2)$ to find the probabilities from a standard normal distribution table.

Examples: The following is a normal distribution which represents the length of a part that is produced at a certain factory.
   • Average μ: 3.2 cm
   • Standard deviation σ: 0.1 cm
This part will fail inspection if it is less than 3.0 cm in length. Calculate what percentage of all manufactured parts that will fail inspection.
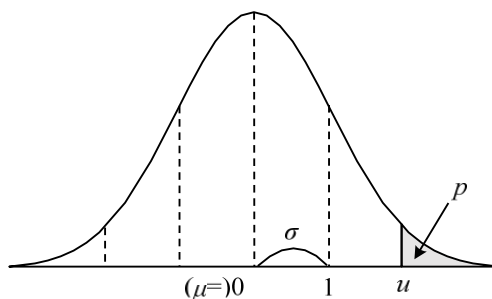
Standard normal distribution table

u	p
0.0	0.500
0.5	0.309
1.0	0.159
1.5	0.067
2.0	0.023
2.5	0.006
3.0	0.001

1) From the normal distribution $N(3.2, 0.1^2)$, normalize the length $x = 3.0$ at which the part fails inspection to the deviation value u of the standard normal distribution $N(0, 1^2)$.

$$u = \frac{\text{Failed product length} - \text{Average length}}{\text{Standard deviation}}$$
$$= \frac{|x - \mu|}{\sigma}$$
$$= \frac{|3.0 - 3.2|}{0.1}$$
$$= 2$$

2) Find the probability p where $u = 2.0$ from the standard normal distribution table.

$p = 0.023$ =>   2.3% of products fails inspection.

3-1-5 Numerical Analysis

Numerical analysis is a computer-aided calculation method of finding an approximate value of the complex calculation that is difficult to find an exact solution. This section explains the basic knowledge that is required for numerical analysis.

(1) Matrix

A matrix is a set of numbers that is aligned in a square or rectangular shape. The matrix A with 2 rows and 2 columns and the inverse matrix A^{-1} (i.e., a matrix which results in the identity matrix I when it is multiplied with A) can be formulated as shown below.

$$A = \begin{pmatrix} a & c \\ b & d \end{pmatrix} \qquad A^{-1} = \frac{1}{ad-bc} \begin{pmatrix} d & -c \\ -b & a \end{pmatrix} \qquad A \times A^{-1} = I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

Matrices can be used to solve equations, such as simultaneous linear equations.

Examples: Calculate a solution of the following simultaneous linear equations.

$3x + 2y = 31$
$4x + 3y = 44$

1) Represent the simultaneous linear equations in a matrix.

$$\begin{pmatrix} 3 & 2 \\ 4 & 3 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 31 \\ 44 \end{pmatrix}$$

2) Multiply both sides by the inverse matrix to calculate x and y.

$$\begin{pmatrix} x \\ y \end{pmatrix} = \frac{1}{3 \times 3 - 4 \times 2} \begin{pmatrix} 3 & -2 \\ -4 & 3 \end{pmatrix} \begin{pmatrix} 31 \\ 44 \end{pmatrix} = \begin{pmatrix} 3 \times 31 + (-2) \times 44 \\ (-4) \times 31 + 3 \times 44 \end{pmatrix} = \begin{pmatrix} 5 \\ 8 \end{pmatrix}$$

$x = 5, \ y = 8$

(2) Factorization

Factorization is a process which converts an integer (or integral expression) into the product of multiple integers (or the product of integral expressions). (The reverse process is called

"expansion of expression.") Factorization is used for solutions to problems, such as higher-degree equations.

Examples: Calculate a solution of the following quadratic equation.

$$2x^2 - x - 15 = 0$$

1) Factorize the quadratic equation.
$$2x^2 - x - 15 = (2x + 5)(x - 3)$$

2) Calculate x so that one of the terms becomes 0 from the fact that the equation equals to 0 by multiplication.

$$2x + 5 = 0 \qquad \cdots \qquad x = -2.5$$
$$x - 3 = 0 \qquad \cdots \qquad x = 3 \qquad\qquad x = -2.5 \text{ or } x = 3$$

---

(3) Logarithm

A logarithm refers to the x in an equation, such as $a = b^x$, and is represented as $x = \log_b a$ (which is read as "x is the log base b of a"). Logarithms of base 10 are particularly called common logarithms, and also the base number 10 is often omitted (e.g., $\log x$) ($\log_{10} 2 \approx$ 0.3010.) The following laws apply to logarithm:

[Law 1] $\log_b a^n = n \times \log_b a$
[Law 2] $\log_b (x \times y) = \log_b x + \log_b y$
[Law 3] $\log_b a = \log_n a \div \log_n b \qquad (n > 0, n \neq 1)$

---

(4) Differentiation and integration

The following is a summary of the differential and integral relationships of a function $f(x)$.

Function: x^n	$f(x)$ Differentiation $f'(x)$	Derivative: $n \times x^{n-1}$
	$\int f(x)\,dx$ Integration $f(x)$	
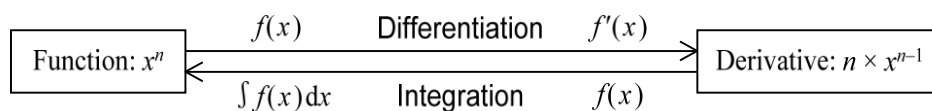
Differentiation is used for such tasks as calculating the slope of a tangent. In order to use Newton's method which is used to calculate a solution of higher-degree equation $f(x) = 0$, since the tangent to the function $f(x)$ must be calculated, the function $f(x)$ must be differentiable.

Examples: Calculate the slope of the tangent to the following function $f(x)$ when $x = 2$.
$$f(x) = x^3 - 6x - 4$$

1) Calculate the derivative $f'(x)$ of the function $f(x)$.
$$f'(x) = 1 \times 3 \times x^{3-1} - 6 \times 1 \times x^{1-1} - 4 \times 0 \times x^{0-1}$$
$$= 3x^2 - 6$$

2) Calculate the slope of the tangent when $x = 2$.
$$f'(2) = 3 \times 2^2 - 6 = 6$$

Integration is used for tasks, such as finding the area within an interval that is enclosed by a curve. The integral with the constant of integration is called an indefinite integral. An integral for which the interval of integration is defined is called a definite integral.

Examples: Calculate the area of the interval $[1, 2]$ ($x = 1$, $x = 2$) which is enclosed by the function $f(x)$ and the x axis.
$$f(x) = 6x^2 - 5$$

1) Calculate $F(x)$ to get $\int f(x)\,dx = F(x) + C$.   (indefinite integral)
(C is the constant of integration.)
$$F(x) = (6 \div 3) \times x^{2+1} - (5 \div 1) \times x^{0+1} + C$$
$$= 2x^3 - 5x + C$$

2) Calculate the area of the interval $[1, 2]$.   (definite integral).

$$\int_1^2 f(x)\,dx = F(2) - F(1)$$
$$= (2 \times 2^3 - 5 \times 2 + C) - (2 \times 1^3 - 5 \times 1 + C) = 3$$

(5) Bisection method

The bisection method is a method to calculate an approximate solution for higher-degree equation $f(x) = 0$. This method works by repeating the process of dividing the range of possible solutions in half to approach the actual solution. In compared with Newton's method, which utilizes the tangent of $f(x)$ to calculate the approximate solution, this method is slower to converge at the solution.

(1) Define the range of possible solutions, then use the intermediate value x_1 to find $f(x_1)$.

(2) $f(x_1) > 0$, so narrow the range of solutions to the first half and calculate $f(x_2)$ for the intermediate value x_2.

(3) $f(x_2) < 0$, so narrow the range of solutions to the second half and calcualte $f(x_3)$ for the intermediate value x_3.

Note: Repeat until the solution is found.
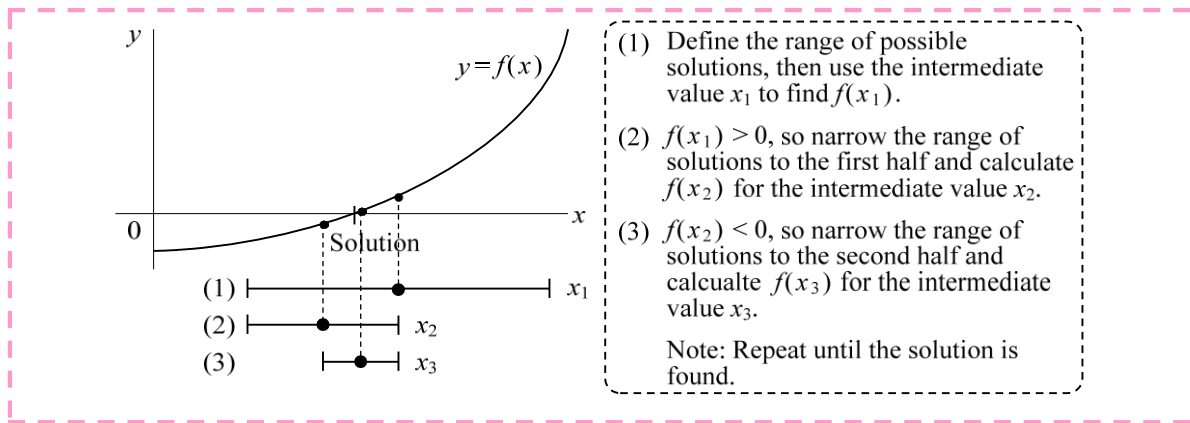
It is necessary to be aware of the following types of error that can occur when bisection method calculations are performed. There are two methods of representing error: absolute error, which represents the degree of error directly, and relative error, which represents the error as a percentage (i.e., ratio) to the true value.

- Rounding Error

  When a computer has to represent a real number with a limited number of digits, error is introduced by rounding off, rounding up, or truncating the value to the digits that are less than the least digit.

- Truncation Error

  This error is caused by truncating after a limited number of passes on the basis of specified conditions (e.g., convergence value, repeat count) when calculations could be repeated infinitely.

(6) Interpolation method

Interpolation method is a method to find the function value $f(x)$ in regards to an unknown variable by deriving the polynomial $f(x)$ from the relationship between known discrete variables.

Note: Derive the polynomial $f(x)$ from known data ($\bullet$) to find the unknown data ($\circ$).
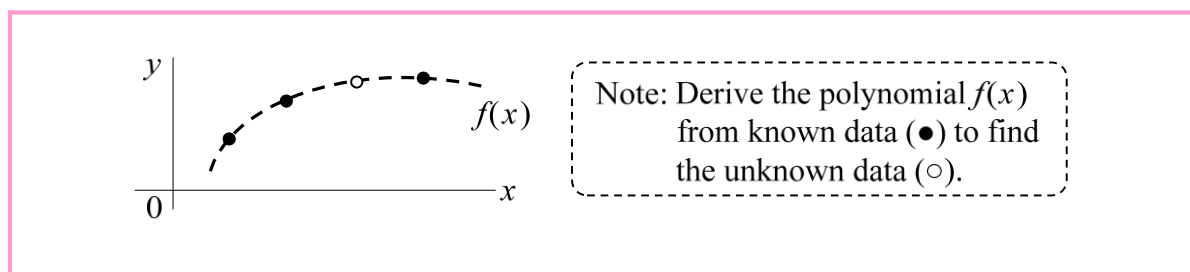
Common interpolation methods are Lagrange interpolation and spline interpolation. Interpolation is used in fields such as CG (computer graphics) to draw curves. The concepts,

such as trapezoid rule and Simpson's method, are also types of interpolation, which are used to find the area that is enclosed by a curve and the *x* axis.

3-1-6 Queueing Theory

Queueing theory is a method of statistically estimating the amount of waiting time or the number of people who are waiting when users are lined up and waiting for a service (e.g., at the register counter in a convenience store). This method is often used to determine the number of counters and the number of staff members on the basis of the average response time at the counters.

There are different models for queueing depending on differences, such as how customers arrive, variation in service time, or the number of service counters. A common queueing model is the M/M/1 model in which the customer arrival interval and service time are both random, with a single processing counter. In the M/M/1 model, the arrival interval follows a Poisson distribution and the service time follows an exponential distribution.

The following are the terms that are used in the M/M/1 model and their meanings.

Term	Representation	Meaning (using customers at a store checkout counter as an example)
Average arrival rate	λ	The number of customers who arrive per unit time.
Average inter-arrival time	$1/\lambda$	The average time interval (T_a) at which customers arrive at the checkout counter.
Average service rate	μ	The number of customers who can be processed per unit time.
Average service time	$1/\mu$	The average processing time (T_s) per customer.
Usage rate (utilization factor)	ρ	The checkout counter usage rate (the ratio of processing time to unit time). $\rho = \lambda / \mu$
Average retention number	L_w	The average number of customers both waiting in the queue and currently being served. $L_w = \rho / (1 - \rho)$
Average waiting time	T_w	The average customer waiting time from a customer entering the queue until processing begins. $T_w = L_w \times T_s = L_w \times (1 / \mu)$ $= \rho / [(1 - \rho) \times \mu]$

Average processing time (Average response time)	Tq	The average processing time from a customer entering the queue until processing is complete. $T\text{q} = T\text{w} + (1 / \mu)$
Average queue length	Lq	The average number of customers in the queue who are waiting to be served. $L\text{q} = L\text{w} \times \rho$

Examples: At a particular lottery ticket stand, an average of 4 customers arrive every minute, and a lottery ticket can be sold (processed) to an average of 5 customers per minute. Calculate each numeric value of the queueing theory when this lottery ticket stand is assumed to follow an M/M/1 model.

- Average arrival rate: (λ)   = 4 customers / minute
- Average inter-arrival time: ($1/\lambda$)   = 1 minute / 4 customers = 0.25 minutes/customer
- Average service rate: (μ)   = 5 customers / minute
- Average service time: ($1/\mu$)   = 1 minute / 5 customers = 0.2 minutes/customer
- Usage rate: (ρ)   = λ/μ = (4 customers/minute) / (5 customers/minute)
                                             = 0.8
- Average retention number: (Lw)   = $\rho / (1 - \rho) = 0.8 / (1 - 0.8) = 0.8 / 0.2$
                                             = 4 (customers)
- Average waiting time: (Tw)   = $L\text{w} \times (1/\mu)$
                                             = 4 customers $\times$ 0.2 minutes/customer
                                             = 0.8 minutes
- Average processing time: (Tq)   = $T\text{w} + (1 / \mu)$ = 0.8 minutes + 0.2 minutes
                                             = 1.0 minutes
- Average queue length: (Lq)   = $L\text{w} \times \rho$ = 4 customers $\times$ 0.8 = 3.2 customers

3-1-7 Graph Theory

Graph theory refers to a theory for using a graph. A graph is composed of a set of vertices V, and a set of edges (or branches) E which connect those vertices. There are two types of graphs in relation to their edges: undirected graphs which have undirected edges, and directed graphs which have directed edges.

[Example of an undirected graph]

$V = \{V_1, V_2, V_3, V_4, V_5\}$

$E = \{E_1, E_2, E_3, E_4, E_5, E_6\}$
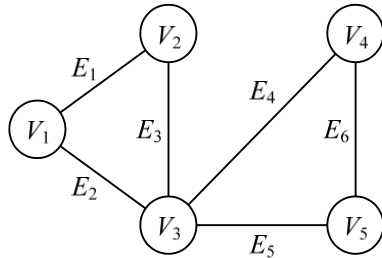
[Example of a directed graph]

$V = \{V_1, V_2, V_3, V_4\}$

$E = \{E_1, E_2, E_3, E_4, E_5\}$
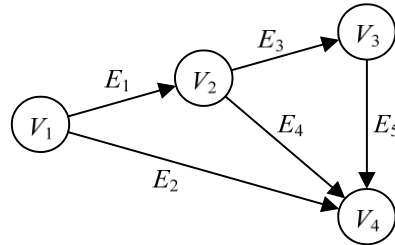
A set of adjacent vertices and edges in a graph is called a walk. There are four types of walks, as described below. Examples of each walk are written down by using the undirected graph above.

- Trail: A walk with all different edges.

  [Example] $(V_1, E_2, V_3, E_4, V_4, E_6, V_5, E_5, V_3)$
- Path: A walk with all different vertices.

  [Example] $(V_1, E_1, V_2, E_3, V_3, E_5, V_5)$
- Circuit: A trail in which the start and end vertices are the same.

  [Example] $(V_1, E_2, V_3, E_5, V_5, E_6, V_4, E_4, V_3, E_3, V_2, E_1, V_1)$
- Cycle: A path in which the start and end vertices are the same.

  [Example] $(V_1, E_1, V_2, E_3, V_3, E_2, V_1)$

A graph can be represented by some types of data structures, such as a matrix, an array, or a list. The common method of representing a graph is an adjacency matrix which shows the adjacent (or connected) status between vertices. The following shows what it looks like if the above undirected graph is represented by using an adjacency matrix and an array. In some cases, a 1 is recorded in place of an edge name to indicate the existence of the edge, or the cost of the edge (e.g., distance, time) may be also recorded.

$$\begin{pmatrix} 0 & E_1 & E_2 & 0 & 0 \\ E_1 & 0 & E_3 & 0 & 0 \\ E_2 & E_3 & 0 & E_4 & E_5 \\ 0 & 0 & E_4 & 0 & E_6 \\ 0 & 0 & E_5 & E_6 & 0 \end{pmatrix}$$

	V_1	V_2	V_3	V_4	V_5
V_1	0	E_1	E_2	0	0
V_2	E_1	0	E_3	0	0
V_3	E_2	E_3	0	E_4	E_5
V_4	0	0	E_4	0	E_6
V_5	0	0	E_5	E_6	0

[Types of graphs]

• Tree

This is a type of undirected graph with no closed path.

• Complete graph

This is a connected graph in which all different vertices are connected as a single edge.

• Eulerian graph

This is an undirected graph that can be drawn with a single stroke. If the start and end vertices are the same, all vertices must have an even number of connected edges.
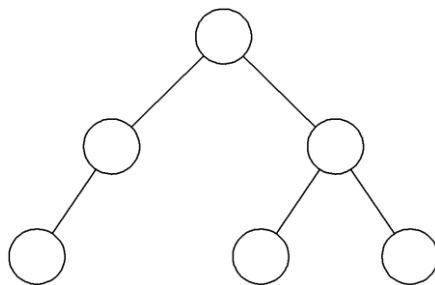
Tree
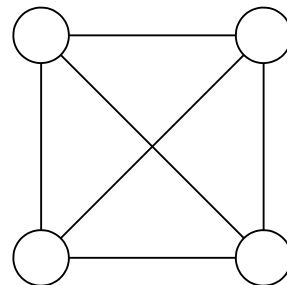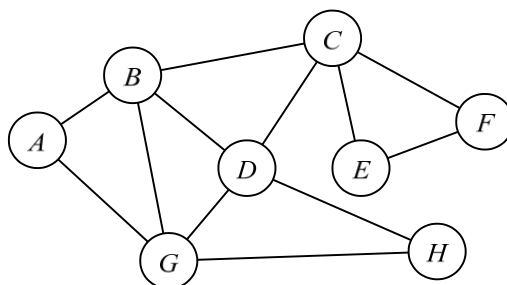
Complete graph

[Example of a single stroke]
$A \rightarrow B \rightarrow G \rightarrow D \rightarrow B$
$\rightarrow C \rightarrow F \rightarrow E \rightarrow C$
$\rightarrow D \rightarrow H \rightarrow G \rightarrow A$

Eulerian graph

A state transition diagram, which shows the change in state of an object over time or in response to external events, can also be referred to as a type of directed graph. However, a state transition diagram sometimes has edges which include a vertex that connects back to itself, so mathematically this means it may not actually be a graph.
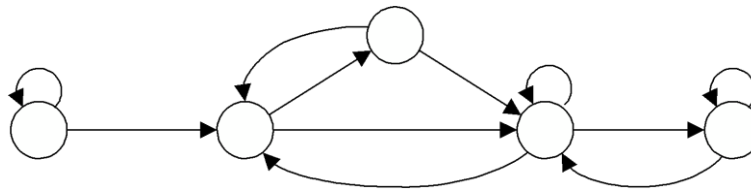
Figure 1-7   State transition diagram

A graph is used to solve problems, such as a shortest path problem or a traveling salesman problem.

3 - 2   OR (Operations Research)

OR (Operations Research) refers to the use of statistical science technology or statistical methods to find the optimal solutions to problems that are related to system operations planning and management in order to aid in the management decision making process.

3-2-1 Linear Programming

LP (Linear Programming) is a technique that is used to find the solution for obtaining the greatest effect from a given condition. It is often used to solve allocation problems in order to determine resource allocation or production volume for manufacturing and production planning. It is also used to solve transportation problems in order to determine how much of a product should be supplied from supply points for multiple demanding points.

Linear programming derives multiple linear inequalities (i.e., constraint expressions) from a set of constraints in order to find a solution which obtains the maximum value of an objective function. When there are only a couple of variables, a simultaneous equation can be used to solve this problem, but with three or more variables it may be necessary to use the simplex method which uses a table (or matrix) to find a solution.

Examples: Calculate the maximum profit from the following constraints for when products *X* and *Y* are manufactured and sold by using raw materials *A* and *B*.

   [Constraints]

     • Product *X* is manufactured by using 6 kg of raw material *A* and 2 kg of raw material *B* per product.

- Product *Y* is manufactured by using 3 kg of raw material *A* and 4 kg of raw material *B* per product.
- A profit of \$3,000 can be obtained from the sale of product *X*, and a profit of \$4,000 from product *Y*.
- Only 120 kg of raw material *A* and only 100 kg of raw material *B* can be used.

	Product *X*	Product *Y*	Usage restriction amount
Raw material *A* (kg)	6	3	120
Raw material *B* (kg)	2	4	100
Profit (\$)	3,000	4,000	

1) Derive the objective function (i.e., the expression to calculate profit) and the constraint expressions, where the production volumes of product *X* and *Y* are *x* and *y*, respectively.

[Constraint expressions] $6x + 3y \leq 120$ ⋯ Raw material *A*

$2x + 4y \leq 100$ ⋯ Raw material *B*

$x \geq 0, \quad y \geq 0$ ⋯ The production volume must be an integer 0 or greater.

[Objective function]   Profit $= 3x + 4y$ ⋯ Maximum (in units of \$1,000)

2) Calculate *x* and *y* from the constraint expressions.

$x \leq 10, \quad y \leq 20$

3) Substitute the maximum values for *x* and *y* in the objective function, and calculate the maximum profit.

Maximum profit $=$ \$3,000 per product $\times$ 10 products

$+$ \$4,000 per product $\times$ 20 products

$=$ \$110,000

3-2-2 Scheduling

Scheduling is the act of creating a schedule for activities or other tasks. There are some scheduling methods, such as PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method). With PERT, a plan is made for estimating an activity period. With CPM, a plan is made in consideration of shortening the schedule with a minimum cost. Sometimes, it can be difficult to distinguish between PERT and CPM, because it is sometimes written as PERT/CPM or PERT/COST which also includes costs into PERT.

[PERT characteristics]
- Can be used for large-scale, complex projects.
- Enables the calculation of the total number of days (i.e., minimum required work period) to complete the project.
- Establishes a clear order of activities, which enables the understanding of a vital point for management.
- Enables the calculation of the number of extra margin days for an activity.

(1) Arrow diagrams

An arrow diagram is a chart which depicts the flow of each activity for a project on the basis of the preceding activity. Nodes (i.e., circles) are placed at both ends of each arrow, and the number is assigned to each node. In addition, the activity name is written above each arrow, and the number of required days below the arrow. An arrow diagram is often used in PERT, so it is sometimes called a PERT chart. It is also used in CPM and other scheduling methods.

Examples: Create an arrow diagram for a project that is composed of the following activities.

Activity	Number of days required	Preceding activity
A	3	None
B	2	None
C	1	A
D	2	A
E	4	A
F	2	B, C
G	1	D
H	1	D, E, F
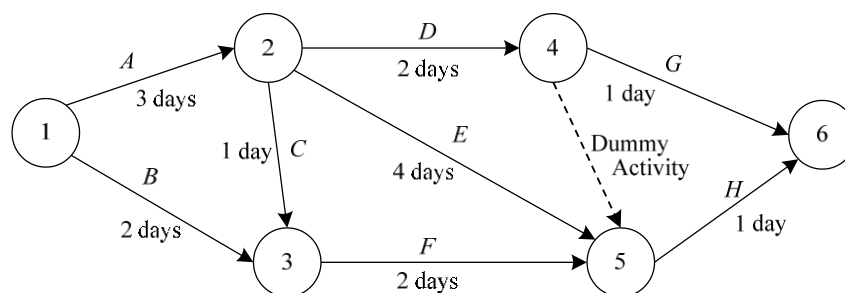
(i) **Earliest node time**

The earliest node time is the earliest start time (or day) of an activity at a node. The earliest node time can be calculated by using a forward computation which treats the starting node 1 as "day 0" to add up all the required days of each activity forward. If there are multiple paths to reach a node, the value for the path that results in the largest sum is used as the earliest node time. The earliest node time for the end (i.e., last) node that is found by these calculations is the minimum number of days required to complete all activities (i.e., the project).
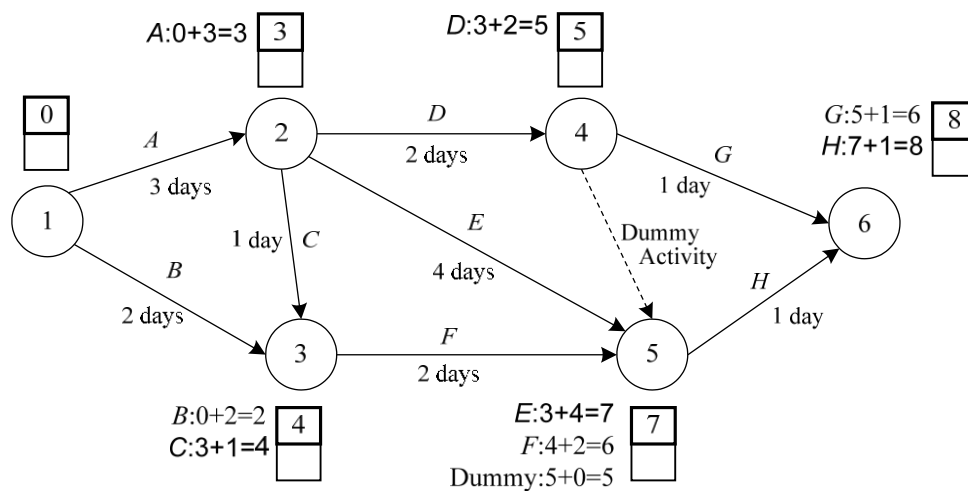
(ii) **Latest node time**

The latest node time is the latest start time (or day) of an activity at a node within the range of the minimum number of days required to complete the project. The latest node time can be calculated by using a backward computation which starts from the end (i.e., last) node and subtracts the required days for each activity backward from the earliest node time for the latest node time (i.e., arrival point). If there are multiple paths to reach a node, use the value for the path that results in the smallest difference for the latest node time. On the basis of the latest node time and the earliest node time that are found by these calculation, the number of extra margin days (slack) for each node can be calculated by using the expression "the latest node time − the earliest node time."
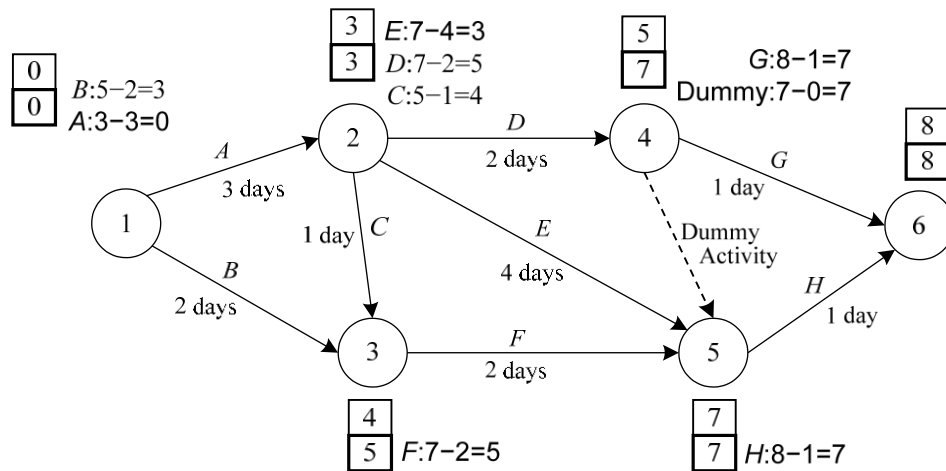
(iii) **Critical path**

This is a path in which there is no extra margin days for activities because two nodes with 0 slack are connected to each other (the earliest node time = the latest node time). If a delay occurs in an activity on a critical path, the entire work schedule will be delayed, so special care should be put into the management of these paths. A critical path is written by activity names ($A{\rightarrow}E{\rightarrow}H$) or node numbers ($1{\rightarrow}2{\rightarrow}5{\rightarrow}6$).
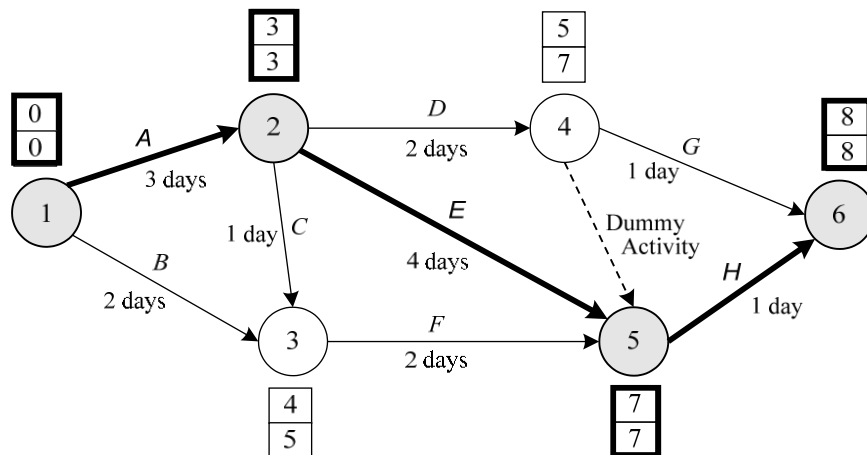
To shorten the overall work schedule, one way is to reduce the number of days for any of the activities along a critical path. The following are different methods to shorten a work schedule.

> • **Crushing**
>
> Crushing is a method in which additional staff members or cost is used to shorten the work schedule.
>
> • **Fast-tracking**
>
> Fast-tracking is a method of shortening a work schedule by breaking down specific activities into smaller parts and performing them in parallel or by

(2) Gantt charts

A Gantt chart is a type of chart that is used to perform schedule management. For each activity, the planed activity period is written along with the actual activity period above and below, with a bar that is drawn to represent the length of an activity. This type of chart makes it easy to see the progress of an activity, but cannot be used to see the time sequence of activities.

Activity \ Month	1	2	3	4	5	6	7	8	···
Activity 1									
Activity 2									
Activity 3									
:					:				

☐ Plan   ▨ Result
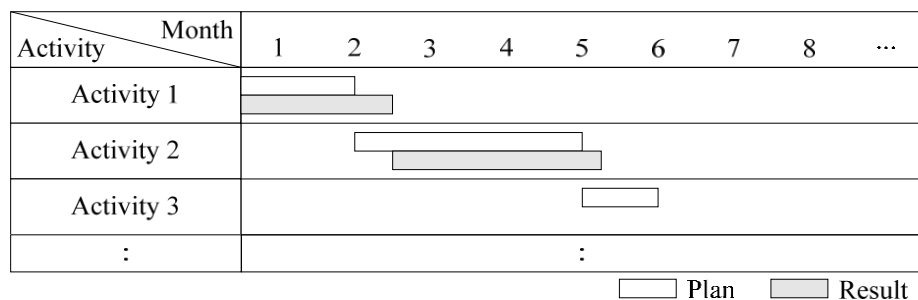
3-2-3 Inventory Problems

An inventory problem refers to the issue of how to efficiently manage the inventory of products which are stored in a warehouse. It is important to prevent the out of stock which causes opportunity loss, and also to ensure not to have surplus stock in order to prevent increased costs.

(1) Inventory control

Inventory control is performed to manage inventory with the minimum cost, with preventing to be out of stock or surplus stock. The following terminology is used in relation to inventory control.

- Total inventory cost
  This is the total cost that is required to perform inventory control.
    Total inventory cost = Storage cost + Ordering cost
      - Storage cost (Inventory cost, Inventory storage cost)
        This is the cost (e.g., warehouse cost, labor cost, utilities cost) that is required to store inventory. This is determined by the annual storage cost per stock, and the annual average inventory quantity.
          Storage cost = Annual average inventory quantity

× Annual storage cost per stock

- Ordering cost (Procurement cost)

  This is the cost (e.g., labor cost, communications cost, insurance premium) that is required for ordering a product. This is determined by the fixed cost for a single order and the number of orders. (This does not involve the order quantity.)

  Ordering cost = Number of orders × Ordering cost per order

- EOQ (Economic Order Quantity)

  This is the order quantity that is required to minimize total inventory cost.

- Safety stock

  This is a certain quantity of inventory that is set aside in advance in order to prevent out of stock. Safety stock is generally considered separately from total inventory cost or EOQ.

If the single order quantity is increased, the average inventory quantity will increase along with the storage cost. If it is decreased, the number of orders will increase along with the ordering cost. With this in mind, the following explains how to calculate EOQ (Economic Order Quantity). Each item in this explanation is written by using the following symbols.

Item	Symbol
Order quantity per order (items/order)	Q
Total annual demand (items/year)	D
Annual storage cost per stock (dollar/item per year)	P
Ordering cost per order (dollar/order)	H

[How to calculate total inventory cost]

1) Since the storage cost is determined by the average inventory quantity, first calculate the annual average inventory quantity. The following is a model of inventory changes.
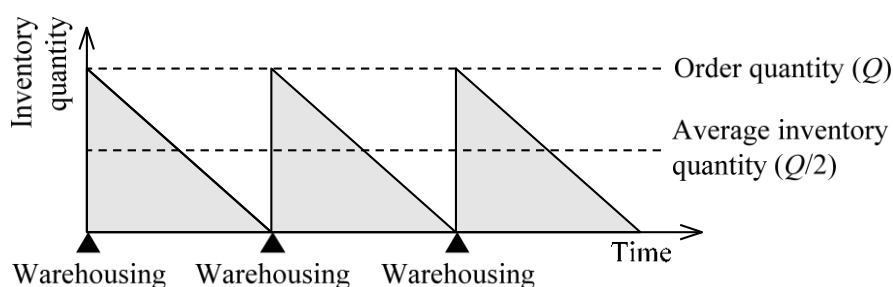
Therefore, the average inventory quantity is "Order quantity (Q) ÷ 2".

Storage cost $= (Q \div 2) \times P$

2) Since the ordering cost is determined by the number of orders, first calculate the annual number of orders. It is necessary to order enough to meet the total annual demand, so the number of orders is calculated as "Total annual demand (D) ÷ Order quantity (Q)".

Ordering cost $= (D \div Q) \times H$

3) The total inventory cost can then be calculated as "Storage cost + Ordering cost" as follows:

$$\text{Total inventory cost} = \frac{Q}{2} \times P + \frac{D}{Q} \times H$$

EOQ (Economic Order Quantity) is calculated as the value of Q that minimizes the total inventory cost. Therefore, it is required to differentiate the equation of the total inventory cost and calculate the value of Q where the slope of the tangent is 0 (i.e., the point where the tangent is parallel with the x axis = the bottom of the curve that represents the expression of the total inventory cost.) If the differentiation is too difficult to solve, it may be easier to understand by looking at the relationship between the order quantity and the cost (i.e., storage, cost ordering cost, total inventory cost) on a graph.
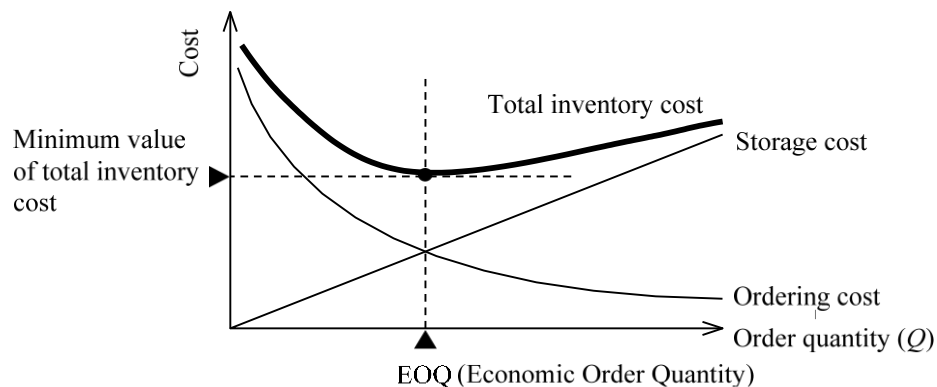
From the graph, it is clear that the point where the total inventory cost is minimized is where the order quantity is "Storage cost = Ordering cost". Therefore, the EOQ (Economic Order Quantity) value for Q can be calculated as follows:

$$\text{Storage cost} = \text{Ordering cost}$$
$$(Q \div 2) \times P = (D \div Q) \times H$$
$$Q = \sqrt{(2 \times D \times H) \div P}$$

(2) Ordering method

An ordering method is a method that is used to order a product. The ordering method is a vital element in inventory problems. When a product is ordered, it must also consider the procurement period until the ordered product is delivered. Some common ordering methods are listed below.

- Periodic ordering method
  With this ordering method, the ordering interval is set in advance and demand is forecast for each order to calculate the required order quantity. This ordering method is most suitable for high-ranking (Rank *A*) products that have a high unit price, make up a large portion of overall sales, and require careful management.

  Order quantity = Projected demand for ordering interval
  + Projected demand for procurement period
  − Inventory quantity at time of order
  + Safety stock quantity
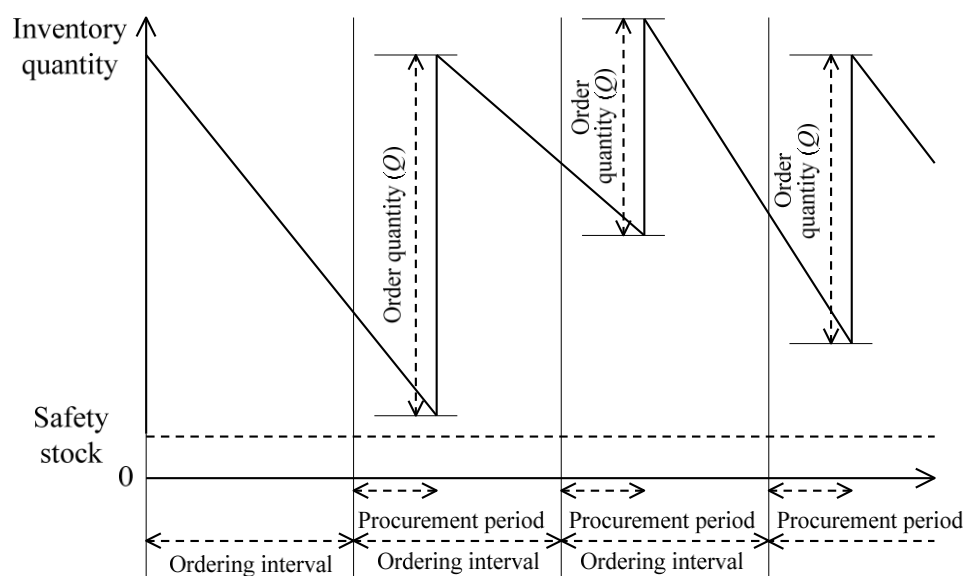
- Fixed quantity ordering method (Order point method)
  With this ordering method, the order quantity is fixed, but the ordering interval is not set. When the inventory falls below the order point, an order is placed for EOQ (i.e., the quantity that minimizes total inventory cost). This ordering method is most suitable for mid-ranking (Rank *B*) products that have a low unit price and make up a medium portion of overall sales.

  Order point = Projected demand for procurement period
  + Safety stock quantity
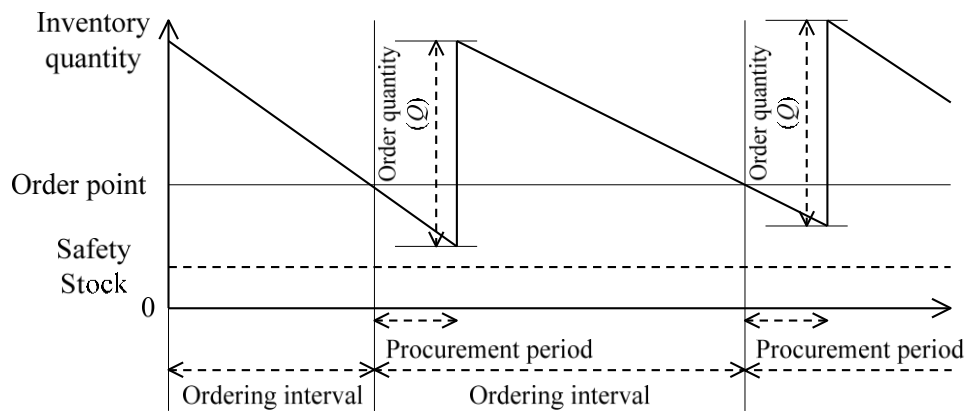
- **Two-bin method**

  With this ordering method, inventory is kept on two shelves. When one shelf goes out of stock, an order is placed for the quantity on that shelf while the inventory from the other shelf is being used. This method is generally most suitable for inexpensive products that are consumed in large quantity.

3-2-4 Demand Forecasting

Demand forecasting is the advance forecasting of future demand in order to make product manufacturing plans and order plans.

The following are three approaches for a concept of demand forecasting.

(1) **Forecasting by using past trends**

This concept is to predict future demand by analyzing trends in past data.

- **Time series analysis**

  This is an analytical method that identifies specific trends from past time series data.

Trend variations	A variation that indicates a long-term increase (or decline) trend
Cyclical variations	A variation that indicates a periodic trend of several years to a decade or so
Seasonal variations	A variation because of natural conditions or social customs
Irregular variations	An accidental variation because of the disaster or other unpredictable factors

- **Correlation analysis/Regression analysis**

This is a method that analyzes correlation between cause and effect in past actual demand. A correlation coefficient is calculated by correlation analysis to study the strength of associations, while a regression line is calculated by regression analysis to use for demand forecasting.

(2) Forecasting by using current index

This is a concept to forecast future demand from index currently in use. It includes the cross-section method that makes comparisons with data for similar products at the same points in time in the past, and the leading indicator method that identifies index to indicate future trends on the basis of statistical data.

(3) Forecasting by using models

This is a concept to create and analyze models for forecasting future demand. It includes econometric analysis that finds solutions to modeled prediction equations (i.e., simultaneous equations), and inter-industry analysis that creates linear programming models by using inter-industry relations tables.

The following are also methods for demand forecasting.

- Least squares method

This is a method that mathematically calculates trend lines such that the error between values on the graphed trend lines (i.e., predicted values) and actual values is minimized. It is used in cases such as finding regression lines.

- Moving average method

This is a method that performs forecasting by calculating the mean of partial time series with moving along the time axis. It levels variations in data in order to make trends easy to spot.

- Exponential smoothing

This is a method that calculates current period predicted values through the weighted average of the previous period actual value and previous period predicted value that are weighted by an exponential smoothing constant (α), as shown in the following expression.

Current period predicted value = α × Previous period actual value
+ (1 − α) × Previous period predicted value

3-2-5 Game Theory

Game theory is a technique to consider the optimal strategy for a player to win a game. In corporate activities, it is used to identify the most effective future strategy from among

multiple possible strategies. In game theory, strategy is determined by representing the profit or loss of strategies with the following payoff table (payoff matrix).

[Payoff table (1)]

	Sunny	Cloudy	Rainy
Strategy S1	+80	+20	−40
Strategy S2	+60	+10	−10
Strategy S3	+40	+30	−20

[Payoff table (2)]

Strategy of B / Strategy of A	B1	B2
A1	+10	−10
A2	−20	+30

Payoff table (1) shows the benefit that varies with the tomorrow's weather when a company has selected one of strategies *S1* though *S3*. On the other hand, payoff table (2) shows how the benefit to company *A* varies with the strategy (*B1* or *B2*) that is selected by company *B*, when company *A* has selected strategy *A1* or *A2*. In this case, a profit for company *A* is a loss for company *B*, and a loss for company *A* is a profit for company *B*. (Such a game is called a two-player zero-sum game.)

When a strategy is determined, it is not possible to perfectly predict future conditions. In response, strategy is determined on the basis of criteria for judging future uncertainty. Criteria for judging future uncertainty can be divided into the following three cases.

> • Definite future
>   Future conditions are known in advance, or specific conditions can be seen as coming about.
> • Probable future
>   A certain number of future conditions can be imagined, with a known probability of each condition occurring.
> • Indefinite future
>   A certain number of future conditions can be imagined, although which conditions will come about is a complete unknown.

When the future is a definite one, the optimal strategy can be taken for the conditions that can be expected. For example, if it is known that tomorrow's weather will be sunny in payoff table (1), then the maximum profit of +80 can be obtained by selecting strategy S1. Moreover, if it is known that company *B* will surely select strategy *B1* in payoff table (2), a maximum profit of +10 can be obtained by selecting strategy *A1*.

However, cases in which the future is a definite one are rare. Since the future is often a probable or indefinite one, some judgment criteria are used to determine strategies.

(1)   In the case of probable future

The judgment criteria for the case of a probable future are explained in payoff table (1) as a 30% probability that tomorrow's weather will be sunny, a 50% probability that it will be cloudy, and a 20% probability that it will rain.

> - Expectation principle
>   This is a concept that calculates expected values for the case of taking each strategy from the probabilities that future conditions will occur, and sees the strategy for which the expected value is highest as the optimal strategy.
>   Example: Calculate the expected value for each strategy.
>   Expected value for strategy $S1 = (+80) \times 0.3 + (+20) \times 0.5 + (-40) \times 0.2 = +26$
>   Expected value for strategy $S2 = (+60) \times 0.3 + (+10) \times 0.5 + (-10) \times 0.2 = +21$
>   Expected value for strategy $S3 = (+40) \times 0.3 + (+30) \times 0.5 + (-20) \times 0.2 = +23$
>   => The strategy $S1$ which offers the highest expected value is seen as the optimal strategy.
>
> - Most probable future principle
>   This is a concept that sees the strategy, which obtains the maximum benefit under the conditions of the highest probability of occurrence from among the future conditions, as the optimal strategy.
>   Example: The cloudy (50%) has the condition with the highest probability of occurrence in the future. Thus, strategy $S3$, which offers the maximum benefit (+30) when the weather is cloudy, is seen as the optimal strategy.
>
> - Aspiration level principle
>   This is a concept that selects the optimal strategy (e.g., the strategy which yields the maximum benefit) from among strategies that meet the intention (i.e., criteria) of the decision-maker.
>   Example: If the decision-maker has set criteria of "Select a strategy with the possibility of yielding the maximum profit, from among strategies with a maximum loss of not more than 20," then between strategies $S2$ and $S3$ (i.e., both of which yield a maximum loss of not more than 20), strategy $S2$ with the possibility of a maximum profit of +60 is the optimal strategy.

In the case of a probable future, a decision tree, such as the following, may be used. In a decision tree, decision-making that is represented with □ (decision node) and indefinite events that are represented with ○ (chance node) are numbered in order. Those nodes are to be options through linking logically and in time series, and the outcomes of options are written in end nodes that are represented with ●.
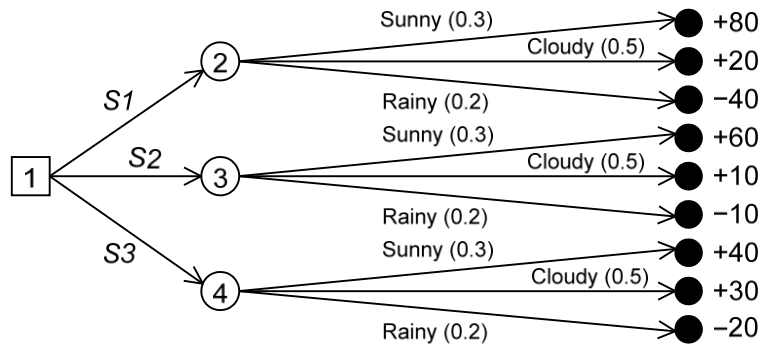
(2) In the case of indefinite future

Judgment criteria for the case of indefinite future are explained in payoff table (2).

- Laplace's principle

  This is a concept that assumes that each condition has the same probability of occurrence, and calculates the optimal strategy on the basis of the expectation principle.

  Example: Assume that company *B* has equal probabilities of selecting strategy *B1* and *B2* to calculate the expected value.

  Strategy $A1 = (+10) \times 0.5 + (-10) \times 0.5 = \pm 0$

  Strategy $A2 = (-20) \times 0.5 + (+30) \times 0.5 = +5$

  =>The strategy *A2* with the maximum expected value is seen as the optimal strategy.

- Maxi-max principle (or Mini-min principle)

  This is a concept that sees the strategy which, from among the best case (i.e., the maximum benefit) for each strategy, obtains the greatest benefit, as the optimal strategy.

  Example: Find the maximum benefit for each strategy.

  Strategy *A1*: When company *B* selects strategy *B1*, maximum benefit is +10

  Strategy *A2*: When company *B* selects strategy *B2*, maximum benefit is +30

  =>The strategy *A2* with the largest maximum value is seen as the optimal strategy.

- Maxi-min principle (or Mini-max principle)

  This is a concept that determines the strategy which, from among the worst case (i.e., the minimum benefit) for each strategy, obtains the greatest benefit, as the optimal strategy.

  Example: Find the minimum benefit for each strategy.

  Strategy *A1*: When company *B* selects strategy *B2*, minimum benefit is −10

  Strategy *A2*: When company *B* selects strategy *B1*, minimum benefit is −20

=>The strategy *A1* with the greatest minimum value is seen as the optimal
strategy.

- Mini-max regret principle

  This is a concept that sees, for each condition, the strategy with the smallest maximum
  value of the difference (i.e., regret) between the benefit that is predicted when the
  best-case strategy is selected, and the benefit of the strategy that is actually adopted.

  Example: Find the maximum value of the regret for each strategy.

    Strategy *A1*: When company *B* selects strategy *B2*, maximum regret is 40

    Strategy *A2*: When company *B* selects strategy *B1*, maximum regret is 30

      =>The strategy *A2* with the smallest maximum regret is seen as the optimal
      strategy.

In the case of a payoff table such as that at right, no matter which strategy company *B* selects, company *A* is better off by selecting strategy *A1*. A strategy such as *A1* is called a dominant strategy (or superiority strategy).

Strategy of *B* / Strategy of *A*	*B1*	*B2*
A1	+20	+10
A2	+10	−10

3-2-6 Optimization Problems

Optimization problems are those problems which identify solutions that are best cases for specified conditions. Linear programming, scheduling, and inventory planning, which have been explained earlier, are optimization problems.

The following are two approaches to optimization problems.

- Divide-and-conquer approach

  This is a method that divides large and complex problems into small problems, and solves each of these to find a solution to the overall problem. It can be seen as a top-down approach that splits up problems from the whole into parts.

- Dynamic programming

  This is a method that solves large and complex problems by beginning with parts for which optimal solutions can be fixed, to in the end find a solution to the overall problem. It can be seen as a bottom-up approach that integrates problems from parts into an overall solution.

The following example will consider a shortest path problem to find how many paths of the shortest ones from *A* to *B* in the diagram pass through *X*.
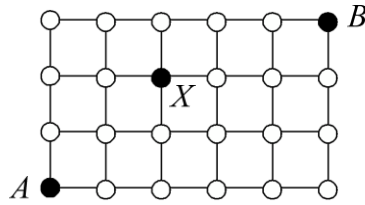
[Solution using the divide-and-conquer approach]

Divide into the shortest paths from *A* to *X*, and the shortest paths from *X* to *B*.

  1) Calculate the number of shortest paths from *A* to *X*.

     Shortest paths are the number of combinations of vertical 2, horizontal 2: $_4C_2 = 6$ paths

  2) Calculate the number of shortest paths from *X* to *B*.

     Shortest paths are the number of combinations of vertical 1, horizontal 3: $_4C_1 = 4$ paths.

  3) Calculate the number of shortest paths from *A* to *B* via *X*.

     $_4C_2 \times _4C_1 = 6 \times 4 = 24$ paths

[Solution using the dynamic programming]

Fix the shortest paths from *A*, in order. (Each number indicates the number of paths.)
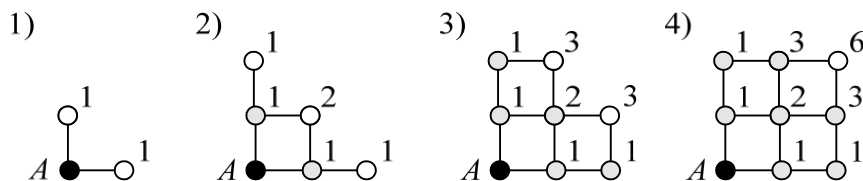
3-3　IE (Industrial Engineering) Analysis Techniques

IE (Industrial Engineering) analysis techniques are techniques for the numeric and engineering management and operation of work. These aim to eliminate irrational effort (i.e., a state of burden or load exceeding capacities), wasted efforts (i.e., a state of burden or load falling short of capacities), and irregular efforts (i.e., a state of the previous two states appearing in turn).

(1)　Work analysis

Work analysis investigates and analyzes actual work conditions to clarify work (i.e., work to be improved) that generates irrational, irregular, and wasted efforts.

- Process analysis

  This analyzes work processes to clarify how resources are involved in each process.

- Motion analysis

  This clarifies the human behaviors that are necessary for carrying out work.

  - Therbligs

    Therbligs are used in motion analysis. They are 18 basic motions that are broken down from human motions, and the 18 symbols that are used to represent the basic motions.

- Time analysis

  This clarifies the times for motions that are necessary for carrying out work.

  - Stopwatch method

    This is a work time analytical technique that measures work time by using a stopwatch or other timer.

- Operation analysis

  This clarifies the operational status of persons or machines that is involved in work.

  - Work sampling method

    This is a technique that performs numerous instantaneous observations of what work status the observation target was in at certain points in time, and from that, estimates operational status, work time, and other factors.

(2) Work improvement

Work improvement is the elimination of the irrational, irregular, and wasted efforts in work that are targeted for improvement. It sets standard work times and other measurements for making effective use of human and physical resources.

- PTS (Predetermined Time Standard) method

  This is a method that breaks down the work that is performed by people into basic operations, and from the standard time that is defined in advance for each basic operation, calculates the standard work time. It may be used in time analysis of work for which measurement of work time is difficult, and in estimating work time.

- Experience estimate method

  This is a method that determines standard work time through the experiential decision of people who are involved in the work.

QC (Quality Control) Techniques

QC (Quality Control) techniques are all activities which are carried out to draft and achieve plans for the most economical production of products that sufficiently satisfy customers (or consumers). They are performed according to the PDCA cycle. The key points of quality control are the setting and assuring of specified values (e.g., mean values) for product length, weight, or other characteristics, and the controlling of unevenness in products. These mean values are set in the ISO 9000 series for quality control systems.

A variety of mathematical techniques are used to control unevenness in products. Quality control using mathematical techniques is called SQC (Statistical Quality Control).

[Four principles of statistical quality control]
(i) Principle of clarification of objectives
The purposes for collecting data statistics are made clear, and the objects to be controlled are accurately identified.
(ii) Principle of quantification
Data must be represented in numerals, with statistical processing possible.
(iii) Principle of stratification
This divides the overall objects to be controlled into multiple groups (i.e., strata) in order to ensure equal quality throughout, as much as possible.
(iv) Principle of probabilitization
From the data overall, samples are extracted (i.e., data is sampled) at random and without bias.

(1) Inspection techniques

Inspection techniques are techniques for inspecting whether the quality of manufactured products satisfies specified values (i.e., quality criteria). Inspection techniques are also used in acceptance inspections for the acceptance of subcontracted products.

(i) Sampling inspection
Sampling is an inspection technique. When n items are sampled from a population (i.e., all object data), the inspection results in a pass when the number of defective items is m or fewer, and a reject when the number is $m+1$ or more.

When the defective rate (i.e., the probability that a defective item is included) of the population is p, the probability $p(m)$ that the number of defective items is m when n items are sampled, can be represented as follows:
$$p(m) = {}_n\mathrm{C}_m \times p^m (1-p)^{n-m}$$

On the other hand, the probability that defective products are m or less, $p(\leq m)$, can be represented as follows:

$$p(\leq m) = p(0) + p(1) + \cdots + p(m-1) + p(m)$$

Here, when m is fixed, $p(\leq m)$ becomes a function of p. This is represented as $f(p)$, and on a graph yields an OC (Operating Characteristic) curve as shown in Figure 1-8. On an OC curve, a higher defective rate p means a lower inspection pass rate $f(p)$.
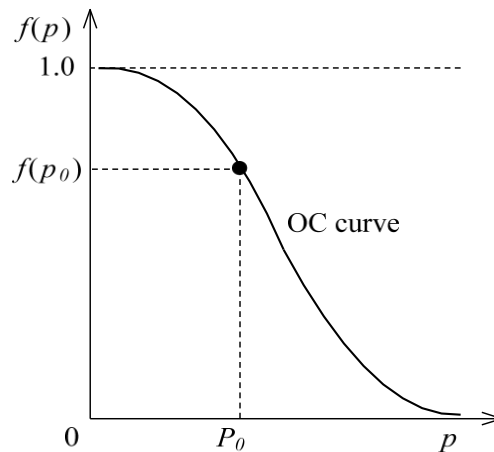
Figure 1-8   OC curve (Graph of function $f(p)$)

As shown by the OC curve in Figure 1-8, when the defective rate is p_0, the inspection pass rate of the population becomes $f(p_0)$. However, even if the real defective rate of the population is higher than p_0, the inspection may incorrectly result in a pass. This is called consumer's risk for its inconvenience to the product user. On the other hand, even if the real defective rate of the population is lower than p_0, the inspection may result in a reject. This is called producer's risk for its inconvenience to the producer. OC curves are also used in defective rate estimation, which estimates the defective rate from the inspection pass rate.

(ii) 100-percent inspection

This method is to inspect each individual product. While it offers certainty as a method, its applications are limited if the cost and time that are required to inspect all products are considered.

(iii) Simulation

This method is to model complex events that are difficult to actually carry out, and predict the results. In the inspection technique, inspection results are predicted through simulation before the inspection is performed, and are deemed to have passed if they

fall within a predicted range.

For example, the failure rate for machinery, which is used in manufacturing products, is modeled with a failure rate curve (bathtub curve), as shown in Figure 1-9. This is used in such cases of estimating (or predicting) the defective rate of manufactured products from the failure rate of machinery.
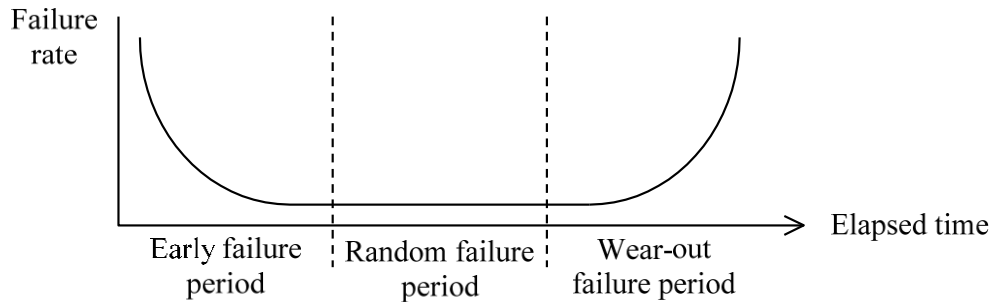
Figure 1-9   Failure rate curve (Bathtub curve)

(2)   QFD (Quality Function Deployment)

QFD (Quality Function Deployment), which is defined by JIS Q 9025, is a methodology for using various changes and expansions in order to achieve quality goals for products. Quality function deployment is a general name for the following five deployments, and can be summarized in a deployment table in which the results of hierarchically analyzing elements are systematically displayed.

- Quality deployment

  This is a method that converts required quality into quality characteristics (i.e., characteristics that are originally built into products, processes, or systems which is related to required quality), defines the design quality of products, and expands this to the quality of each functional component/individual component, and elements of processes.

- Engineering deployment

  This is a method that considers whether the functions to implement design quality can be achieved with currently possible features, and identifies bottleneck technologies. The deployment by a company of its own technology is also sometimes called engineering deployment.

- Cost deployment

  This is a method that seeks to reduce costs or identify problems in costs by allocating target costs in response to required quality or functions.

- Reliability deployment

  This is a method that clarifies guaranteed items for reliability with respect to required

quality.
- Job function deployment

This is a method that hierarchically analyzes and clarifies the work that forms quality.

(3) 7 QC tools/New 7 QC tools

7 QC tools and new 7 QC tools are diagramming techniques that are used in quality control. The 7 QC tools have long been used primarily for manufacturing and inspection departments. On the other hand, the new 7 QC tools have been proposed as QC techniques for sales, service, and R&D departments, within TQC (Total Quality Control) which is involved in organizations in all departments and at all levels.

The following are the technique (or diagram) names of the 7 QC tools and the new 7 QC tools.

7 QC tools	New 7 QC tools
(1) Pareto chart	(1) Affinity diagram
(2) Histogram	(2) Association diagram
(3) Scatter diagram	(3) Matrix diagram
(4) Control chart	(4) Matrix data analysis
(5) Stratification (Area graph)	(5) Arrow diagram
(6) Check sheet	(6) Tree diagram
(7) Cause-and-effect diagram (Fishbone diagram)	(7) PDPC (Process Decision Program Chart)

[7 QC tools]

(1) Pareto chart

This is a diagram that combines a bar graph and line graph to enable control and analysis by viewing the cumulative total percentages of the whole. Specifically, a bar graph is drawn with bars in descending orders by quantity, and the cumulative total percentage of the whole for each bar is represented with a line graph. This is used in situations including ABC analysis, which clarifies key control items.

(2) Histogram

This is a diagram that allows to understand the overall characteristics or the data variability by dividing the range of data into several sections and plotting the number of data items in each section as a bar graph.

(3) Scatter diagram

This is a graph that sets two corresponding types of data on the vertical and horizontal axes, after which the measured values are plotted. It enables correlation between the data sets (i.e., the presence of mutual influence) to be viewed through the degree of dispersion of points. (This is used in correlation analysis and regression analysis.) In particular, a diagram in which points on the graph are displayed as some number of groups and allows to view data characteristics, may be called a portfolio diagram.

(4) Control chart

In a control chart, a CL (Central Line) that represents normal values, a UCL (Upper Control Line) that represents the upper limit of normal values, and an LCL (Lower Control Line) that represents the lower limit of normal values are all written, and then data (i.e., mean value) is plotted as a point and each point is connected to be displayed as a line graph. When data such as the changes in product size, weight, or constituents, or the number of occurrences of defectives, differs significantly from other data, a control chart allows identification of whether the difference is caused by chance or caused by abnormality in manufacturing processes. When the plotted data falls within the range of the control lines, manufacturing processes are normal. However, when the data falls outside the range of the control lines or deviates from the norm, improvement is needed. In contrast to an $\overline{X}$ control chart on which mean values are plotted, there is also the R control chart on which the data range (i.e., "maximum value − minimum value") is plotted.

(5) Stratification (Area graph)

Stratification is the classification of data. For example, raw materials for a product can be classified by manufacturer, by lot, by place of production, by size, and so on. Even problems that appear complex can be made simple through classification, and it becomes easier to discover a solution. In place of stratification, area graphs may be included. An area graph is a type of line graph that makes time series analysis easy.

(6) Check sheet

This is a table or diagram that is formatted in advance so as to enable understanding of a whole by collecting itemized data and confirming items through checks.

(7) Cause-and-effect diagram (Fishbone diagram)

This is a diagram for systematically organizing the relationships between characteristics (or effects) and factors (or causes), in order to uncover causes.
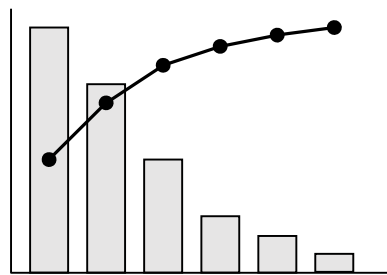
Pareto chart
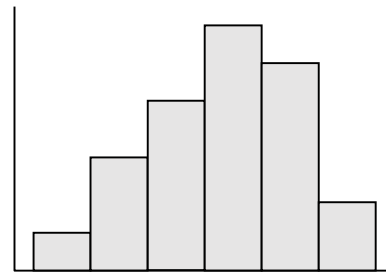
Histogram
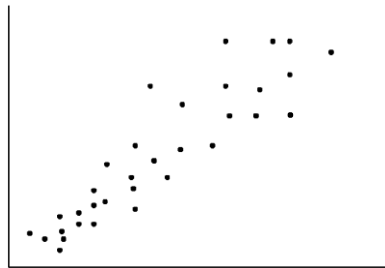
Scatter diagram (positive correlation)
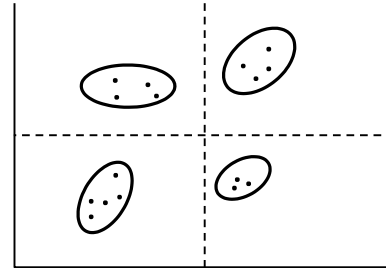
Portfolio diagram
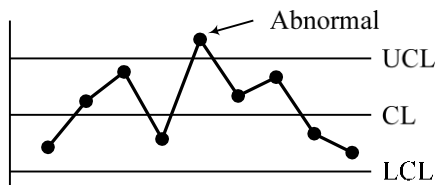
$\overline{x}$ Control chart
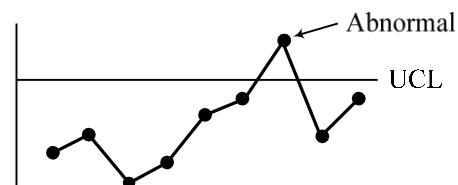
R control chart
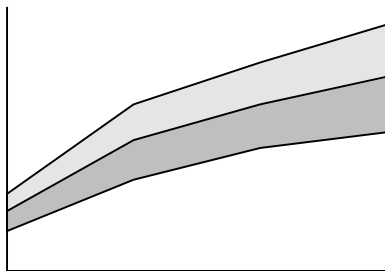
Window lock	✔
Stove main valve	✔
Air conditioner switch	✔
Gas main valve	✔
Water heater main valve	✔
Wallet	
Commuter pass	
Room lighting	✔

Area graph

Check sheet
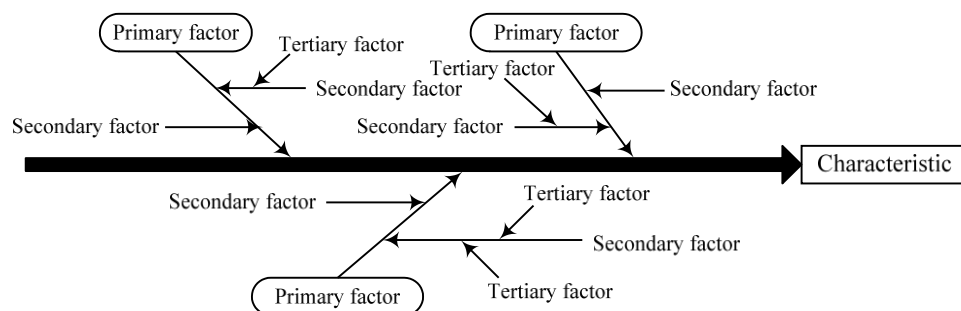
Cause-and-effect diagram (Fishbone diagram)

[New 7 QC tools]

(1) Affinity diagram

This is a diagram that, for complex and ambiguous problems, sorts items on the basis of resemblance and strength of the relevance, and then organizes and

groups problem discovery and causal relationships.

(2) Association diagram

This is a diagram that organizes effects (or problem points) and causes, and causal relationships such as objectives and measures, by connecting these with arrows. It is used to clarify causal relationships for problems in which complex factors are intertwined, and to reveal clues to solutions or to solve the causes of problems.

(3) Matrix diagram

This arranges problem elements (or data) in rows i.e., (horizontal axis) and columns (i.e., vertical axis), and uses symbols to represent the existence or degree of relationships at the intersections of row and column elements. It is used to clarify the relationships among data.

(4) Matrix data analysis

This is an analytical method that is used when numerical data is handled in a matrix diagram. It can be used for when trends cannot be grasped from voluminous numerical data, and for discovering key items.

Roughly speaking, the procedures for matrix data analysis are: arrangement of elements (or data) in a matrix; calculation of correlation coefficients; analysis of causal relationships; and display of the existence and degree of relationships at the intersections of row and column elements.

(5) Arrow diagram (Refer to p.59 for the details.)

This is a diagram that uses arrows to display the flow of each activities, on the basis of its preceding activities. It is used to find the total number of days required, or key management activities, in scheduling.

(6) Tree diagram (Logic tree)

This is a diagram that seeks approaches or plans that are required to achieve objectives or goals, organizes the findings, and displays these in tree form. It is effective in uncovering the core of a problem and opening a path to a solution, while group members redraw the relation diagram with reaching consensus and overturning ideas between them.

(7) PDPC (Process Decision Program Chart)

This is a diagram used to predict conceivable outcomes and situations, prevent trouble, and move forward with plans in as desirable a direction as possible.

Attitude/Stance

Expression

Line of sight

Gesture

Clothes

Way of walking

Content

Composition

Manner of speaking

Allegory

Greetings
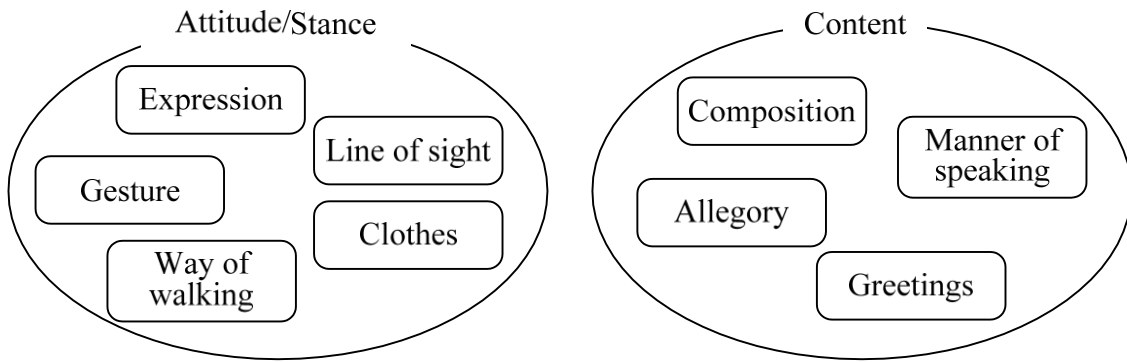
Affinity diagram

Association diagram

```
Delay in               →  Dependence on
industrialization         agriculture
     |                          |
     |                          ↓
     |                    Cultivation of
     |                    farmland
     ↓                          |
Securing of fuel       →  Deforestation
for living                      |
     ↑                          ↓
Unstable state of        Depletion of
society                  tropical rain
     |                   forests
     |                          ↑
     ↓                    Delay in
                         afforestation
                         projects
```
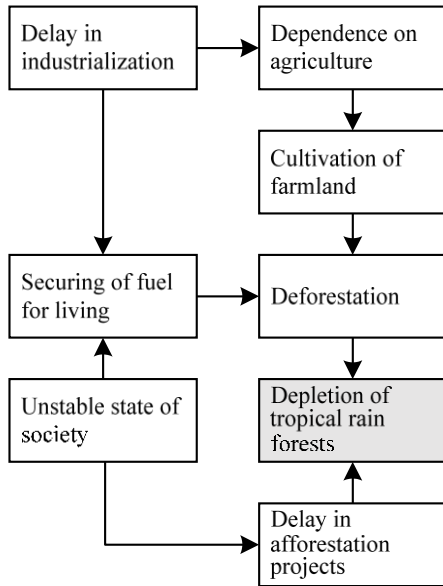
Association diagram

Technique \ Characteristic	Current status assessment	Planning	Investigation of causes	Data collection	Current state analysis	Data comparison	Process management
Check sheet	○			●	○		
Cause and effect diagram	○		●				
Histogram	○				●	○	
Scatter diagram	○				○	●	
Control chart	○					○	●
Affinity diagram	●				○		
Arrow diagram		●					○

Matrix diagram

Tree diagram

```
Success of training
   ├─ Employee participation ─ Securing of training time
   │         ├─ Request for training participation by subordinates
   │         └─ Early notification of training plan
   └─ Contribution of training outcomes to business practice
             ├─ Highlighting the importance of training ─ Distribution of materials in advance
             ├─ Measures to increase understanding by participants ─ Training content on the basis of work
             └─ Status survey after training participation
```

Tree diagram

PDPC (Process Decision Program Chart)

```
Plan extended training
        ↓
Search for lodging facilities
    ↓                    ↓
Lodging facilities      Lodging facilities
unavailable             available
    ↓                    ↓
Cancel extended        Make reservation ─→ Reservation completed
training                 ↓                      ↓
                       Reservation cannot     Contact participants
                       be completed             ↓
                                              Holding of extended training
```

PDPC (Process Decision Program Chart)

3 - 5　Business Analysis

Business analysis is the investigation and analysis of current business operations in order to improve its efficiency and quality. The results of business analysis are used in operational improvement and in optimal operational planning.

In business analysis, a variety of information (or data) concerning business operations is collected, then organized and analyzed. This subsection describes techniques for data collection, organizing, and analysis.

3-5-1　Data Collection Techniques

Data collection techniques are techniques for the collection of various kinds of information (or data). The following are typical data collection techniques.

- Brainstorming

  This is a method for collecting many opinions or ideas concerning a problem to be solved or a thing to be achieved. When the following four rules are followed, speakers can freely put forth thoughts and opinions, which can be expected to lead to innovative ideas.

Prohibition of criticism	Participants should not criticize what others say.
Freewheeling	Participants should speak boldly and freely, even when they stray a bit from the objective.
Quantity over quality	Participants should focus on generating many opinions rather than quality opinions.
Free piggybacking	Participants should be free to build on and combine the ideas of others.

- Questionnaire survey

  This is a method of collecting large volumes of data by organizing items to be surveyed in the form of questionnaire items, distributing the survey to many people, and collecting the responses. It offers merit as a way to collect large volumes of data at low cost. However, it presents problems in that, depending on the content of the questions and the recipients. For example, responses may deviate from the target or comments may be biased, which results in inability to collect valid data.

- Interview (Interview survey)

  This is a method of meeting and speaking directly with people to collect data. Interviews are commonly conducted with individual persons or with groups. In some

cases, it can be conducted by telephone. Since the interview is conducted by talking directly, it enables the collection of high-quality comments that meet the purpose of the survey. However, time and cost requirements present a difficulty.

- Focus group

This refers to a group that is selected from a larger whole in order to collect information, or to the method of collecting information through interactive interviews with such groups. Focus groups are used for collecting prior information (e.g., advance information collection to narrow down questionnaire items and content before a questionnaire for the whole is conducted). They are also used as a means of collecting opinions from specified customers concerning new products, within marketing and other activities.

3-5-2 Data Organizing Techniques

Data organizing techniques are techniques for organizing collected information (or data). The following are typical data organizing techniques.

- KJ method

The KJ method, which is named from the initials of its originator Kawakita Jiro, is used to organize numerous comments that are collected through brainstorming or other means.

1) Information collection	Data is collected through brainstorming or other methods.
2) Creation of cards	A card is created for each piece of data.
3) Grouping	Data with similar content is formed into groups.
4) Creation of headers	A header (title or nameplate) is attached to each group.
5) Diagramming	For each group, all cards are pasted onto a board. These are then organized by drawing around cards with arrows and outlines.
6) Documentation	The content is documented on the basis of the diagramming.

Note: Steps 3) and 4) are repeated until those groups become 5 or 6 groups at the end.

- Buzz session

This is a method for studying problems in each small groups and drawing out

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conclusions for the whole on the basis of conclusions for each group.

1)	The overall group is divided into small groups.
2)	A leaders and a recorder are decided in each group.
3)	Members in each group discuss topics freely.
4)	The opinions in each group are gathered together.
5)	Each group leader presents the group's conclusion.
6)	An overall conclusion is drawn.

• Delphi method

This is a method that uses anonymous questionnaires survey to collect and statistically aggregate opinions from a large number of professionals and experts when forecasts are made on the basis of current trends. Through repeated feedback and reconsideration of the aggregated opinions, the opinions are made to converge, and the accuracy of the forecasts is enhanced.

• Monte Carlo method

This is a method that derives approximate solutions by carrying out a large number of simulations and numerical analyses using probability distributions and random numbers. Monte Carlo methods include the bootstrap method, by which characteristics of the population are estimated through a large number of samplings of collected information (i.e., samples). This is used when collected information is scarce and precise data analysis is difficult.

• Scenario writing method

This is a method that works out a scenario by arranging collected information in order of time. This is used for future forecasting of technology trend etc.

3-5-3 Diagrams and Graphs

Diagrams and graphs represent the various collected information (or data) and the results of organizing information, in visual and easily understood form. In particular, graphs are available in many types, so it is important to make selection of the appropriate graph for the application.

(1) Decision table / Decision tree

Decision tables and decision trees are diagrams that summarize actions, processes, and outcomes according to conditions. These are used to organize complex conditions or prevent checklist items from being overlooked.

- **Decision table**

  A decision table summarizes actions or processes according to conditions, in tabular form.

Condition title field	Condition input field (Y/N/–)
Behavior title field	Behavior input field (X/–)

  Y: True; N: False; –: Undetermined

  X: Act; –: Do not act

- **Decision tree**

  A decision tree arranges outcomes, according to conditions and actions, in a tree-like structure.
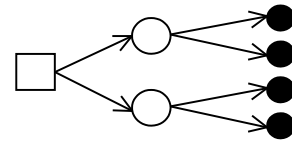
  □: Decision-making (decision node)

  ○: Uncertain events (chance event node)

  (Refer to p.69 for the details.)

Example: The following rules for payment of business travel allowances are to be summarized in a decision table.

"For a business travel of at least 500 km one way, a per-diem allowance of $30 will be paid for a one-day trip. An additional lodging expense allowance of $50 will be paid for an overnight stay. Meanwhile, for a business travel of at least 200 km but less than 500 km one way, a per-diem allowance of $10 will be paid for a one-day trip. An additional lodging expense allowance of $50 will be paid for an overnight stay. An allowance will not be paid for one-way business travel of less than 200 km."

\<Decision table\>

At least 500 km one-way	Y	Y	N	N	N
At least 200 km but less than 500 km one-way	N	N	Y	Y	N
Less than 200 km one-way	N	N	N	N	Y
One-day business trip	Y	N	Y	N	–
Pay a per-diem allowance of $10	–	–	X	X	–
Pay a per-diem allowance of $30	X	X	–	–	–
Pay a lodging expense allowance of $50	–	X	–	X	–

(2)　Bar graph

Bar graphs are graphs that display data as bars. They are suited to comparisons of quantity. The histogram of the 7 QC tools is one type of bar graph.

(%) Usage status by Internet application
Compound bar chart

(number) Mainframe delivery status by class
Cumulative bar chart
(Source: Informatization White Paper)

Male/female population comparison, Tokyo (2000)
Pyramid graph

Types of Internet connection lines in public schools
Percentage bar graph
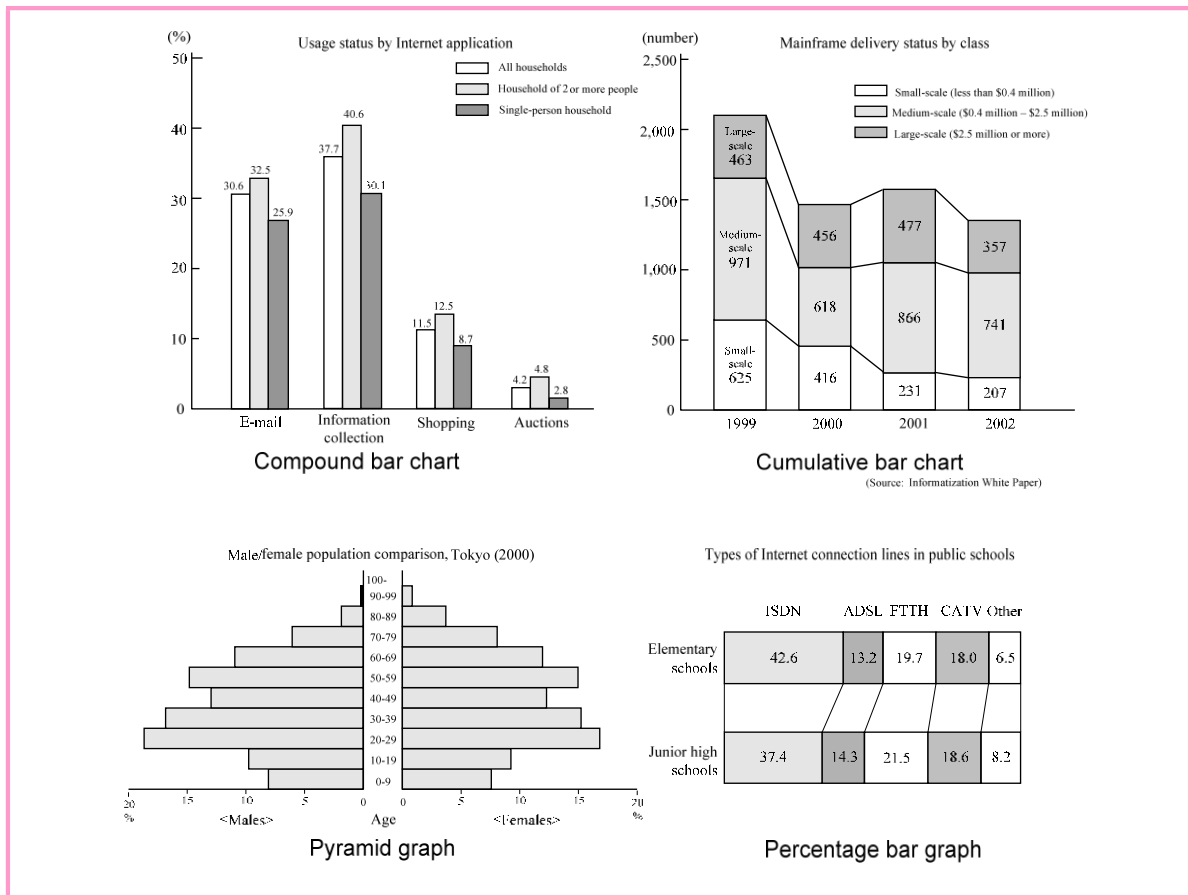
(3) Line graph

Line graphs are graphs that data is connected by lines. They are suited to displaying quantities that change over time. The area graph of the 7 QC tools is one type of line graph.

Number of successful Information Technology Engineers Examination applicants
Fan chart

Discount rate transition
Step graph
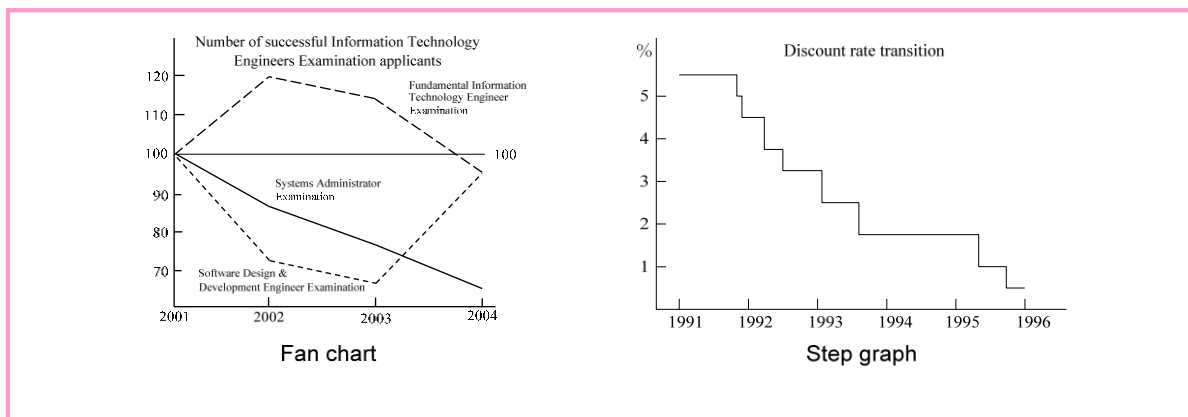
(4) Pie chart

Pie charts are graphs that represent the percentages of individual component elements against a total of 100%. They are suited to comparisons of the percentages of component elements.

Types of Internet connection lines in public schools (Source: Informatization White Paper)

Pie chart

Double pie chart
Outer chart: Elementary schools
Inner chart: Junior high schools

Donut chart
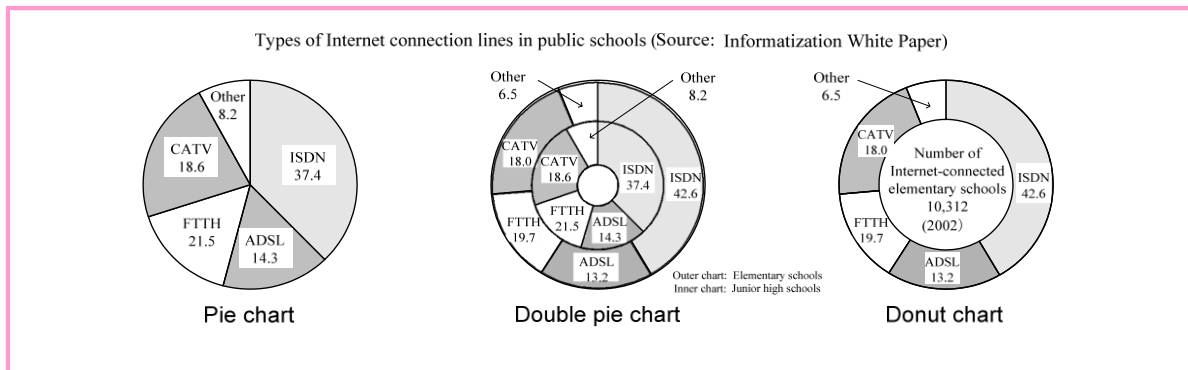
(5) Chart

Chart is a general name for a diagram or graph that visually represents information. In general, a diagram that is created for a specific purpose is often called a chart.

- Radar chart

  This is a chart that sets a standard form for multiple evaluation items, plots ratios against those standards, and represents the balance among items by a polygonal shape connected with lines. For example, when food prices in Tokyo are set to 1 (i.e., 100%) for displaying food prices in New York on a radar chart, it allows an understanding of the variance (i.e., difference) in the balance.

- Z chart (Z graph)

  This is a chart that represents individual numeric values, their cumulative total, and the difference in compared cumulative values by using a line graph. For example, with sales volume by month at the base, each month's cumulative sales can be represented with a line graph rising from left to right. In addition, for each month, total 1-year sales for the year up to and including that month can be shown on a line graph. This can be used to check the company's sales record by seeing whether the line is rising or declining.

- SD chart

  This is a chart that is used to indicate impressions or feelings with respect to certain survey items. At both ends of multiple horizontal axes, the chart places antonyms of the characteristics to be evaluated, divides the evaluation of the degree of each characteristic into several levels, and connects the points that indicate the relevant degrees to depict a psychological state, an impression, and so on.

- Pie intersection chart

  This is a chart that represents the mutual relationships among elements or items through the intersections of multiple circles, with each circle indicating one element or item. The overlapping portions of circles indicate elements or items that are shared between those circles.

Comparison of food prices in Tokyo and New York
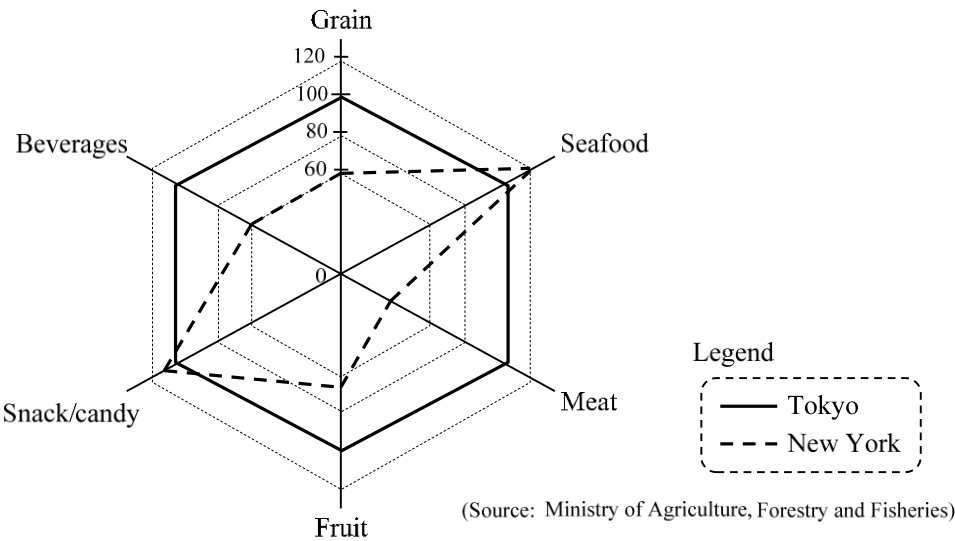
Radar chart
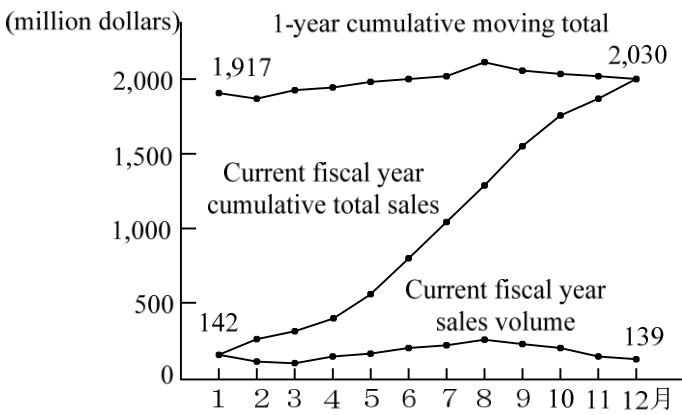
Z chart (Z graph)
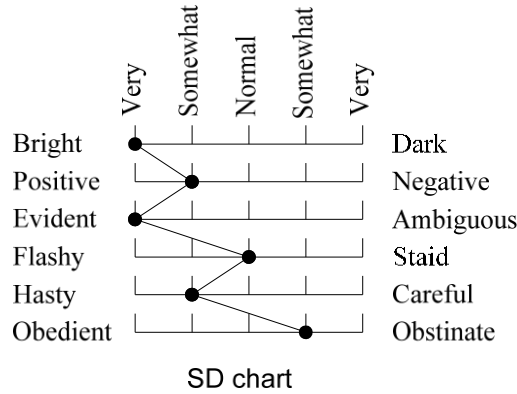
SD chart
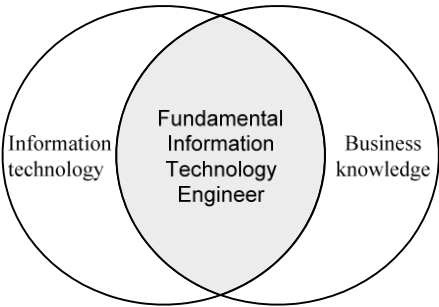
Pie intersection chart

3-5-4 Data Analysis Techniques

Data analysis techniques are techniques that find data characteristics, law, regularity, and other properties by organizing collected information (or data) and analyzing the resulting data. The applied mathematics, OR, IE analysis techniques, and QC techniques which have been discussed so far can all be called data analysis techniques.

(1) ABC analysis (Pareto analysis)

ABC analysis (Pareto analysis) is a technique that manages products, services, or other items with dividing into three levels (i.e., A, B, and C). In ABC analysis, Pareto charts are used for division into three ranks according to cumulative percentage. The following are general judgment criteria for the three ranks (i.e., A, B, C).

Rank	Judgment criteria
A	Items that account for up to 70% of the cumulative percentage
B	Items other than those in Rank A that account for up to 90% of the cumulative percentage
C	Items other than those in Ranks A and B

Example: When sales by product are indicated by values in the table, find the results of ABC analysis.

Product name	Product a	Product b	Product c	Product d	Product e	Product f
Sales	$750	$100	$300	$50	$150	$650

1) Products are arranged in descending order of sales, sales are accumulated from the top of the order, and ranks are determined from each product's percentage of the cumulative total sales.

Order	Product name	Sales	Cumulative total sales	Cumulative percentage	Rank
1	Product a	$750	$750	37.5%	A
2	Product f	$650	$1,400	70.0%	A
3	Product c	$300	$1,700	85.0%	B
4	Product e	$150	$1,850	92.5%	B
5	Product b	$100	$1,950	97.5%	C
6	Product d	$50	$2,000	100.0%	C

2) Create Pareto chart.
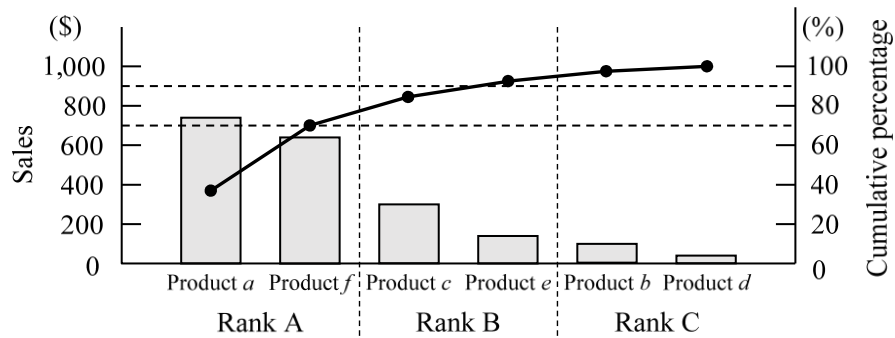
(2) Data mining

Data mining is a method that uses mathematical and statistical techniques on large volumes of collected and organized data to analyze law, regularity, and other properties that are useful and important to companies and management. As indicated by the use of the word "mining," the method analyzes large volumes of collected and organized data, and mines regularity and order to assist company management (e.g., marketing strategy). For example, the method can extract laws, such as "Defective rate increases in the afternoons on days before holidays" from large volumes of manufacturing data.

In data mining, techniques, such as the following, are used to discover laws and regularities.

- Star schema

  This is a database schema (i.e., definitions and descriptions of the logical structure, storage structure, and physical structure of the database) that is used for analysis, with the analysis values radiating outward from the analysis target. Creation of indexes to implement a star schema is one preparation for achieving data mining.

- Cluster analysis method

  This is an analytical technique for grouping items to quantitatively find similarities (by distance or degree of similarity) within the target data. In order to represent the results of analysis, dendrograms, such as the following, are used.
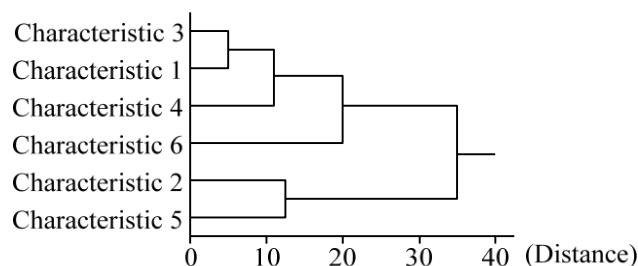
General data mining extracts data from mission critical systems and makes use of data warehouses, which are multidimensional databases that are constructed for information analysis. However, what is commonly used now is not only a single company's data warehouses but also the large-scale data called big data. As per its name, big data is massive data on the scale of petabytes (PB, 10^{15} bytes) or exabytes (EB, 10^{18} bytes). It can include text, images, audio, and other forms of data. Big data is attracting attention as an information source that, through techniques such as data mining, can yield knowledge that was previously unobtainable. However, since the processing of big data can be difficult by using existing technology and software, its information may be provided by governments or specialized organizations that possess large-scale distributed processing systems or other environments for analyzing big data.

4 Legal Affairs and Standardization

Corporate activities are addressed by a variety of laws and regulations, and also by guidelines and standards that are proposed by the ministries and agencies and industry organizations. This section describes laws and regulations, guidelines, and standardization.

Note: In regards to legal affairs, basic concepts of laws and regulations are common in many countries, but the actual laws and regulations are inevitably domestic. On the other hand, guidelines and standards may be domestic or international. Most of the descriptions from 4-1 to 4-5 in this section are written depending on Japanese laws and regulations, guidelines, and standards. Please check the relating laws and regulations, guidelines, and standards in each country. Basic concepts of international guidelines or knowledge about international standards may be asked in ITPEC Examination.

4 - 1 Intellectual Property Rights

Intellectual property rights refer to the property rights for all intellectual products that are created through human mental labor. The Intellectual Property Basic Act addresses intellectual property.

[Objectives of the Intellectual Property Basic Act (excerpt from Article 1)]

The purpose of this Act is to promote measures for the creation, protection and exploitation of intellectual property in a focused and systematic manner by stipulating the basic principles on the creation, protection, and exploitation of intellectual property and the basic matters to achieve the principles, clarifying the responsibilities of national government, local governments, universities, etc. and business operators, establishing the Intellectual Property Strategy Headquarters, and providing stipulations on the development of a strategic program on the creation, protection, and exploitation of intellectual property.

Intellectual property rights are classified into rights concerning intellectual creations and rights concerning trade dress. These rights are protected by law, and their infringement is subject to compensation for damage.

Types of intellectual property rights

- **Rights concerning intellectual creations**
  - Patent rights (Patent Act)
  - Utility model rights (Utility Model Act)
  - Design rights (Design Act)
  - Copyright (Copyright Act)
  - Semiconductor circuit layout rights (Act on the Circuit Layout of a Semiconductor Integrated Circuit*)
  - Plant breeders' rights (Plant Variety Protection and Seed Act)
  - Trade secrets (Unfair Competition Prevention Act) (Technical and sales information)

- **Rights concerning trade dress**
  - Trademark rights (Trademark Act)
  - Trade names (Companies Act, Commercial Code)
  - Labeling of goods/services, etc.; form of goods/services (Unfair Competition Prevention Act)

  (Unfair competition acts)
  ○ Confusion creating acts
  ○ Acts of unauthorized use of famous indication
  ○ Configuration imitation acts
  ○ Illicit obtainment of a domain name
  ○ Acts of causing misidentification

Note:
⬭ : Commercial property rights
∗ : Abbreviation is Semiconductor Chip Act."

The United Nations has established the WIPO (World Intellectual Property Organization) as an international expert body for protection of intellectual property. Also WTO (World Trade Organization) has articles about intellectual properties in TRIPS Agreement (Agreement on Trade-Related Aspects of Intellectual Property Rights).

(1) Copyright Act

The Copyright Act is a law for the protection of the rights (copyright) of author who created his/her works. Author's works include works of language such as novels, screenplays, papers, and lectures; works such as music, dance, pantomime, paintings, prints, and photographs; and derivative works that are created through the translation or adaptation of works. However, notices, orders, notifications, and similar items from the central, regional, or other government bodies, and translations or compilations of these (e.g., white papers) are not deemed author's works.

In the Copyright Act, copyrights are classified into moral rights of author (i.e., rights concerning the personal benefit of author), property rights of author (i.e., property rights pertaining to author's works), and others.

Moral rights of author		
	Right to make the work public	The right to make the work public or not make it public
	Right to determine the indication of the author's name	The right to indicate or not indicate the author's name (true name or pseudonym name)
	Right to maintain integrity	The right to maintain the integrity of author's works and their titles
Property rights of author		
	Right of reproduction	The right to reproduce author's works
	Rights of public transmission	The right to effect a public transmission of author's works (or to make transmittable to the public)
	Rights of distribution	The right to distribute author's works through the reproductions
	Right of ownership transfer	The right to offer author's works to the public by transferring ownership of the works or the reproductions
	Right of rental	The right to offer author's works to the public through the rental of the works or the reproductions

While the moral rights of author cannot be transferred to a third party, the property rights of author can be transferred. In addition, neighboring rights that are similar to the moral rights of author accrue to concerned parties who are engaged in activities closely related to the corresponding works.

Under the Copyright Act, when rights have been infringed upon by unauthorized reproduction, alteration, etc. of author's works, the copyright holder may demand that the infringing party cease the unauthorized use or provide compensation for damages. (Copyright infringement constitutes a legal case when a suit is brought by the victim of infringement.) However, the following exceptions also apply.

- Reproduction of a work for the purpose of private use does not constitute copyright infringement. However, reproduction that makes transmittable to the public does constitute copyright infringement.
- In the cases of non-profit-making activities, reproduction of a work included in books, documents, and other materials from libraries, etc. does not constitute copyright infringement.
- Quotation of a work already made public does not constitute copyright infringement. However, the quotation must be performed, to the extent justified by the purpose of the

quotation.

- In schools or other educational institutions, reproduction of a work already made public, to the extent deemed as necessary, does not constitute copyright infringement. However, this is not applicable in cases that unreasonably prejudice the interests of the copyright holder.
- Reproduction of a publicly available work as examination questions, etc. does not constitute copyright infringement. However, this is not applicable in cases that unreasonably prejudice the interests of the copyright holder.

Since copyright is an automatic principle by which copyright accrues automatically at the time that a work is created by the author, there is no need to perform procedures, such as patent application, examination, or registration. However, in order to prevent disputes and to protect the rights of authors, a copyright registration system exists that allows registration of the true name, the issued date/creation date, rights, etc. with the Agency for Cultural Affairs. While the Agency for Cultural Affairs has jurisdiction over copyrights, the SOFTIC (SOFTware Information Center) is the point of contact for registration of computer programs.

The Copyright Act protects "expressions," for which computer programs and databases are the subjects in the information processing area. Programming languages, conventions (or protocols), and algorithms are not "expressions" and are not subject to protection. For computer programs that are protected, there are no limits on the purpose of use (e.g., OS, language processors, application software) or form of expression (e.g., source code, object code). Meanwhile, for databases, copyright is established when there is originality with respect to the selection and the systematic configuration of information. (It is not established for the information that is recorded in the database and for the database overall.)

In addition to the above, the following points should be noted with regard to copyrights related to the information processing area.

- Protection of program works does not extend to any programming language, rule, or algorithm used for creating the works. What is protected is expression, not know-how or algorithms.
- The authorship of a computer program work which, on the initiative of a juridical person, etc. is made by an employee (including temporary employees) in the course of his/her duties in connection with the juridical person, etc.'s business, shall be attributed to such juridical person, etc., unless otherwise stipulated by contract or work regulations or the like at the time of the making of the work.
  => The making of the work by employee who is engaged in the juridical person,

etc.'s business, on the initiative of the juridical person is called employee work. For works other than programs that are created in the course of his/her duties, the juridical person is stipulated as the author in cases in which "the juridical person, etc. makes the work public under its own name." For that reason, programs for which the juridical person is the author are generally recognized as works even when they are not made public.

- The term of protection for a private work is from the time of the creation of the work to 50 years following the death of the author. In contrast to this, the term of protection for juridical person's work is 50 years following the making public of the work.

- If the user had knowledge at the time of acquisition that the program was illegally copied, it constitutes copyright infringement. However, if the program was acquired without knowledge that it was illegally copied, it does not constitute copyright infringement.

- Reproduction of a program for the purpose of backup, or alteration within allowed limits through customization functions, etc., does not constitute copyright infringement. However, it constitutes copyright infringement by the act of reproduction through the forcibly removing copy protection (copy guard) that is set for the purpose of prohibition of reproduction, even if the purpose is to do backup.

- For programs (or works) for which alteration is allowed, rights equivalent to those of the original author are granted to the author of the altered derivative works.

(2) Industrial Property Law

The Industrial Property Law is a law to protect industrial property rights (the patent right, the utility model right, the design right, and the trademark right). It aims to protect inventions, devices, designs, trademarks, and other ideas, and other intangible assets such as originality and trustworthiness, and to support the development of industry.

- Patent Act

  Among technological creations by making use of laws of nature, this Act provides protection for highly advanced "inventions." Patent rights become registered following application to the Japan Patent Office, and subsequent examination and assessment. The duration of a patent right is 20 years, during which the patent holder may possess an exclusive license to articles involving the patent. When patent rights have been infringed, the patent holder may claim an injunction on use or compensation for damages from the infringing party.

  - Software patent

    This is a patent for software that is necessary to achieve an invention, or for the

invention of the software.

- Business model patent

  This is a patent that is aimed at protection of a business model using IT (e.g., computers, software).

- Cross-licensing

  This is a form of business by which two companies that hold patents mutually consent to license of patents each other.

- Patent pool

  This is a form of business by which patent rights that are held by multiple companies are shared and managed in one location.

- Utility Model Act

  This is a law to protect "devices," essentially minor inventions that are not necessarily technical or highly advanced. Common applications are for original and convenient improvements or ideas that are aimed at daily lifestyle goods, toys, etc. These become registered following application to the Japan Patent Office and subsequent examination and assessment. The duration of utility model rights is 10 years.

- Design Act

  This is a law to protect the "design" such as form, color, and other design aspects of products. Its purposes are the protection and use of the rights of the design creator. The design becomes registered following application to the Japan Patent Office and subsequent examination and assessment. The duration of design rights is 20 years. In principle, in order to qualify for design registration, a design must not be publicly known.

- Trademark Act

  This is a law to protect "trademark" such as trademarks, service marks, and other commercial marks. Its purposes are the protection and use of the rights of the trademark inventor. These become registered following application to the Japan Patent Office and subsequent examination and assessment. The duration of trademark rights is 10 years, but renewal registration is possible.

(3) Other intellectual property right laws

(i) Unfair Competition Prevention Act

This law protects trade secrets of a company. The trade secrets refers to confidential information that will result in disadvantage to a company if the information is leaked to competing companies. Trade secrets include technical information such as manufacturing technology, blueprints, and experimental data, and sales-related information such as customer lists, product information, and sales data. The purpose of

the Act is to protect these trade secrets and enable demands for injunctions and for compensation of damages in cases of theft or other unfair use. However, trade secrets that are protected by this law must fulfill the following requirements.

[Requirements for trade secrets]
- Must be kept secret
- Must be secret and useful for commercial activities considering technology and business
- Must be publicly unknown to society

This law also prevents the following sort of actions as unfair competition.

- The act of creating confusion with another person's goods by using an indication of goods or business that is identical or similar to an indication of goods or business that is well-known among consumers as that of another person.
- The act of selling goods that imitate the style or form of another person's goods.
- The act of selling devices or programs that make it possible to view images, listen to sound, or run programs, which are restricted by technological restriction measures, by interfering with effectiveness of such technological restriction measures.
- The act (e.g., illicit obtainment of a domain name) of acquiring or holding a right to use a domain name that is identical or similar to another person's specific indication of goods or services for the purpose of acquiring a wrongful gain (or for the purpose of causing injury to another person)

(ii) Semiconductor Chip Act (Act on the Circuit Layout of a Semiconductor Integrated Circuits)

This is a law that views the layout of the semiconductor integrated circuits in computers as intellectual property, and protects from imitation. Since this layout affects the performance of computers, the law was enacted to protect this intellectual property from imitation. Falling under the jurisdiction of the Machinery and Information Bureau of the Ministry of Economy, Trade and Industry, the duration of a circuit layout right is 10 years from the day that the circuit layout is registered.

(iii) Commercial Code

This refers to general law concerning commercial practices. It stipulates that when merchants use a "trade name" to denote themselves in the pursuit of business, "No person may use, with a wrongful purpose, any name or trade name which makes it

likely that a company will be mistaken for another company."

4 - 2 Security-related Laws and Regulations

This subsection explains major laws, regulations, standards, and guidelines surrounding information security. Generally accepted names are given in the text, with official names in brackets.

(1) Unauthorized Access Prohibition Act
[Act on the Prohibition of Unauthorized Computer Access]

The Unauthorized Access Prohibition Act is a law for the purpose of maintaining the safety and order of telecommunications by preventing crime that is committed via telecommunications lines (e.g., networks) and by controlling access to computers. Under this law, the act of unauthorized access itself is subject to punishment, even if there is no actual damage. Moreover, it stipulates not only measures against the perpetrators of unauthorized access, but also measures (e.g., enforcing strict password management) that are aimed at the administrators of access in order to prevent unauthorized access.

[Acts that are made illegal under the Unauthorized Access Prohibition Act]
- Acts that are conducted over networks (e.g., the Internet, intranet) by using the user ID and password of another person to access computers or wireless LAN base stations for which access is controlled
- Acts that help unauthorized accesses, such as disclosing another person's user ID and password to a third party without the person's permission
- Acts that misuse (or attack) security holes in OS or software

(2) The Penal Code

The Penal Code is the law that stipulates punishments for crimes or similar acts. The area of the Penal Code that deals with computer-related criminal law is also known as the Computer Crime Prevention Law.

- Crimes related to Electromagnetic Records of Unauthorized Command (crime of computer virus creation) (Penal Code of Japan, Article 168, paragraphs 2, 3)
  Penal regulations for persons creating computer viruses
- Crime of computer fraud (Penal Code of Japan, Article 246, paragraph 2)
  Penal regulations for persons committing acts of fraud by using computers

- **Crime of obstruction of business by damaging a computer** (Penal Code of Japan, Article 234, paragraph 2)

  Penal regulations for persons obstructing business by destroying data on computers or causing operations contrary to the intended use of computers

- **Crime of unauthorized creation of electromagnetic records** (Penal Code of Japan, Article 161, paragraph 2)

  Penal regulations for persons engaging in unauthorized creation of data in computers

- **Crime of unauthorized creation of electromagnetic records of payment cards** (Penal Code of Japan, Article 163, paragraph 2)

  Penal regulations for persons engaging in unauthorized creation of credit cards or other cards for payment of charges for goods or services, or persons engaging in unauthorized creation of data in cards for withdrawal of money

(3) Personal Information Protection Act
[Act on the Protection of Personal Information]

The Personal Information Protection Act is a law that aims to balance the use of personal information with protection of the information. It defines the duties, etc. to be observed by business entities that handle personal information.

[Terminology related to the Personal Information Protection Act]

- **Personal information**

  This refers to information about a living individual which can identify the specific individual.

- **Business operator handling personal information**

  This refers specifically to those private enterprises (excluding national or local government bodies) that, among business operators possessing personal information databases, etc. necessary for business, have 5,000 or more of specific individuals identified by personal information on any day in the past six months.

- **Personal information databases, etc.**

  This refers to a database, etc. in a state where specific personal information can be easily retrieved, regardless of whether the information has been digitized or not.

- **Personal data**

  This refers to personal information that constitutes a personal information database, etc.

- **Retained personal data**

  This refers to the retained data on individuals, for which a business operator handling personal information has the authority to disclose, to correct, add or delete

> the contents, to discontinue or erase its utilization, and to discontinue its provision to third parties, etc.

The Act on the Protection of Personal Information stipulates the following duties for business operator handling personal information. However, in situations otherwise determined by laws and regulations or when these are required to protect human life, body, or property, these do not apply when it is difficult to gain the consent of the individual.

- The purpose of utilization of personal information shall be specified as much as possible. Moreover, personal information about a person shall not be handled without obtaining the consent of the person, beyond the scope of the purpose of use.
- Personal information shall not be acquired by wrongful means. Moreover, except in cases in which the purpose of utilization has already been publicly announced, the purpose of utilization shall be promptly notified to the person or must be promptly publicly announced when personal information is acquired.
- Necessary and proper measures shall be taken for the security control of information, including the prevention of leakage or loss of personal data.
- Personal data shall not be provided to a third party without obtaining the consent of the person. However, this does not apply when the fact that provision to a third party is the purpose of utilization is notified to the person or is in a readily accessible condition for the person.
- The business operator shall endeavor to maintain personal data accurate and up to date.
- When a business operator is requested by a person to disclose, to correct/add/delete retained personal data, to discontinue/erase its utilization, etc., the business operator shall respond without delay.
- A business operator shall be endeavor to appropriately and promptly process complaints about the handling of personal information.

With regard to the state organ and local governments, incorporated administrative agencies, etc. not included among business operators handling personal information, four (excluding the Act on the Protection of Personal Information) of the five laws concerning protection of personal information apply.

Private	Public bodies	
Act on the Protection of Personal Information	Act on the Protection of Personal Information Held by Administrative Organs	Act on the Protection of Personal Information Held by Incorporated Administrative Agencies
	Act for Establishment of the Information Disclosure and Personal Information Protection Review Board	
	Act for establishment of related laws and regulations	
Basic Policy on the Protection of Personal Information (Cabinet decision)		

The following guidelines and systems concerning protection of personal information also exist. These guidelines and systems do not carry legal force. However, considering the loss to companies (e.g., loss to corporate image) which is revealed to be in violation of the Act on the Protection of Personal Information, companies should incorporate these into their compliance activities.

- Guidelines on Personal Information Protection

  The Act on the Protection of Personal Information establishes the minimum required rules for the handling of personal information shared across areas of business. Items on the basis of those minimum rules, established by ministries and agencies overseeing their respective business areas, form the Guidelines on Personal Information Protection.

- Privacy Mark System (P Mark System)

  This is a system that confers a Privacy Mark on private businesses and other organizations that have constructed management systems in conformance with JIS Q 15001 (Personal information protection management systems—Requirements) and have prepared appropriate protection systems for the handling of personal information. Examination organizations that are designated by the JIPDEC (Japan Institute for Promotion of Digital Economy and Community) perform examination of whether implementation systems, regulations, records, implementation status, and other matters fulfill the requirements that are noted in JIS Q 15001.

(4) Electronic Signature Act
[Act on Electronic Signatures and Certification Services]

The Electronic Signature Act is a law that defines the certification systems and other necessary matters concerning designated certification service, to ensure the same legal trust in an electronic signature as that of a "physical signature" or a "personal seal."

There is also a law called the Official Personal Authentication Act. It stipulates the full provision of the electronic certification systems that are required for the official personal authentication services of electronic government.

(5) Act on the Limitation of Liability for Providers
[Act on the Limitation of Liability for Damages of Specified Telecommunications Service Providers and the Right to Demand Disclosure of Identification Information of the Senders]

The Act on the Limitation of Liability for Providers is a law that stipulates limitation of liability for compensation of damages of specified telecommunications service providers, and the right to demand disclosure of identification information (e.g., name, address, mail address, IP address) of the senders, in case of infringement of the rights through information distributing by specified telecommunications services (e.g., the Internet).

(6) Specified Electronic Mail Act (Spam E-mail Prevention Act)
[Act on the Regulation of Transmission of Specified Electronic Mail]

The Specified Electronic Mail Act is a law that regulates the transmission of e-mail by defining prohibited items and other details for transmitting specific types of e-mail for the purpose of commercial gain. It mandates display of "unapproved advertisement*", display of information of the sender (e.g., the business operator, sender), display of the sending e-mail address, acceptance of e-mail reception rejection, and other matters in the sending of specified e-mail. It prohibits transmissions using false sender information such as fictitious e-mail addresses or forged headers; provides for orders for improvement from the Minister for

Internal Affairs and Communications when the prohibitions are not followed; and provides for the imposition of criminal penalties when the orders for improvement are not followed.

(7) Standards concerning information security, etc.

- Standards for Measures Against Computer Viruses

  These are collected by the Ministry of Economy, Trade and Industry. They are measures which are effective in the prevention, discovery, and removal of computer viruses, and in restoration from damage.

- Standards for Measures Against Unauthorized Access to Computers

  These are collected by the Ministry of Economy, Trade and Industry. They are measures that individuals, corporations, and other organizations should perform for the prevention and discovery of damage that is caused by unauthorized computer access, for the restoration from damage, and for the prevention of the expansion and the recurrence.

- Guidelines for Information System Safety Measures

  These are notices by the National Public Safety Commission. They are aimed at parties concerned with information systems, for the purpose of securing the safety of citizens' lifestyles and maintaining the order of information society. They indicate measures that should be taken to prevent or minimize damage that is caused by crimes, fraudulent behavior, leaks of personal information, and disaster that involve information systems, and also indicate measures to ensure cooperation with police following crimes.

- Standards for Information System Safety Measures

  These standards from the Ministry of Economy, Trade and Industry enumerate measures to be implemented by users of information systems to prevent risks such as natural disasters, equipment faults, and intentional and negligent risks, and to minimize impacts and speed recovery after occurrences, for the purpose of securing the confidentiality, integrity, and availability of information systems.

(8) Guidelines concerning information security

- Information Security Early Warning Partnership Guideline

  This is a guideline that is jointly established by parties including IPA, JPCERT/CC, JEITA, CSAJ, JISA, and JNSA, in order to control the occurrence of damage from unauthorized computer access, computer viruses, and so on.

- OECD Security Guidelines

  [Guidelines for the Security of Information Systems and Networks]

  These are international guidelines for information security, which are established by

the OECD (Organization for Economic Cooperation and Development). They were considerably revised in 2002, at which time they adopted "security management" and "security culture." The guidelines set three targets for application: information system owners, providers, and users. The guidelines are composed of nine principles: awareness, responsibility, response, ethics, democracy, risk assessment, security design and implementation, security management, and reassessment.

- OECD Privacy Guidelines

[Guidelines on the Protection of Privacy and Transborder Flows of Personal Data] These are international guidelines on protection of personal information, which are recommended by the OECD (Organization for Economic Cooperation and Development). They recommend that OECD member nations respect the following eight basic principles concerning personal information. Japan's Act on the Protection of Personal Information also covers the content of the OECD Privacy Guidelines.

(i) Collection Limitation Principle

Collect information by lawful and fair means.

(ii) Data Quality Principle

Keep data accurate, complete, and up-to-date, to the extent necessary for the purpose of use.

(iii) Purpose Specification Principle

Specify the purposes not later than at the time of information collection.

(iv) Use Limitation Principle

Do not use information for purposes other than that specified.

(v) Security Safeguards Principle

Protect information against such risks as loss, destruction, modification, or disclosure.

(vi) Openness Principle

Make general disclosure concerning developments, practices, and policies.

(vii) Individual Participation Principle

Clearly indicate the location of data concerning persons, and allow challenges to the data.

(viii) Accountability Principle

Data controllers must comply with measures which give effect to the principles.

4-3 Laws on Labor and Transactions

This subsection explains major laws and regulations concerning labor and transactions. Generally accepted names are given in the text, with official names in brackets.

4-3-1 Laws on Labor

(1) Labor Standards Act

The Labor Standards Act is a law that regulates minimal standards for working conditions (e.g., wages, working hours, breaks, holidays, disciplinary actions, termination of employment) for the protection of workers.

[Terminology related to the Labor Standards Act]

- Article 36 agreement

  This is a labor-management agreement that is concluded for overtime or holiday work in excess of working hours that are stipulated in Article 32 (8 hours/day, 40 hours/week). The Article 36 agreement is so named for Article 36's recognition of extension of working hours and holiday labor through the provision of notification of the agreement to administrative authorities.

- Discretionary labor system

  This is a system by which actual working hours are left to the discretion of workers, with remuneration that is paid according to "deemed working hours" (Article 38, paragraph 3, 4).

- Flexible working hours system

  This is a system that leaves the starting and ending times for work to workers, within a fixed range (Article 32, paragraph 3). In general, a day is divided into core time and flexible time, and the starting and ending times of work are decided within flexible time.

- Maternity protection

  These are protection provisions for pregnant women. The provisions stipulate leave prior to and after birth (Article 65), limits on working hours (Article 66), and child care hours (Article 67), among other matters.

Japan's Three Labor Laws, consisting of the following two laws in combination with the Labor Standards Act, are the laws that form the core of laws on labor.

- Trade Union Act

  This is a law that enables negotiations on working conditions to take place on equal footing between workers and employers. It primarily stipulates matters concerning the conclusion of collective agreements, collective bargaining rights, and the organization of labor unions.

- Labor Relations Adjustment Act

> This law provides for prevention and resolution of labor disputes and the fair adjustment of labor relations. Arbitration and mediation of labor disputes are performed by Labor Relations Commissions.

(2) Worker Dispatching Act (Worker Dispatching Business Law)
[Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers]

The Worker Dispatching Act is a law that is aimed at ensuring the proper operation of worker dispatching undertakings, the protection of dispatched workers, and the stability of employment. It stipulates the business types that are able to perform dispatching, the period of dispatch, and an approval system for dispatching companies (i.e., the dispatching business operator), for the protection of dispatched workers.

Worker dispatching undertakings are those businesses that dispatch workers who have employment agreements with the dispatching companies, to client companies that have entered into a temporary worker dispatch contract. Workers dispatched to the client companies engage in work under the instruction of those companies. For that reason, secondary dispatch by which dispatched workers (who have not concluded employment agreements) are dispatched to another company, or disguised contract work by which the client company issues instructions with concluding service contracts that do not engender authority to provide instructions, is prohibited.

> [Provisions of the Worker Dispatching Act (excerpt)]
> - Dispatching companies appoint a responsible person acting for dispatching undertaking, and perform advice and guidance to dispatched workers, handling of the complaints by dispatched workers, management of dispatched workers' personal information, and other tasks.
> - Dispatching companies prepare management record of dispatching undertaking, and record the dispatch period, the working days, the time of work, the type of work performed, etc. of dispatched workers.
> - Client companies appoint a responsible person acting for client, and perform to make the worker dispatch contracts known to other persons concerned, handling of the complaints by dispatched workers, liaison and coordination with dispatching companies, and other tasks.
> - Client companies prepare management record of client, and record the working days, the time of work, the break hours, the type of work performed, etc. of dispatched workers.
> Note: Period of dispatch, working days and holidays, time of work, work performed,

and other matters are managed by the dispatching company, and must not be subject to modification nor approval by the client company.

- Dispatching companies do not bear the responsibility for completion of deliverables or the defect liability.

(3) Other laws on labor

- Industrial Safety and Health Act

This is a law that stipulates minimum standards concerning the health and safety of workers.

- Act on Securing, Etc. of Equal Opportunity and Treatment between Men and Women in Employment

This is a law that concerns securing, etc. of equal opportunity and treatment between men and women in employment.

- Act on the Welfare of Workers Who Take Care of Children or Other Family Members Including Child Care and Family Care Leave

This law concerns the welfare of workers who take care of children or other family members.

- Act on Improvement, etc. of Employment Management for Part-Time Workers

This law concerns matters including improvement of the employment management for part-time workers.

- Whistleblower Protection Act

This law stipulates measures to protect whistleblowers to provide for nullity, etc. of dismissal because of whistleblowing (i.e., reports of actions in violation of the protection of citizens' lives or interests).

4-3-2 Laws on Transactions

(1) Subcontract Act
[Act against Delay in Payment of Subcontract Proceeds, Etc. to Subcontractors]

The Subcontract Act is a law that, by preventing delay in payment of subcontract proceeds, etc., ensures fair transactions between main subcontracting entrepreneurs that commission manufacturing or other contract, and subcontractors that undertake manufacturing or other contract, and that protects the interests of the subcontractors. Relationships between main subcontracting entrepreneurs and subcontractors are categorized according to capitals.

[Contracts included in manufacturing or other contract]

- Manufacturing contract

  This is the contract of the manufacture of products, components, or metal dies used in the manufacture, etc.

- Service contract

  This is the contract of all or part of the provision of service.

- Information-based product creation contract

  This is the contract of the creation of information-based products (e.g., programs).

(2) Civil Code

The Civil Code is the general law that is applied to resolution of civil issues. Matters concerning transactions in the Civil Code are covered in "Chapter 2 Contracts" of Part III, and the following two forms of contract are stipulated.

- Service contract

  This is a contract by which the contractor promises to complete work for the ordering party, and the ordering party promises to pay remuneration to the contractor for the outcome of the work. The contractor performs the arrangement of workers (e.g., subcontractors) and issues instruction, and bears responsibility for the completion of deliverables and the defect liability for a fixed period (excluding defects, etc. resulting from the direction of the ordering party).

- Mandate contract

  This is a contract by which the mandator mandates a juridical act and the mandatary accept the mandate. The mandatary does not incur the responsibility for completion of deliverables or the defect liability in principle. A mandate contract that is not a juridical act is generally called a (quasi-)mandate contract.

In a service contract, the contractor issues instructions to workers in an employment relationship, directing the workers to execute the work. The following diagram shows the differences between a service contract and a (temporary worker) dispatch contract.
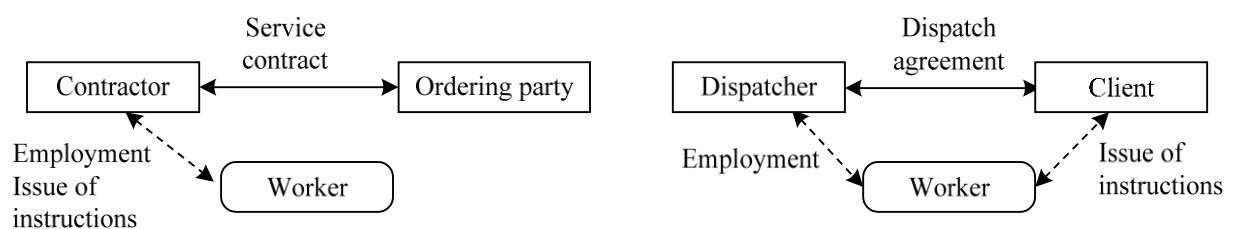
A mandate contract takes the same form as a service contract, with secondment to subsidiaries or affiliated companies incurring authority to provide instructions to the secondment destination in the same manner as a dispatch contract (with the employment contract differing by form of secondment).

(3)　Commercial Code

The Commercial Code is the general law that is applied to business, commercial transactions, and other commercial affairs of merchants. However, the Civil Code applies to matters of commercial affair that are not stipulated by the Commercial Code. The area of the Commercial Code that deals with transactions is "Part II Commercial Transactions", which is sometimes called Commercial Transactions Law. Revisions to the Commercial Code are made in response to changes in forms of commerce over time, and areas of law such as the Companies Act have been separated from the Commercial Code to become independent codes.

(4)　Other laws on transactions

- Electronic Consumer Contract Act

  [Act on Special Provisions to the Civil Code Concerning Electronic Consumer Contracts and Electronic Acceptance Notice]

  This is a law that stipulates special provisions to the Civil Code in cases where there is a certain mistake in the elements comprising an electronic consumer contract (i.e., contracts formed between business operator and consumer via electromagnetic means) executed by a consumer and an electronic acceptance notice is dispatched by a consumer with respect to a contract made by parsons at a distance.

  - Under Article 95 of the Civil Code, manifestation of intention (i.e., a contract) with mistake has no effect in the event of gross negligence. However, in electronic consumer contracts over the Internet, mistakes in operation (i.e., negligence by the consumer) easily occur, which can make this determination of invalidation of mistakes difficult. In response, in the case that confirmation measures (e.g., screens confirming the content of agreements) were not implemented by the business operator, the law allows for the invalidation of contracts that are not intended by the consumer (e.g., measures against one-click fraud).

  - Article 97 of the Civil Code provides for an arrival principle by which manifestation of intent toward a party at a distance becomes valid from the time that notification of the intent arrives at the other party. On the other hand, Article 526 of the Civil Code provides for a dispatch principle, by which a contract between parties at a

distance becomes valid from the time that an acceptance notice is sent. However, a contract application and a notice of acceptance that are delivered by electronic means such as by e-mail between parties at a distance reach the counterparty almost instantaneously, and thus, Article 526 of the Civil Code (i.e., dispatch principle) will not be applicable. Instead, the time that the notice of acceptance for a contract (electronic acceptance notice) reaches the other party is deemed the time that the contract between parties at a distance enters validity.

- Premiums Representation Act

  [Act against Unjustifiable Premiums and Misleading Representations]

  This is a law that regulates misleading representations of product or service quality, content, prices, etc., while it also prevents sales that is accompanied by excessive premiums that are not commensurate with the products. It limits the maximum value of premiums, and protects the interests of general consumers by preserving an environment in which consumers can voluntarily and rationally select better products and services.

- Specified Commercial Transactions Act

  [Act on Specified Commercial Transactions]

  This is a law that stipulates transactions between service providers and consumers that are prone to troubles, such as door-to-door sales and mail order sales. It stipulates regulations on solicitations and other rules that service providers should follow to prevent disputes, and sets forth items such as a cooling-off system to protect consumers.

4-3-3 Contracts Concerning Transactions Between Companies

(1) Outsourcing contracts (subcontracts)

Outsourcing contracts (subcontracts) are contracts that are concluded when all or part of a business or work is commissioned to an external business operator that is not part of the contracting company. In concluding the contract, related laws must be taken into consideration in response to the commissioned content.

Outsourcing contract	Related laws
Temporary worker dispatch contract	Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers (Worker Dispatching Undertakings Act)

Service contract	Civil Code, Subcontract Act
(Quasi-)mandate contract	Civil Code

(2) NDA (Non-Disclosure Agreement)

A NDA (Non-Disclosure Agreement) is an agreement that is concluded to enforce promises to not disclose a company's trade secrets (i.e., to maintain those secrets) when the company commissions work to another business operator and the latter learns of trade secrets through the commissioned business. Different names such as secrecy agreement or confidentiality agreement may be used by some business operators, but the intended content of these is the same.

(3) License agreement (software license agreement)

License agreements (software license agreements) are agreements that are concluded between a software intellectual property rights holder and a user, concerning compliance items in the use of software (e.g., the possibility of or conditions for use, alteration, and redistribution). The compliance items are called a software license, and the form of which allows classification of software as follows:

- Packaged software

  This refers to software that is generally sold commercially.
- Freeware (free software)

  This is software that is distributed free of charge. Copyrights are retained by the developer, and restrictions are set on alteration and redistribution. CC (Creative Commons) licenses and other means are used to display the restrictions that are set by the author.
- Shareware

  This is software that allows trial use free of charge, but requires payment for continued use after the trial period. In other respects, it is the same as freeware.
- PDS (Public Domain Software)

  This is software for which copyright has been abandoned and which can be used free of charge.
- OSS (Open Source Software)

  This is software for which duplication, redistribution, alteration, etc. are not restricted.

The following are the license agreements that are applied to general package software.

Appropriate license agreements should be concluded to prevent unauthorized use of software.

- **Volume license agreement**

  This is an agreement, for companies and other large-volume purchasers of software, which provides a software master and sets the number of allowed installations.

- **Site license agreement** (corporate license agreement)

  This is an agreement which authorizes the use of multiple users and/or multiple computers in specified companies or organizations.

- **Server license agreement**

  This is an agreement that recognizes installation of software on a server and its use by clients.

- **CAL (Client Access License)**

  This is an agreement that recognizes the right of clients to use software (or services) on a server.

- **Machine license agreement**

  This is an agreement that recognizes the use of software on a single computer or a fixed number of specified computers.

- **User fixed license agreement**

  This is an agreement that recognizes the use of software by a single user or a fixed number of specified users.

- **Shrink-wrap license**

  A shrink-wrap license (with the name referring to shrink-wrap packaging) is a license that deems the purchaser of package software to have consented to the software usage agreement at the time of opening the package.

By contrast, typical **OSS licenses** include the following. Rather than restricting duplication, redistribution, alternation, etc. of software, OSS licenses often adopt the concept of **copyleft**, which requires that the same license is also applied to secondary works.

- **GPL (GNU General Public License)** / **LGPL (GNU Lesser GPL)**

  This is a representative copyleft license that is created by the FSF (Free Software Foundation).

- **BSDL (BSD License)**

  This is a license that allows unrestricted reproduction, distribution, and alteration of software, on the condition that copyright is displayed and disclaimers (e.g., a notice that the software is non-warranted) are included.

(4) Software development consignment model contract

The software development consignment model contract is a software development license that is concluded when software development is commissioned to an external party. It was established by a general incorporated association, the JISA (Japan Information Technology Service Industry Association), on the basis of sources including the "information system/model transaction/contract" that is published by the Ministry of Economy, Trade and Industry.

4 - 4 Other Related Laws and Regulations

(1) IT Basic Act
    [Basic Act on the Formation of an Advanced Information and
    Telecommunications Network Society]

The IT Basic Act is a law that stipulates basic principles and a basic policy on the development of strategies with respect to the formation of an advanced information and telecommunication network society. The purpose of this Act is to determine the responsibilities of the Government of Japan and local public entities, to establish the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters), and to provide for the development of a Priority Policy Program on the formation of an advanced information and telecommunications network society to swiftly and thoroughly introduce the measures for the formation of an advanced information and telecommunications network society.

[Basic policy on development of strategies]
- Integrated promotion of advanced information and telecommunications networks including their continued expansion
- Formation of world-class advanced information and telecommunications network society
- Promotion of education and learning and human resource development
- Promotion of electronic commerce, etc.
- Informatization of administration
- Use of the information and communication technology in the public sector
- Ensuring of security of advanced information and telecommunications networks, etc.
- Promotion of research and development
- International collaboration and contribution

(2) Network-related laws and regulations

Network-related laws and regulations are laws that are established for the appropriate and safe use of networks. In basic terms, these are laws and regulations that are placed upon telecommunications carriers, and one example of the network-related laws and regulations is Act on the Limitation of Liability for Damages of Specified Telecommunications Service Providers and the Right to Demand Disclosure of Identification Information of the Senders.

- Telecommunications Business Law
  This is a law for the purpose of making the operation of the highly public telecommunications business appropriate and rational, securing the smooth provision of telecommunications services, and protecting the benefit of users by the promotion of fair competition.
- Radio Law
  This is a law for the purpose of increasing the public welfare by ensuring the fair and efficient use of radio waves.
- Communications Interception Law
  [Law on Communications Interception During Criminal Investigations]
  This is a law that, within the context of criminal investigations, enables the interception of telephone and other telecommunications (e.g., e-mail) that are used for communication among criminals, etc. It is applied only in cases that it is extremely difficult to reveal the true facts of cases without performing interception of telecommunications that are used for communication among criminals.

(3) Financial Instruments and Exchange Act

The Financial Instruments and Exchange Act is a law that ensures the fairness in the issuance of securities and the transactions of financial instruments, by providing for necessary matters relating to persons who engage in the financial instruments business and securing the appropriate operation of financial instruments exchanges. This law also covers the development of systems for disclosure of corporate affairs and other related matters, and requires the submission of reports including the following.

- Annual securities report (Article 24)
  This is a report on key matters concerning accounting status and business contents, which is information that is required for the protection of the public interest and of investors. Companies which are the issuers of securities (e.g., stocks) shall submit a report to the Prime Minister for each business year.

- Internal control report (Article 24-4-4)

  This is a report on the evaluation of systems which is necessary to ensure the appropriateness of documents on finance calculation and other information. Companies which are required to submit an annual securities reports shall submit this report to the Prime Minister together with the annual securities report for each business year. The part of the internal control report in the Financial Instruments and Exchange Act is sometimes called J-SOX Act.

(4) Companies Act

The Companies Act is a law that stipulates the establishment, organization, operation, and management of companies. Within the Companies Act, "Part II Stock Company" covers the establishment of a stock company, stocks, company organs, and other matters. Chapter IV of this Part regulates matters including the selection and authority of a stock company's organs (e.g., shareholders' meetings, directors, board of directors, accounting advisors, auditors, board of auditors, accounting auditors or committees, and executive officers), according to standards such as Large Company (capital of ¥500 million or more, or total liabilities of ¥20 billion or more) and Company with Committees (a stock company with a nominating committee, an audit committee, and compensation committee). Part V regulates reorganization such as entity conversion, mergers, corporate splits, etc.

The Companies Act also regulates the following two matters.

- Business reports (Article 438)

  At Stock Companies, the Financial Statements (e.g., the balance sheets, the profit and loss statements) and the business reports shall be submitted at annual shareholders' meetings. Moreover, Directors shall report the content of business reports at annual shareholders' meetings.

- Internal control (Article 362)

  A Company with Board of Directors that is a Large Company shall decide matters concerning the development of systems necessary to ensure that the execution of duties by directors complies with laws and regulations and the articles of incorporation, and other systems prescribed by the applicable Ordinance of the Ministry of Justice as systems necessary to ensure the properness of operations of a Stock Company.

  Note: Internal control refers to mechanisms within a company or other organization, by which the organization constructs and operates systems for the proper execution of its business.

(5) Tax law

Tax law is a general name covering laws for the imposition of taxes. For each type of tax, laws stipulate matters concerning taxpayers, the scope of taxable income, etc., tax amount calculation methods, and procedures for the filling of return, the payment, and the refunds, and matters necessary to ensure the appropriate fulfillment of tax liability.

- **Corporation Tax Act**
  This law regulates the corporation taxes (e.g., business taxes) that corporations are liable to pay.
- **Income Tax Act**
  This law regulates the income taxes that are imposed on the income of individuals and corporations.
- **Consumption Tax Law**
  This law regulates the consumption taxes that are imposed on the transfer of assets, etc. (e.g., sale of goods).

(6) E-Document Law (Electronic Document Law)

The e-Document Law (Electronic Document Law) is a comprehensive name for two laws: the Act on Utilization of Information and Communications Technology in Document Preservation, etc. Conducted by Private Business Operators, etc.; and the Act on Revision, etc. of Related Acts that Accompany the Enforcement of the Act on Utilization of Information and Communications Technology in Document Preservation, etc. Conducted by Private Business Operators, etc. The Act admits the preservation, etc. of documents by private businesses in the form of electromagnetic records (i.e., digital data) rather than on paper. Since authenticity of documents is a vital matter under the Electronic Document Law, means such as time authentication (time stamp authentication) are used.

(7) Electronic Ledger Preservation Law
[Law Concerning Preservation of National Tax Records in Electronic Form]

The Electronic Ledger Preservation Law is a law that stipulates the methods of preserving national tax-related books and documents that are created through the use of computers as special provisions to the Income Tax Act, Corporation Tax Act, and other laws concerning national tax. The law's aims include reducing burdens concerning the preservation of taxpayers' national tax-related books and documents, with ensuring the appropriate fulfillment of national tax liability. The Law recognizes the preservation of books and documents by

using electronic records (i.e., digital data) or computer-output microfilm (i.e., microfilm created through the output of electromagnetic records using computers), as long as specific requirements are met.

(8) Information Disclosure Act
[Act on Access to Information Held by Administrative Organs / Incorporated Administrative Agencies, etc.]

The Information Disclosure Act is a law that stipulates that any person may request the disclosure of administrative documents that are made by administrative organs (documents and electromagnetic records having been prepared or obtained by employees of administrative organs in the course of his/her duties) or corporate documents. In principle, when there is a disclosure request for information that is made by a citizen, the information must be disclosed except non-disclosure information (e.g., personal information, corporate information, and information pertaining to national security). The Information Disclosure Act stipulates that administrative organs and incorporated administrative agencies bear an accountability for their activities to citizens.

(9) PL Act (Product Liability Act)

The PL Act (Product Liability Act) is a law that stipulates liability of manufacturers, etc. for compensation of damage in the case of harm to body, life, or property which is caused by defects in manufactured items (or products).

[Precautions in the PL Act]
- In the pursuit of liability for compensation of damage, the Civil Code stipulates that the burden of proof lies with the victim side, and therefore, the consumer side must demonstrate that damage resulted from defects in manufactured items.
- Since manufactured item refers to either manufactured or processed movables, programs are not subject to the Law. However, in the case that a machine with an embedded program causes damage because of a defect in the program, the manufacturer of the machine will incur liability.
- Manufacturer, etc. refers to any person (i.e., manufacturer) who manufactured, processed, or imported the products, and any person who provides any representation of name, etc. on the product which holds himself/herself out as its substantial manufacturer.
- Liability for compensation of damage is not incurred in cases such as the following.
  - When the state of science or technology at the time of delivery of the manufactured item was unable to recognize the presence of the defect

- • When the defect resulted from the design or instructions of the party commissioning (or requesting) manufacture, and there was not negligence in the occurrence of the defect
- • When 3 years have passed since the victim or the proxy thereof became aware of the damages and of the party that liable for the compensation of damages, or 10 years have passed since the delivery of the products

(10) Environment-related laws

- • Waste Management Act

  [Waste Disposal and Public Cleansing Act]

  This is a law that is aimed at the preservation of the living environments and the improvement of public health, by the reduction of waste discharged, the appropriate process of separation, storage, collection, transport, recycle, disposal, etc. of wastes, and the clean-up of living environments.

- • Act for Promotion of Use of Recycled Resources

  This is a law that stipulates the separation, collection, recycling, and reuse of resources and wastes. Laws including the following have been established for types of recycled object.

Name of law (abbreviation)	Recycled object
Containers and Packaging Recycling Law	Bottles, cans, wrapping paper, pet bottles, etc.
Home Appliance Recycling Law	Air conditioners, refrigerators, washing machines, televisions, etc.
Construction Material Recycling Law	Concrete, wood materials, etc.
Food Recycling Law	Food waste, etc.
Automobile Recycling Law	Parts from disassembly of automobiles, etc.
PC Recycle Law	PCs, etc.

4 - 5 Compliance

Compliance refers to measures by which companies "comply with laws, regulations, rules, social norms, etc." Compliance can be seen as the creation of systems by which all members of a company, from top management to employees, observe the corporate ethics/morals,

observe numerous laws and rules related to corporate activity in accordance with corporate philosophy (management philosophy), and detect and rectify violations at an early stage.

[Components of compliance]

- CSR (Corporate Social Responsibility)

  In corporate activities, CSR refers to the responsibilities that a company should fulfill with respect to social conditions and to various demands from citizens, regions, etc.

- Corporate governance

  This refers to measures for the purpose of sound management activities, to enable companies to earn the trust of customers and markets.

- Internal control

  Internal control refers to mechanisms within a company or other organization by which the organization constructs and operates systems for the appropriate execution of its business.

- Respect for human right

  This refers to activities that respect and protect people's rights as human beings. This includes compliance with the Act on the Protection of Personal Information to protect the rights of customers, pursuit of the work-life balance and the mental health, and the observance of the Labor Standards Act to protect the human rights of workers.

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(1) System Management Standards

System Management Standards are practical guidance for organizations to establish effective information system strategies; to carry out effective information system investment within the life cycle of information system planning, development, operation, and maintenance; and to appropriately improve and operate controls to reduce risk.

System Management Standards note the following concerning compliance.

(i) Establish an organization for legal and regulatory compliance and appoint management for it.

(ii) Identify applicable laws and regulations to the organization, and inform and educate stakeholders.

(iii) Define the information ethics, and inform and educate related persons.

(iv) Establish policies concerning processing of personal information, protection of intellectual property rights, and provision of information disclosure.

(v) Assess level of compliance with laws, regulations, and the information ethics, and take necessary actions for improvement.

In addition, System Management Standards I. Strategic IT Plan, "1-3 Development of the total optimization plan", notes that "Consider compliance requirements in the development of the total optimization plan."

(2) Software Management Guidelines

Software Management Guidelines are a collection of matters that corporations, organizations, etc. should implement to prevent the illegal duplication of software. Since illegal reproduction of software constitutes a serious violation of compliance (i.e., infringement of the copyright law), organizations must enforce software management in accordance with these guidelines.

[Basic matters in Software Management Guidelines]
- Basic matters that corporations, etc. should implement
- Matters that persons responsible for software management should implement
- Matters that software users should implement

(3) Export Control Internal Rules
[Internal Rules Concerning Compliance with Export-Related Laws and Regulations]

Export Control Internal Rules refers to a compliance program (i.e., a plan for compliance with laws and regulations by companies) that are promoted by the Ministry of Economy, Trade and Industry. Prior to the export of computer-related products, etc., organizations are required to confirm that cargo specifications, export destination, means of use, and other matters are not in violation of laws and regulations, in order to prevent misuse of the exported goods overseas as arms or weapons. While items prohibited for export are stipulated by the Foreign Exchange Act and other regulations, the Export Control Internal Rules were established because errors can easily occur under the further involvement of the U.S. EAR (Export Administration Regulations), etc.

- Foreign Exchange Act [Foreign Exchange and Foreign Trade Act]
  This is a law that, on the basis of freedom of foreign exchange, foreign trade, and other foreign transactions, enables the proper development of foreign transactions and the maintenance of peace and security in Japan and in the international community through the minimum necessary control or coordination, and thereby ensures equilibrium in the international balance of trade and currency stability, and at the same time, to contribute to the sound development of the Japanese economy.

(4) Information ethics and engineer ethics

Ethics (or morals) are an awareness of compliance with law, and represent a path that humans should continue to preserve. The ethics of persons involved in corporate activities take on particular importance in the area of compliance.

- Information ethics (information morals)

  This refer to the ethics that are deemed necessary for involvement with information (or IT). These ethics include heeding the Intellectual Property Rights Act, the Act on the Protection of Personal Information, the Act against Unjustifiable Premiums and Misleading Representations, and other laws and regulations, and following information communications manners, or "netiquette," for using the Internet.
- Engineer ethics

  These are the ethics that are required of engineers. Professionalism (i.e., the ethical sense as a professional), with an awareness of engineers' social responsibilities as professionals on the basis of a code of ethics (i.e., a policy of ethical legal compliance) for engineers, is required.

4 - 6   Standardization and Certification Systems

4-6-1 Standards/Specifications and Standardization Organizations

(1) JIS (Japanese Industrial Standards) / JISC

JIS (Japanese Industrial Standards) is based on an original draft that is created by the JSA (Japanese Standards Association) and is deliberated by the JISC (Japanese Industrial Standards Committee). It is an industrial standard that is established by the competent ministers (i.e., Minister of the Environment, Minister of Economy, Trade and Industry, Minister of Health, Labor and Welfare, Minister of Land, Infrastructure and Transport, Minister for Internal Affairs and Communications, Minister of Agriculture, Forestry and Fisheries, and Minister of Education, Culture, Sports, Science and Technology), and is one of Japan's national standards. In deliberative councils that are established by the Ministry of Economy, Trade and Industry, JISC conducts studies and deliberations on industrial standardization overall, on the basis of the Industrial Standardization Act.

There are mainly two ways to formulate each JIS. One is to formulate it technologically identical to ISO or by modifying ISO. The other is to formulate it domestically or uniquely to Japan. In the case of the former type of JIS, the JIS number is identical to ISO number.

Name of standard		Content of standard	Relation with ISO
JIS X sector		A standard concerning information processing overall	
JIS Q sector		A standard concerning management systems overall	
	JIS Q 9000	A standard concerning quality management systems	Identical to ISO 9000
	JIS Q 14001	A standard concerning environmental management systems	Identical to ISO 14001
	JIS Q 15001	A standard concerning personal information protection management systems	No relation
	JIS Q 20000-1	A standard concerning service management systems	Identical to ISO/IEC 20000-1
	JIS Q 27001	A standard concerning information security management systems	Identical to ISO/IEC 27001

(2) IS (International Standards) / ISO

IS (International Standards) are standards that are established by international standardization bodies that is represented by ISO (International Organization for Standardization). ISO is an international standardization organization that is established in 1947. Headquartered in Geneva, Switzerland, it is composed of representative standardization organizations from many countries. It aims to establish international standards for all sectors of industry (e.g., mining, agriculture, pharmaceuticals), with the exception of the sectors of electric and electronic technology. The ISO performs international certification through the adoption of the ISO certification scheme. In addition, for WTO (World Trade Organization) member nations, the WTO mandates integration with international standards such as ISO standards, and adoption of international standards for certification schemes.

Standards that are established by ISO are indicated with the prefix "ISO"; those which are established jointly with the IEC (see below) are indicated with "ISO/IEC".

Name of standard	Content of standard
ISO 9000	Standards concerning quality management systems
ISO 14000	Standards concerning environmental management systems
ISO/IEC 20000	Standards concerning service management systems
ISO/IEC 27000	Standards concerning information security management systems

(3)　Other standardization bodies

- **ITU (International Telecommunication Union)**

  This is an international standards body in the telecommunications sector, which was reorganized from the CCITT (Comité Consultatif International Téléphonique et Télégraphique = International Telegraph and Telephone Consultative Committee) in 1993. In addition to standardization work, the primary activities of the ITU include establishing international agreements and treaties concerning telecommunications. It is composed of organizations including major telecommunications service providers, financial institutions, and governmental institutions (Ministry of Internal Affairs and Communications in Japan) with jurisdiction over the telecommunications sectors in their respective countries. Its subordinate organizations include the ITU-T (International Telegraph Union Telecommunication Standardization Sector).

- **IEC (International Electrotechnical Commission)**

  This is an international standardization body in the electrical and electronics technology sector, established in 1906. Its headquarters is located in Geneva, Switzerland. A part of IEC standards has been created jointly with ISO.

- **IETF (Internet Engineering Task Force)**

  This is a voluntary association that promotes the standardization of Internet technology. IETF technical specifications are documented and published under the name RFC (Request For Comments).

- **ANSI (American National Standards Institute)**

  This is a U.S. body for standardization in the industrial sector. Although ANSI standards are essentially U.S. domestic standards, they often become ISO or other international standards.

- **IEEE (Institute of Electrical and Electronic Engineers)**

  This is a body related to the electrical and electronics sector, established in 1963. Its headquarters is located in New York, U.S. It is essentially an academic body, but it also engages in standardization activities and has contributed to standardization in the telecommunications sector in particular.

(4)　De facto standards

De facto standards (or industry standards) are standards that were determined by a particular company or group but have become widely used, thus constituting standards for practical purposes. In contrast to de facto standards, those established by official standardization bodies are called de jure standards.

・OMG (Object Management Group)

This is a standardization group (or body) for object orientation technology. It manages the standard UML (Unified Modeling Language).

・W3C (World Wide Web Consortium)

This is an organization that sets a variety of technical standards that are used on the World Wide Web (WWW). It establishes standards for the HTML and XML that describe web pages.

4-6-2 Standards Related to Software Development

(1) Standardization of development and transaction processes

・SLCP-JCF (Software Life Cycle Process-Japan Common Frame)

This is a common frame that defines the work items that form the basis for the rationalization of software development and its transactions, and offers a "common yardstick" to acquirers and suppliers. In 2013, Common Frame 2013 (SLCP-JCF2013) was released.
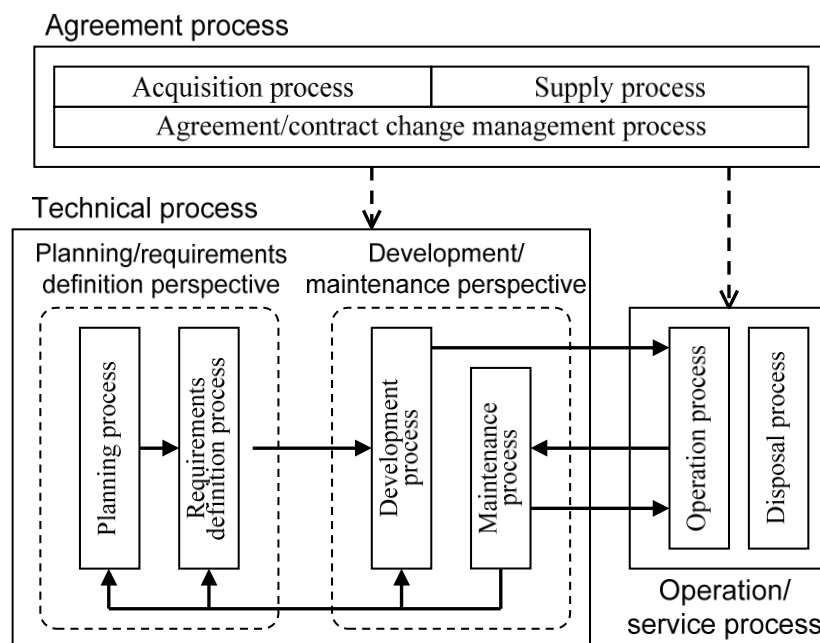
・JIS X 0160 / JIS X 0170

These are JIS standards that provide a defined set of processes to facilitate communication among acquirers, suppliers, and other stakeholders in the life cycle. JIS X 0160 addresses "software products," while JIS X 0170 addresses "systems." These

> standards form the basis for SLCP-JCF.

(2) Standards for environment and IT security evaluation

- **ISO 14001 / JIS Q 14001**

  This is a standard that specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and information about significant environmental aspects.

- **ISO/IEC 15408 / JIS X 5070**

  This is a standard that stipulates evaluation criteria for security technologies and IT security, in the form of a guide for the development, evaluation and/or procurement of IT products with security functionality.

(3) Standards for software

- **CORBA (COmmon Request Broker Architecture)**

  This is a standard specification that enables message exchange among objects created by using different programming languages in a distributed environment. It is defined by OMG, a standardization group (or body) for object orientation technology.

- **EJB (Enterprise JavaBeans)**

  This is a standard specification that is defined on the server side for distributed-network business applications, in the same manner as the JavaBeans specification which is a convention for handling programs that are developed in Java as components of applications.

(4) Standards for data

(i) Character codes

These are the codes that represent characters (e.g., alphabetic characters, numerals). The following types are the character code sets that are used as standards in PCs, etc. in Japan.

- **JIS code**

  This is a code set that is established by JISC (Japanese Industrial Standards Committee) for displaying characters specific to Japanese.

- **Unicode**

This is a 2-byte, universal character code set that is proposed and endorsed by U.S. companies for the smooth interchange of PC data.

- EUC (Extended Unix Code)

This is a character code set that is regulated by AT&T, for the internationalization of UNIX.

(ii) Bar codes

This is a code that represents numbers or letters through differences in the thickness and spacing of lines. The following are JIS standards for bar codes that are used in Japan.

Name of code	JIS standard	Application
JAN code	JIS X 0507	A bar code for displaying product codes (compatible with EAN/UPC; composed of country code / manufacturer code / product code / check digit)
ITF code	JIS X 0502	A bar code for physically distributed product codes
ISBN code	JIS X 0305	International Standard Book Number (bar code for books)
QR code	JIS X 0510	A 2-dimensional code symbol (a 2-dimensional bar code recording information in the vertical and horizontal directions, where the numbers, letters, Kanji characters, and other data can be stored)

4-6-3 Certification Systems

Certification systems are systems for examining and certifying whether products, processes, systems, etc. that are the targets of certification comply with the requirements of the corresponding standards. For organizations, it has important significance to obtain international certification such as ISO certifications.

In certification, a conformity assessment body that is accredited by an accreditation body implements conformity assessments to verify whether products, processes, systems, etc. fulfill specified requirements. At this time, the certification cannot be accorded value (or reliability) if the conformity assessment body cannot perform a correct evaluation through fair examination. For that reason, ISO/IEC 17000 (JIS Q 17000) stipulates the implementation of conformity assessments in a 2-step tiered structure.

[Implementation scheme for conformity assessments]

• Accreditation body

This is a body that performs accreditation (i.e., third-party attestation) of a conformity assessment body's ability to correctly perform specified conformity assessments. By being accredited by an accreditation body, conformity assessment bodies are able to act as certification bodies.

• Certification body

This is a body that implements conformity assessments to confer certification (i.e., third-party attestation). Depending on the target and implementation method of conformity assessments, certification bodies may be called product certification bodies, management system certification bodies, test laboratories, inspection agencies, etc.
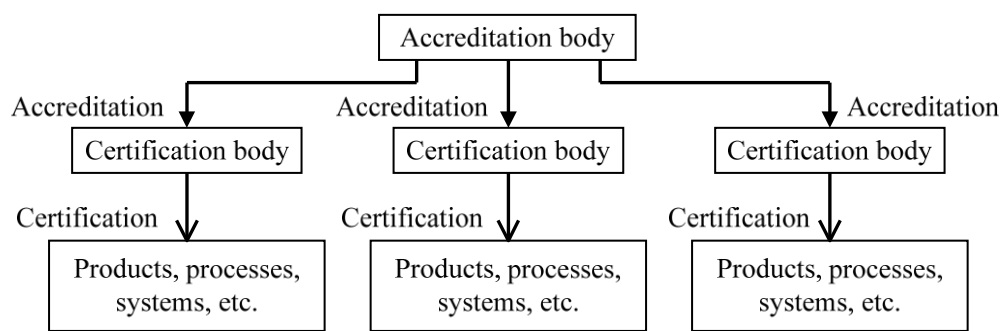
The following are typical international certifications.

• ISO 9000 certification

This is an international certification for quality management systems. It examines not only the quality of products, but also whether the organization's quality management system overall is in conformance.

• ISO 14000 certification

This is an international certification concerning the construction of EMS (Environmental Management Systems). It calls for the construction of environmental management systems and the construction of a PDCA cycle to effect ongoing improvements.

• ISMS (Information Security Management System) conformity assessment scheme

This is an international certification for the construction of security management systems.

Chapter 1   Exercises

Q1

Which of the following is an appropriate explanation of "going concern"?

a) The promotion of energy conservation in today's IT-based society and the approach to the conservation of the global environment

b) The act of publishing the internal state of the company to the society.

c) The concept for any company to continue its corporate activities indefinitely and to continue to meet its missions

d) The responsibilities of a company in response to requests from society or local communities

Q2

A company divides its departments up by territory and uses an independent accounting system for each territory. Which of the following is the management organization that corresponds to this type?

a) Divisional organization

b) Project organization

c) Matrix organization

d) Line and staff organization

Q3

Which of the following is a financial statement that shows the assets, liabilities, and net assets of a company at a specific point in time and indicates the financial situation of the company?

a) Journal book

b) General ledger

c) Income statement

d) Balance sheet

Q4

When the depreciation of a machine that was purchased for 10,000 dollars is conducted with 6-year fixed-rate method, the depreciation cost after the first year is 3,200 dollars. How much is the approximate amount of the depreciation cost (in dollars) after the second year?

a) 1,000   b) 2,200   c) 3,200   d) 6,800

Q5

At the closing account at the end of the fiscal period, the income statement information is obtained as shown in the table below. How much is the operating profit (in millions of dollars) for this period?

Unit: million dollars

Item	Amount
Sales	150
Cost of sales	100
Selling, general, and administration expense	20
Non-operating income	4
Non-operating expense	3

a) 27   b) 30   c) 31   d) 50

Q6

Which of the following is an explanation of ROE?

a) It represents the profitability against the equity capital.
b) It represents the profitability against the total assets.
c) It represents the effectiveness of investments on the basis of the ratio of profit to investment amount.
d) It represents the financial safety on the basis of the ratio of current assets to current liabilities.

When each item that is calculated by using the income statement has a value as shown in the table, how much is the break-even point sales (in dollars)?

Unit: dollar

Item	Amount
Sales	10,000
Variable costs	8,000
Fixed costs	1,000
Profit	1,000

a) 5,000   b) 7,000   c) 8,000   d) 9,000

Which of the following is equivalent to the set "$S - (T \cup R)$"? Here, S is the universal set, T and R are subsets of S, and $\cap$, $\cup$, and $-$ represent each operation of the product set, the union set and the difference set, respectively.

a) $(S - T) - R)$ b) $(S - T) \cup (S - R)$

c) $(S - T) \cup (T - R)$ d) $(S - T) \cap (T - R)$

P, Q, and R are propositions. When the truth value of proposition P is true, which of the following is the appropriate combination of truth values for Q and R so that the two proposition expressions below are true?

Proposition 1:   (not P) or Q
Proposition 2:   (not Q) or R

a) Q is true, R is false.   b) Q is false, R is true.

c) Q is true, R is false.   d) Q is true, R is true.

Q10

When a bag contains four white balls and five red balls, what is the approximate percentage of probability that both balls are red when two balls are removed in succession, without returning the first ball to the bag?

a) 17   b) 20   c) 28   d) 31

Q11

A factory manufactures a component of a certain length, and an error of the length follows a normal distribution with an average error of 1.25 mm and a standard deviation of 0.50 mm. If the allowed range for the error is ±2 mm, what is the percentage of defective products?
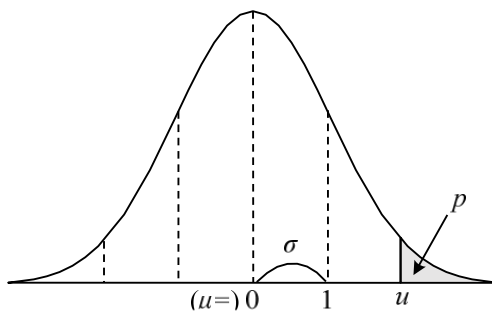
Standard normal distribution table

u	p
0.0	0.500
0.5	0.309
1.0	0.159
1.5	0.067
2.0	0.023
2.5	0.006
3.0	0.001

a) 2.3   b) 4.5   c) 6.7   d) 13.4

Q12

In a visitor counter service, which of the following is the theory that is used to analyze the number of counters and the service time in response to the arrival status of the visitors?

a) XY theory   b) Graph theory

c) Game theory   d) Queueing theory

Every day, store *T* makes sweets *K* and *L* that are then packaged and sold as products *M* and *N* respectively. The combination of packages and the profit per product are as shown in the table. The maximum manufacturing capacity of sweets *K* per day is 360 units, and 240 units for sweets *L*. What is the profit in dollars when all manufactured-and-packaged units of product *M* and product *N* are sold so that the single day sales profit is maximized?

	Sweets *K*	Sweets *L*	Sales profit
Product *M*	6 units	2 units	6 dollars
Product *N*	3 units	4 units	4 dollars

a)   240   b)   360   c)   400   d)   480

Which of the following is the appropriate combination of the earliest and latest node times on the node N4 in the arrow diagram shown in the figure? Here, node N1 starts at time 0.
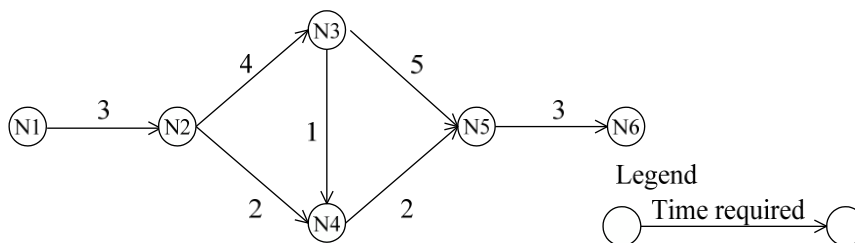
	Earliest node time	Latest node time
a)	5	8
b)	5	10
c)	8	8
d)	8	10

Q15

What is the approximate EOQ for the product that is shown in the table below?

Item	Value
Total annual demand	100,000 units per year
Annual storage cost per stock	50 dollars/unit per year
Ordering cost per order	1,000 dollars per order

a) 1,000   b) 2,000   c) 3,000   d) 4,000

Q16

Company *A* and Company *B* choose a strategy each from two different strategies, and the benefit for choosing each strategy is predicted as shown in the table below. Which of the following is the benefit that is gained by Company *A* when both companies choose a strategy on the basis of the maxi-min principle? Here, in each cell of the table, the value on the left is the benefit of Company *A* and the value on the right is the benefit of Company *B*.

		Company *B*	
		Strategy *b1*	Strategy *b2*
Company *A*	Strategy *a1*	−15, 15	20, −20
	Strategy *a2*	5, −5	0, 0

a) −15   b) 0   c) 5   d) 20

Q17

Which of the following is an appropriate explanation of the work sampling method?

a) When a single cycle of activity time is short or if an activity can be divided before observation, it measures the activity time with a stopwatch.

b) It performs numerous instantaneous observations of what work status the observation target was in at certain points in time, then use the ratio that is obtained from the number of observation records to estimate each work time.

c) It breaks down the observed work content into its basic operations and analyzes them, and then calculates the standard work time from the standard time that is defined in advance for each basic operations for each activity condition.

d) It finds the work time through the experiential decision of people who are involved in the work for an extended period of time, such as a foreman or group leader.

Q18

This figure is an OC curve (Operating Characteristic curve) that represents the results of a sampling of a certain product lot. Which of the following is a description that represents this graph?
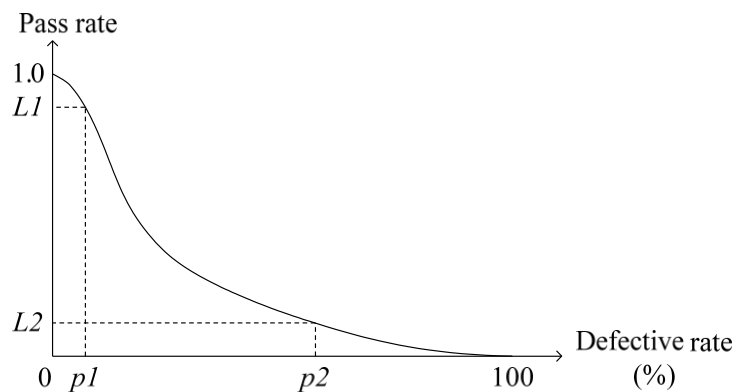
a) The probability that a lot with a defective rate greater than $p1$ passes is greater than $L1$.
b) The probability that a lot with a defective rate lower than $p1$ fails is greater than "$1.0 - L1$".
c) The probability that a lot with a defective rate greater than $p2$ passes is less than $L2$.
d) The probability that a lot with a defective rate lower than $p2$ fails is less than "$L1 - L2$".

Q19

Which of the following is an appropriate explanation of a control chart?

a) It sets two types of data on the vertical and horizontal axes of a graph, and plots the measured values to determine the correlation between the data sets.
b) It systematically organizes the relationships between cause and effect in a fishbone-like format, and clarifies which causes are related to a particular result.
c) It is used to discover abnormalities by representing data variability that occurs in a time series as a line graph and by setting upper and lower limit values.

d) It is used to understand the variability in quality by dividing data into several sections and plotting the number of data items in each section as a bar graph.

Q20

Which of the following is NOT an appropriate rule for brainstorming?

a) Freewheeling
b) Prohibition of criticism
c) Free piggybacking
d) Quality over quantity

Q21

Which of the following is an explanation of the KJ Method?

a) A method of defining the process that are required to reach the desired result in response to a variety of expected problems as an event develops
b) A method of clarifying problems that need to be resolved by grouping collected information on the basis of their reciprocal relationship
c) A method of determining the causal relationship between events which have a mix of complex factors
d) A method of sequentially developing the approaches or plans that are required to achieve objectives or goals and pursuing the optimal process or method

Q22

Which of the following is a case example that is suitable for using a radar chart?

a) Displaying the number of products sold this month by individual sales representatives
b) Displaying the market share of each company for a particular product
c) Displaying the change in the yearly sales volume of a product
d) Displaying the functional merits of a product on the basis of multiple evaluation items

The table below shows an aggregation of the number of defective products by each products. How many types of products are there in group *A*, which are required for an action on the basis of an ABC analysis? It can be assumed that group *A* represents a cumulative percentage of 70%.

Product	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*	*X*	Total
Count	182	136	120	98	91	83	70	60	35	875

a) 3   b) 4   c) 5   d) 6

<Informational: this question is applicable in Japan only.>

Which of the following is a right that is **NOT** included in the industrial property rights?

a) Design right   b) Trademark right
c) Copyright   d) Patent right

<Informational: this question is applicable in Japan only.>

Which of the following is an appropriate description concerning the Copyright Act?

a) In a school or other educational institution, even if a commercially sold workbooks are copied and distributed to students without permission from the publisher, it is not a copyright infringement.
b) If the purpose is for making a backup, copy guard can be removed from a copy guard-protected program without resulting in a copyright infringement.
c) It falls under private use to display a copy of a photo in a commercial photo collection in your living room, and therefore, that is not a copyright infringement.
d) It is not a copyright infringement to place someone else's copyrighted work on your own homepage as long as nobody else references that data.

Q26

<Informational: this question is applicable in Japan only.>

Which of the following is protected under the Unfair Competition Prevention Act?

a) An invention for which a patent right is obtained

b) A unique system development manual that is distributed

c) Vital design documents in order to develop an internal company system that is not managed as confidential information

d) Non-public customer lists for business activities that are handled as confidential information

Q27

<Informational: this question is applicable in Japan only.>

Which of the following is a law that prohibits the abuse of an OS security hole?

a) Act on the Protection of Personal Information

b) Electronic Signature Act

c) Act on the Regulation of Transmission of Specified Electronic Mail

d) Act on the Prohibition of Unauthorized Computer Access

Q28

*<Informational: this question is applicable in Japan only.>*

Which of the following is an appropriate explanation concerning the discretionary labor system?

a) A labor-management agreement is concluded to perform any work beyond designated working hours.

b) Starting and ending times for work are left to workers within a fixed range.

c) Remuneration is paid according to deemed working hours instead of actual working hours.

d) Measures must be taken such that late-night work is not assigned to female employees who are currently pregnant.

Q29

The diagram below shows the employment relationship between companies and a worker. Which of the following is an appropriate relationship between Company *B* and Worker *C*?
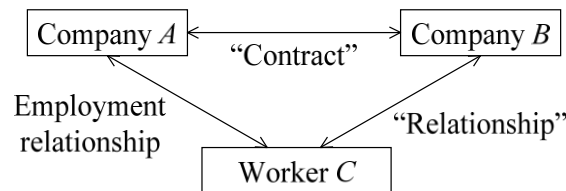
a) When the "Contract" is a mandate contract with Company *A* as a mandatary and Company *B* as a mandator, an employment relationship incurs between Company *B* and Worker *C*.

b) When the "Contract" is a service contract with Company *A* as an entrustee and Company *B* as an entruster, Company *B* has the authority to provide instructions to Worker *C*.

c) When the "Contract" is a secondment-related contract with Company *A* loaning Worker *C* to Company *B*, there is no specific relationship incurred between Company *B* and Worker *C*.

d) When the "Contract" is a temporary worker dispatch contract with Company *A* as a dispatching company and Company *B* as a client, Company *B* has the authority to provide instructions to Worker *C*.

Q30

Which of the following is a law to enable a consumer to cancel an order that is made by mistakes in operation when the consumer purchases a product through the Internet?

a) Act against Unjustifiable Premiums and Misleading Representations

b) Whistleblower Protection Act

c) Act on Special Provisions to the Civil Code Concerning Electronic Consumer Contracts and Electronic Acceptance Notice

d) Act on Specified Commercial Transactions

Q31

Which of the following is an appropriate explanation of a site license agreement?

a) An agreement which pre-defines the number of computers on which the software can be installed.

b) An agreement which grants clients the right to use server software.

c) An agreement which deems the purchaser of package software to have consented to the software usage agreement at the time of opening the package.

d) An agreement which grants usage rights to multiple computers at once.

Q32

<Informational: this question is applicable in Japan only.>

Which of the following is a law that requires companies who meet specific conditions to submit an annual securities report and an internal control report?

a) Basic Act on the Formation of an Advanced Information and Telecommunications Network Society

b) Financial Instruments and Exchange Act

c) Act on Access to Information Held by Administrative Organs

d) Electronic Document Law

Q33

<Informational: this question is applicable in Japan only.>

Which of the following is a case example in which liability to compensate for damages is incurred on the basis of the PL Act?

a) A television that was purchased 20 years ago from an electronics retail store can no longer be used because it is not corresponding to digital broadcasting.

b) When a customer's hand was stuck in a washing machine, an injury incurred because the machine failed to stop because of a control program bug.

c) A downloaded program was infected with a virus and caused important data to be lost from the customer's PC.

d) After a customer purchased stocks by using pre-installed software on his/her PC, the stock value rapidly dropped because of a recession.

Which of the following is a JIS standard concerning environmental management systems?

   a) JIS Q 14001 b) JIS Q 15001   c) JIS Q 20000   d) JIS Q 27001

Which of the following is an appropriate characteristic of JAN codes?

   a) It is a universal 2-byte character code.
   b) It is not compatible with non-Japanese (or overseas) standards.
   c) It includes information such as country code and manufacturer number.
   d) It is a 2D bar code which stores data both horizontally and vertically.