New FE Textbook Vol.2

IT Strategy & Management

IPA

INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN

IT Strategy and Management

Introduction

Chapter 1 Corporate and Legal Affairs

Chapter 2 Business Strategy

Chapter 3 Information Systems Strategy

Chapter 4 Development Technology

Chapter 5 Project Management

Chapter 6 Service Management

Chapter 7 System Audit and Internal Control

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.

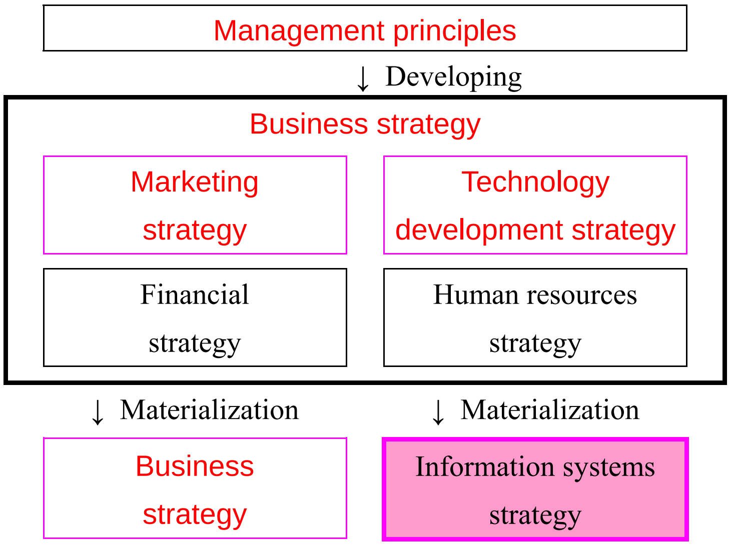
This business system includes software (i.e., business package) that is sold commercially for use in the business field, and software that is developed within companies (or through outsourcing) for their own business operations.

(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

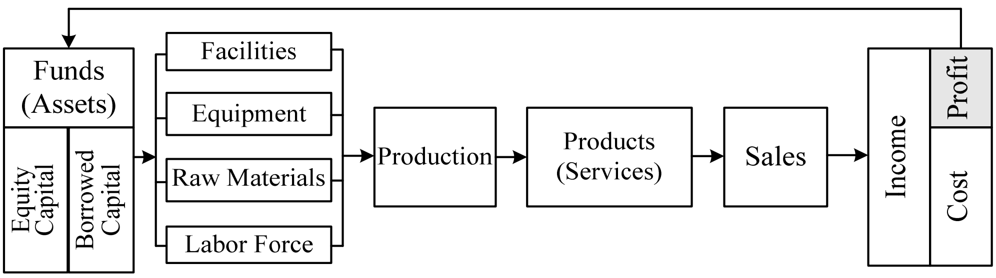
1 Corporate Activities

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

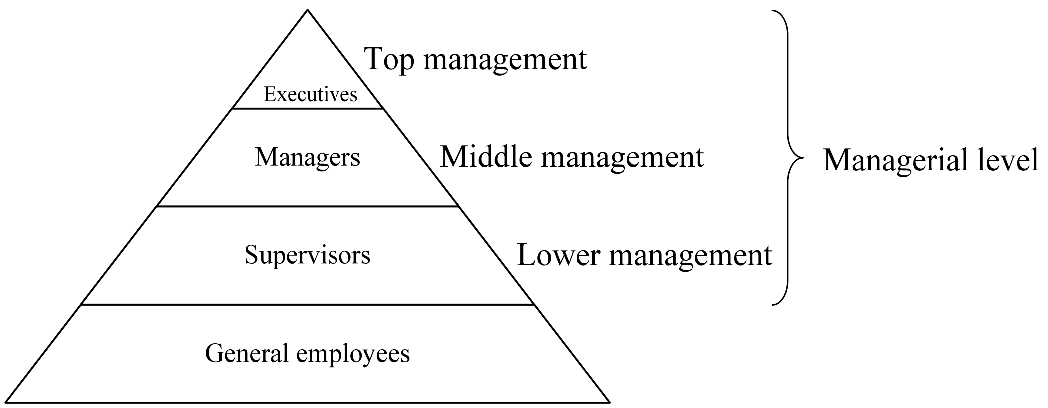
An auditor performs audits of accounting or the execution of operations by directors, and presents the results of those audits at stockholders' meetings. Large companies are required to have an auditor in place at all times.

- 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.

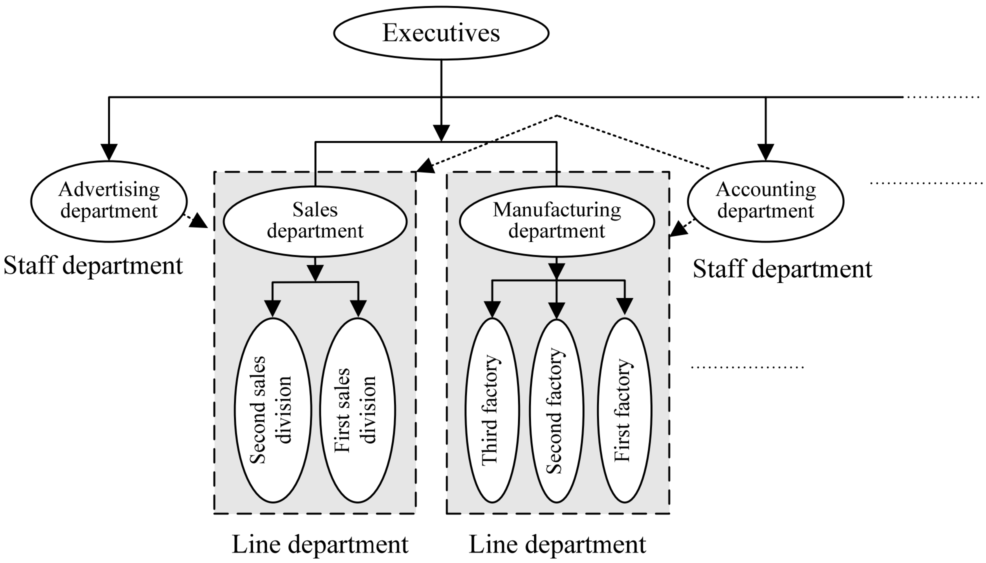


Figure 1-1 Line and staff organization

(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."

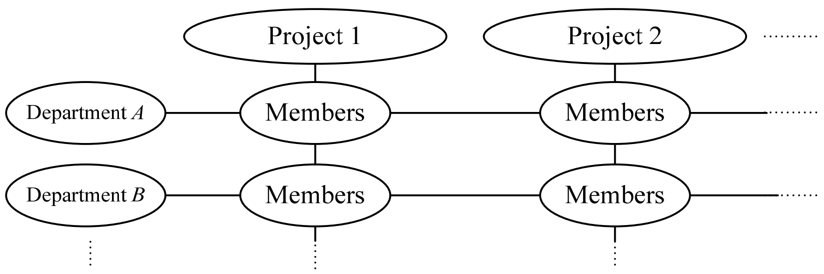


Figure 1-2 Matrix organization

(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.

  Depreciation cost = End of period non-depreciated balance × 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	$\boxed{}$
III. Selling, general and administration expense	210
Operating profit	$\boxed{}$
IV. Non-operating income	60
V. Non-operating expense	80
Current profit	$\boxed{}$

- Gross profit
  = Sales − Cost of sales
  = 980 − 650
  = 330
- Operating profit
  = Gross profit
  − Selling, general and administration expense
  = 330 − 210
  = 120
- Current profit
  = Operating profit + Non-operating income − 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.

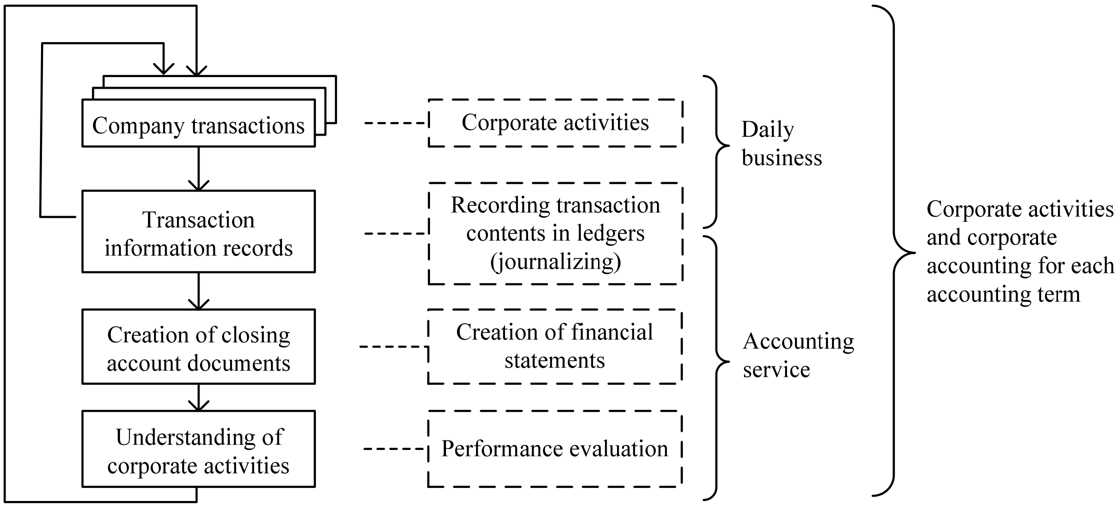


Figure 1-3 Flow of transaction information

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

(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.
>
> $$\text{ROI} = \frac{\text{Profit}}{\text{Investment amount}}$$

(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. $$\text{Equity to total assets} = \frac{\text{Equity capital}}{\text{Total capital}}$$	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. $$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

(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

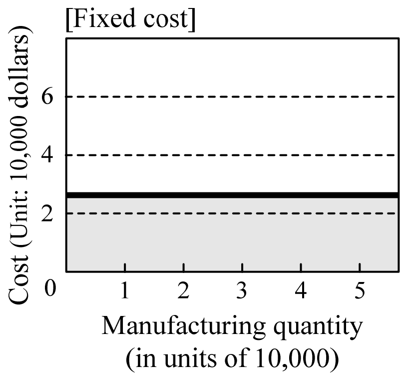
Direct cost accounting is a method of cost control that is used in profit planning. In direct cost accounting, a cost is classified and controlled as follows:

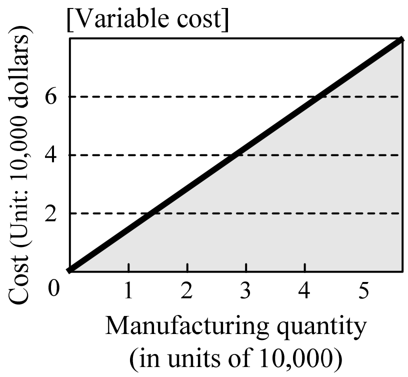
• Fixed cost

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.

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

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

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.

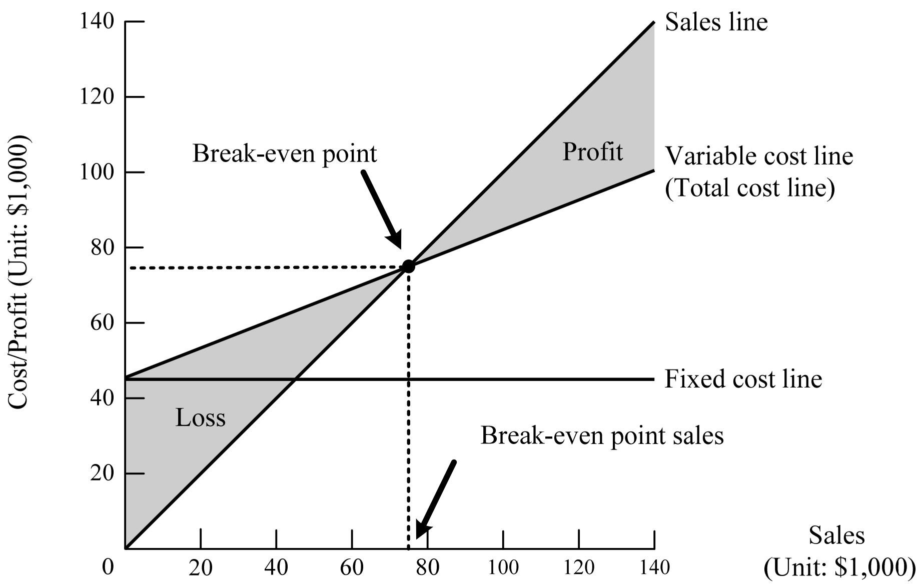


Figure 1-4 Profit chart

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.

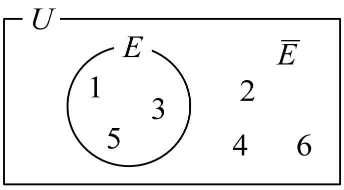


Figure 1-5 Venn diagram

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.

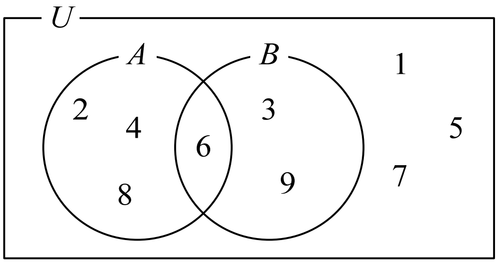


Figure 1-6 Venn diagram for card set

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.

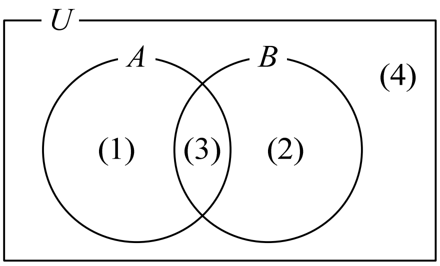
The elements {1, 5, 7} are not in set A nor set B. This means that {1, 5, 7} is a result of the difference which the union set $A \cup B$ is subtracted from the universal set U. This type of set, which is determined by the difference between two sets, is known as a difference set and is represented by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

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

The symbols ("$\cap$", "$\cup$", and "$\overline{}$") 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.

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

$\overline{A \cap B} = \overline{A} \cup \overline{B}$ 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 (¬ : negation, →: 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	$\neg P \rightarrow \neg Q$	If not *P*, then not *Q*. (If it is not raining, then I am not putting up an umbrella.)
Contraposition	$\neg Q \rightarrow \neg P$	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 ($P \rightarrow Q$) 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 $X \rightarrow Y$ and $Y \rightarrow Z$, then it is inferred that $X \rightarrow Z$. This is a common concept that is known as syllogism.

$X \rightarrow Y$	Tama is a cat.
$Y \rightarrow Z$	Cat says meow.

=>

$X \rightarrow Z$	Tama says meow.

- Inductive Inference

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

$X1 \rightarrow Y$	The cat in my house says meow.
$X2 \rightarrow Y$	The neighbor's cat says meow.

=>

$X \rightarrow Y$	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.

=> 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.

=> 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.

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.

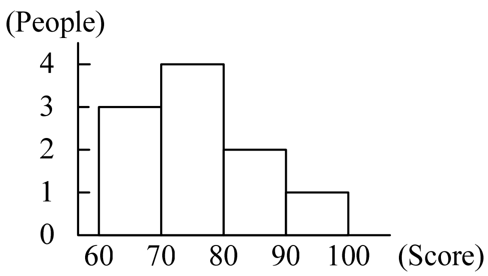
[Observation Values]

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]

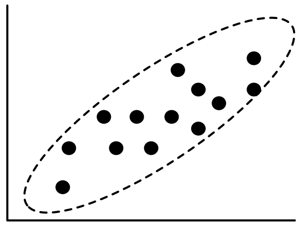
- Variance = $\{(60-80)^2 + (66-80)^2 + (72-80)^2 + (78-80)^2 + (80-80)^2 + (84-80)^2 + (88-80)^2 + (90-80)^2 + (90-80)^2 + (92-80)^2\} \div 10 = 108.8$
- Standard deviation = $\sqrt{108.8} = 10.430\cdots \approx 10.4$

(2) Correlation

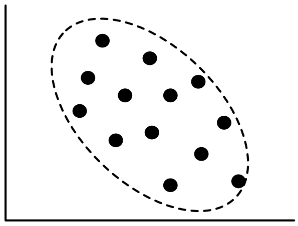
Correlation is a relationship between two variates in which changes in one variate cause changes in the other. The correlation between two sets of observation values is generally analyzed by using a scatter diagram.

- 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.



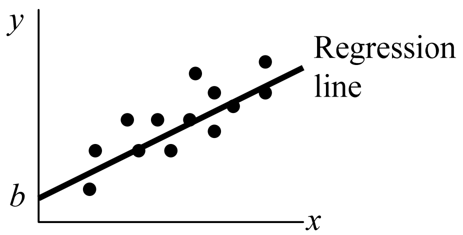
Strong positive correlation



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

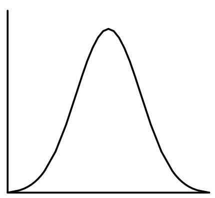
(3) Probability distribution

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:

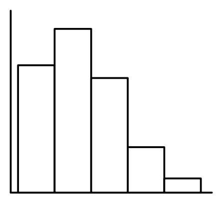
- Normal distribution

This is a probability distribution for continuous probability variables.



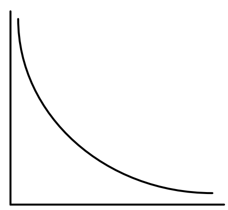
- Poisson distribution

This is a probability distribution for discrete probability variables.

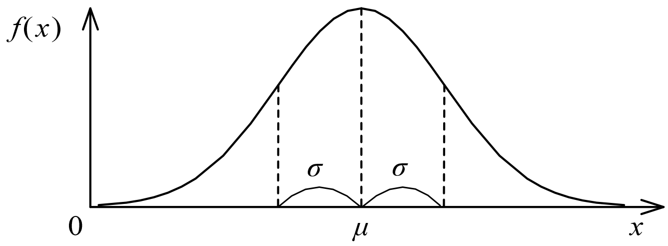


- Exponential distribution

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.

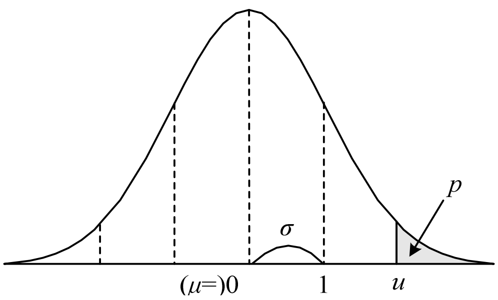


When the average or deviation of a population is estimated or determined, it is complicated to use the probability variable x as-is in those calculations. It is often easier to find the deviation value u, which is standardized to ensure that the probability variable x has an average of 0 and a standard 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.

$$\begin{pmatrix} x \\ y \end{pmatrix} = \frac{1}{3\times3 - 4\times2}\begin{pmatrix} 3 & -2 \\ -4 & 3 \end{pmatrix}\begin{pmatrix} 31 \\ 44 \end{pmatrix} = \begin{pmatrix} 3\times31 + (-2)\times44 \\ (-4)\times31 + 3\times44 \end{pmatrix} = \begin{pmatrix} 5 \\ 8 \end{pmatrix}$$

$x = 5,\ \ y = 8$

(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.

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

(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] $\quad log_b\, a^n = n \times log_b\, a$

[Law 2] $\quad log_b\, (x \times y) = log_b\, x + log_b\, y$

[Law 3] $\quad log_b\, a = log_n\, a \div log_n\, b \qquad (n > 0,\ n \neq 1)$

(4) Differentiation and integration

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

$$\begin{tikzcd}[column sep=huge] \boxed{\text{Function: } x^n} \arrow[r, shift left, "f(x)\quad \text{Differentiation}\quad f'(x)"] & \boxed{\text{Derivative: } n \times x^{n-1}} \arrow[l, shift left, "\int f(x)\mathrm{d}x\quad \text{Integration}\quad f(x)"] \end{tikzcd}$$

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.)

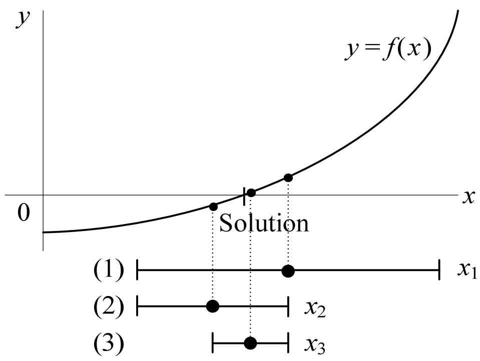
$$F(x) = (6 \div 3) \times x^{2+1} - (5 \div 1) \times x^{0+1} + C$$
$$= 2x^3 - 5x + C$$

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

$$\int_1^2 f(x)\mathrm{dx} = F(2) - F(1)$$
$$=(2\times2^3 - 5\times2 + C) - (2\times1^3 - 5\times1 + C) = 3$$

(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.

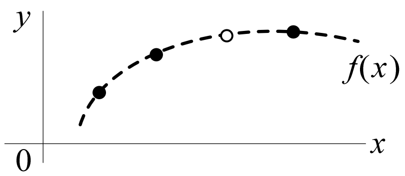
- Rounding Error

  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 (●) to find the unknown data (○).

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 (Ta) 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 (Ts) 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	Lw	The average number of customers both waiting in the queue and currently being served. $Lw = \rho / (1 - \rho)$
Average waiting time	Tw	The average customer waiting time from a customer entering the queue until processing begins. $Tw = Lw \times Ts = Lw \times (1 / \mu)$ $= \rho / [(1 - \rho) \times \mu]$

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

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) = $Lw \times (1/\mu)$ = 4 customers × 0.2 minutes/customer = 0.8 minutes
- Average processing time: (Tq) = $Tw + (1 / \mu)$ = 0.8 minutes + 0.2 minutes = 1.0 minutes
- Average queue length: (Lq) = $Lw \times \rho$ = 4 customers × 0.8 = 3.2 customers

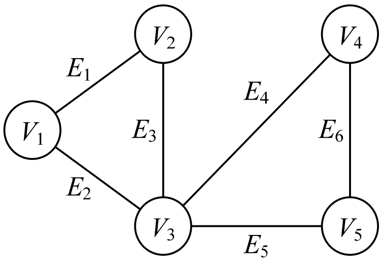
3-1-7 Graph Theory

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]

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

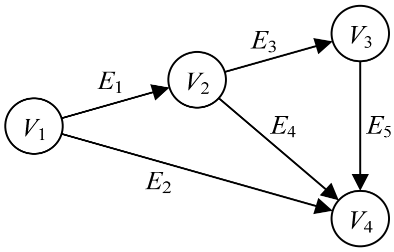
$E = \{E_1, E_2, E_3, E_4, E_5, E_6\}$



[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

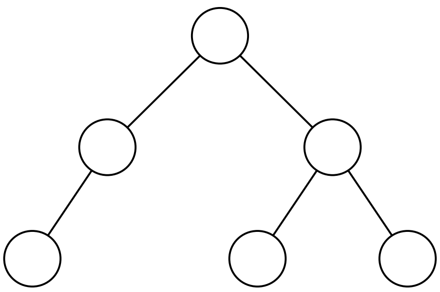
  This is a type of undirected graph with no closed path.

- Complete graph

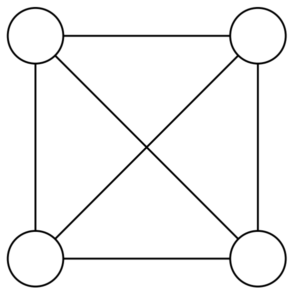
  This is a connected graph in which all different vertices are connected as a single edge.

- Eulerian graph

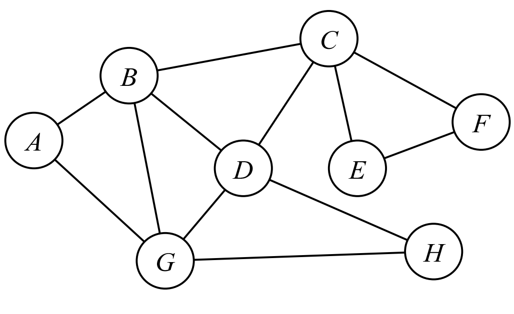
  This is an undirected graph that can be drawn with a single stroke. If the start and end vertices are the same, all vertices must have an even number of connected edges.



Tree



Complete graph



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

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.

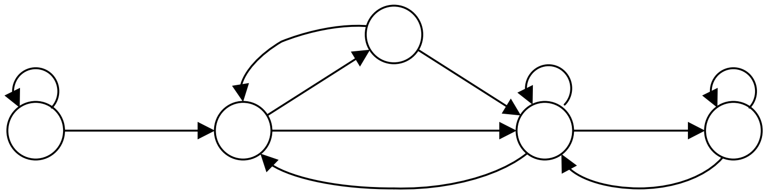


Figure 1-7 State transition diagram

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 × 10 products
+ \$4,000 per product × 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]

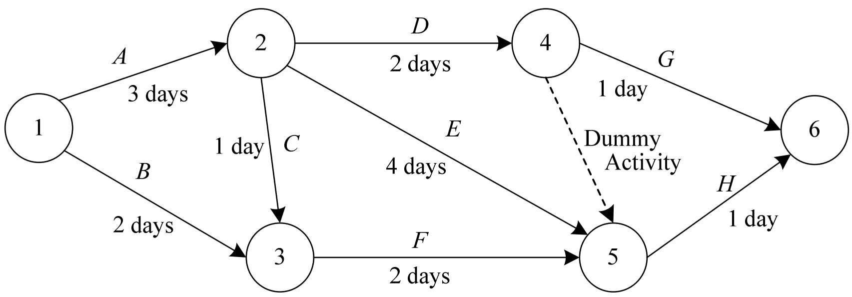
- Can be used for large-scale, complex projects.
- Enables the calculation of the total number of days (i.e., minimum required work period) to complete the project.
- Establishes a clear order of activities, which enables the understanding of a vital point for management.
- Enables the calculation of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

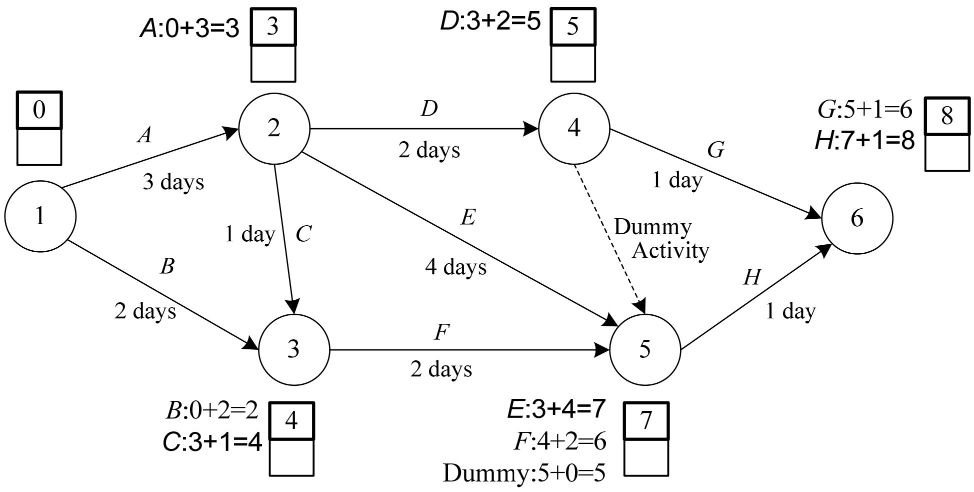
Examples: Create an arrow diagram for a project that is composed of the following activities.

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*



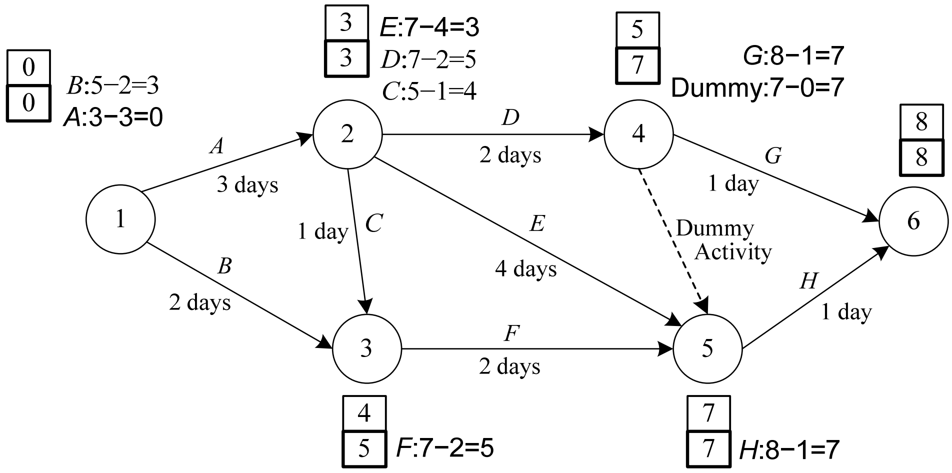
(i) Earliest node time

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).



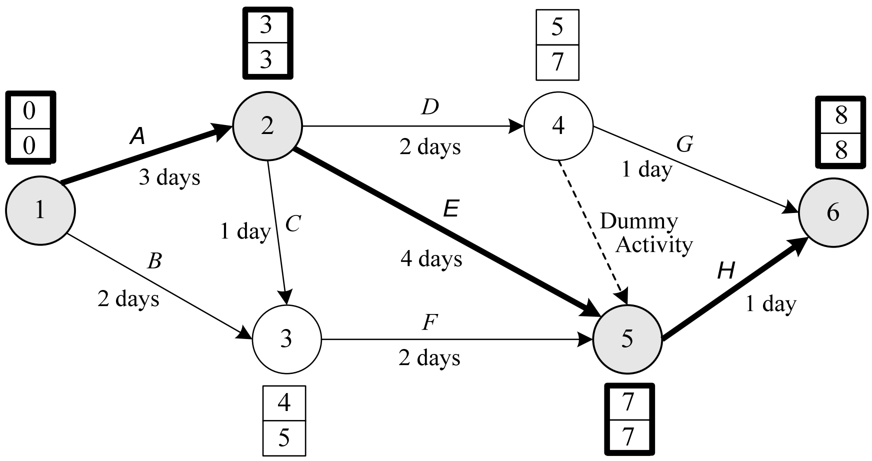
(ii) Latest node time

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→2→5→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.

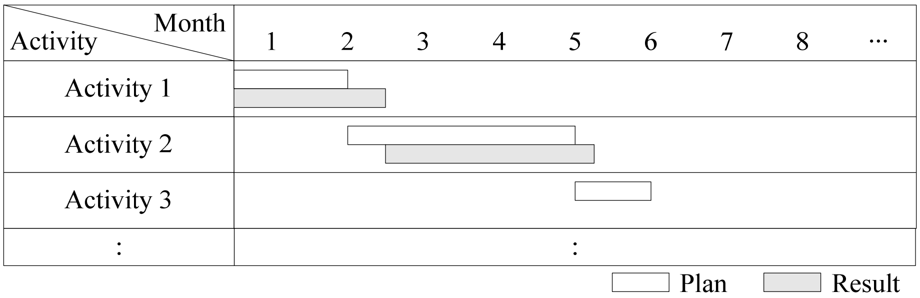
- Crushing

  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 performing the next process before the completion of a preceding process.

(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.



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

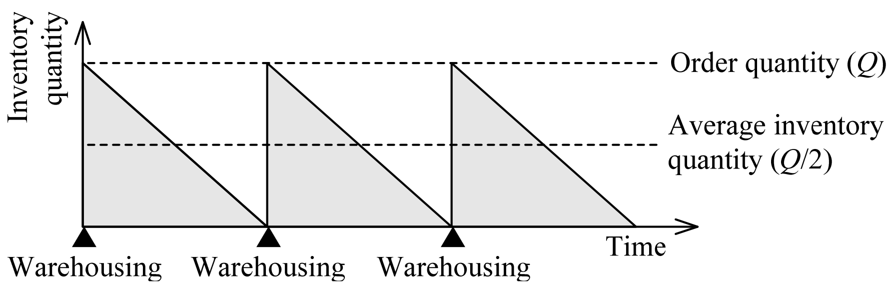
This is a certain quantity of inventory that is set aside in advance in order to prevent out of stock. Safety stock is generally considered separately from total inventory cost or EOQ.

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

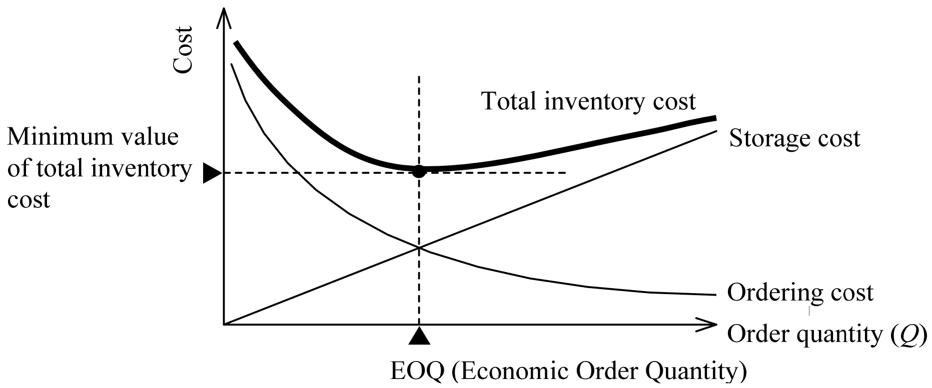
2) Since the ordering cost is determined by the number of orders, first calculate the annual number of orders. It is necessary to order enough to meet the total annual demand, so the number of orders is calculated as "Total annual demand (D) ÷ Order quantity (Q)".

   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:

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

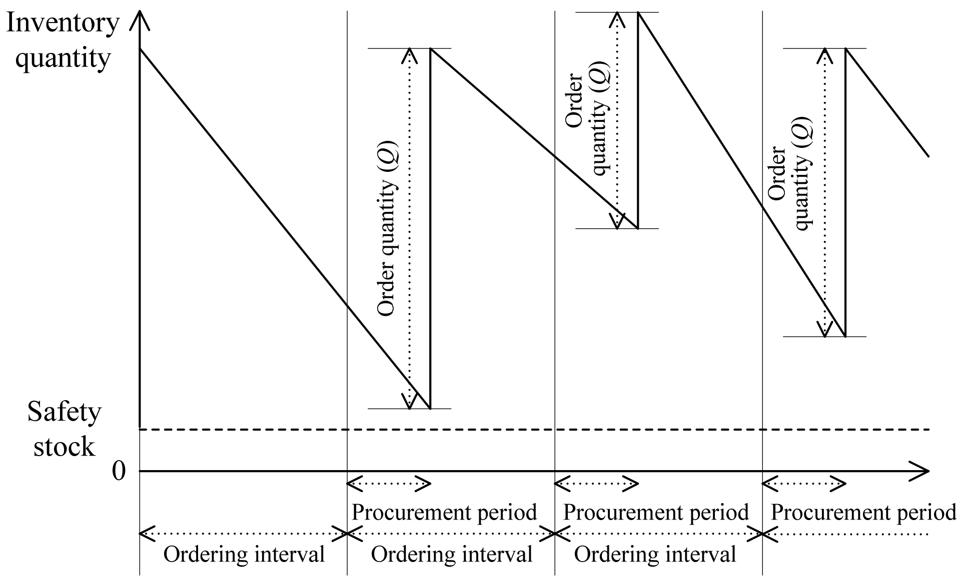
(2) Ordering method

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.

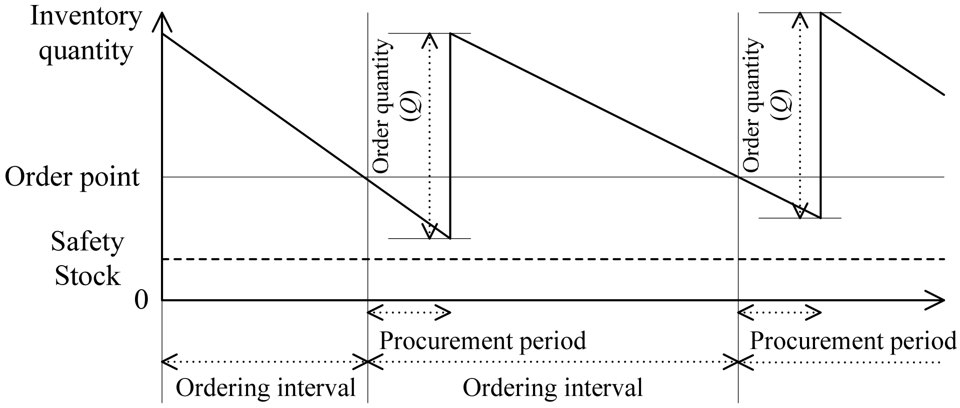
  Order quantity = Projected demand for ordering interval
  + Projected demand for procurement period
  − Inventory quantity at time of order
  + Safety stock quantity



- **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.

$$\text{Current period predicted value} = \alpha \times \text{Previous period actual value} + (1 - \alpha) \times \text{Previous period predicted value}$$

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 *A* \ Strategy of *B*	*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) × 0.3 + (+20) × 0.5 + (−40) × 0.2 = +26

  Expected value for strategy *S2* = (+60) × 0.3 + (+10) × 0.5 + (−10) × 0.2 = +21

  Expected value for strategy *S3* = (+40) × 0.3 + (+30) × 0.5 + (−20) × 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.

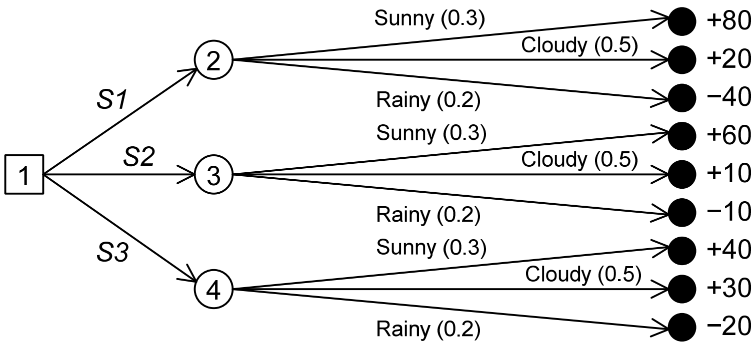
  Example: The cloudy (50%) has the condition with the highest probability of occurrence in the future. Thus, strategy *S3*, which offers the maximum benefit (+30) when the weather is cloudy, is seen as the optimal strategy.

- 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) × 0.5 + (−10) × 0.5 = ±0

  Strategy *A2* = (−20) × 0.5 + (+30) × 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.

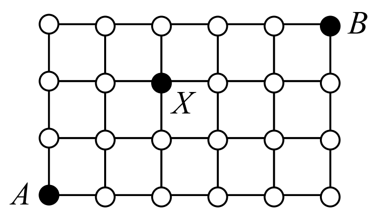
- **Divide-and-conquer approach**

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*.



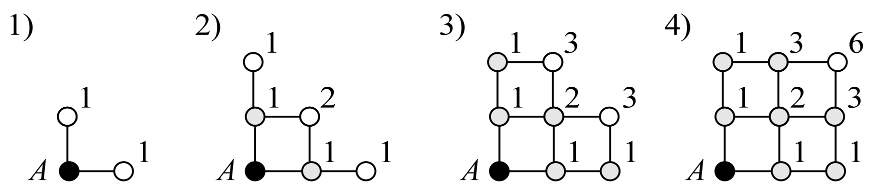
[Solution using the divide-and-conquer approach]

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.

3 - 4 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 $f(p)$.

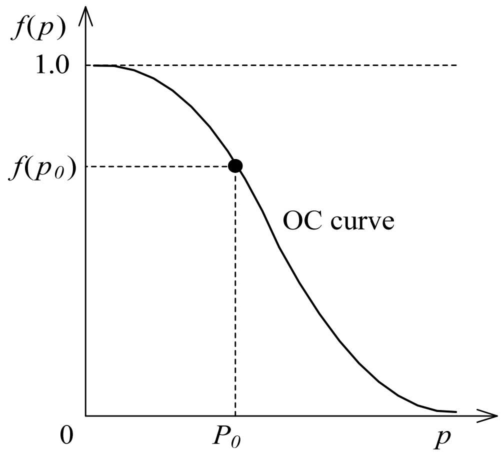


Figure 1-8 OC curve (Graph of function $f(p)$)

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.

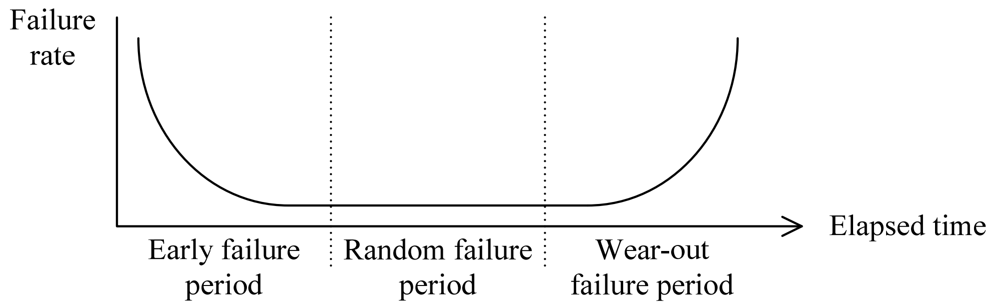


Figure 1-9 Failure rate curve (Bathtub curve)

(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)

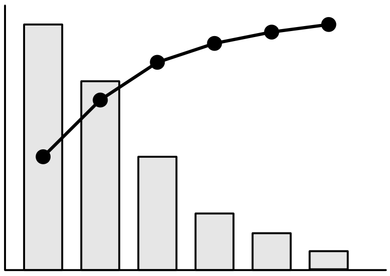
Stratification is the classification of data. For example, raw materials for a product can be classified by manufacturer, by lot, by place of production, by size, and so on. Even problems that appear complex can be made simple through classification, and it becomes easier to discover a solution. In place 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

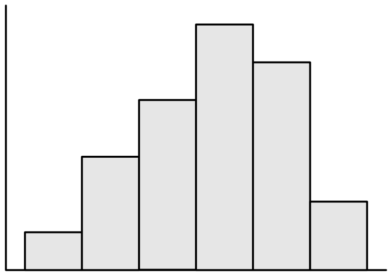
This is a table or diagram that is formatted in advance so as to enable understanding of a whole by collecting itemized data and confirming items through checks.

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

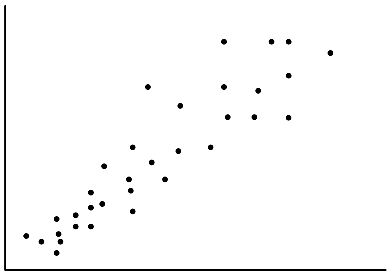
This is a diagram for systematically organizing the relationships between characteristics (or effects) and factors (or causes), in order to uncover causes.



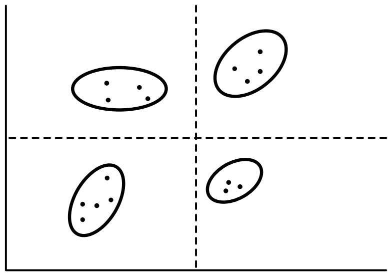
Pareto chart



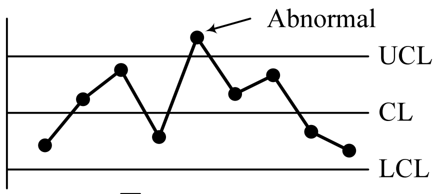
Histogram



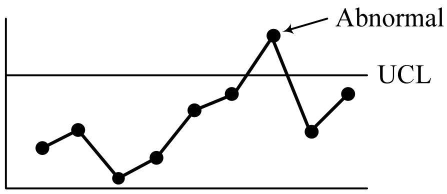
Scatter diagram (positive correlation)



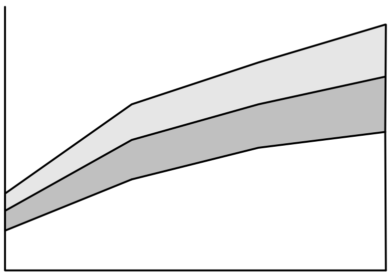
Portfolio diagram



$\overline{x}$ Control chart



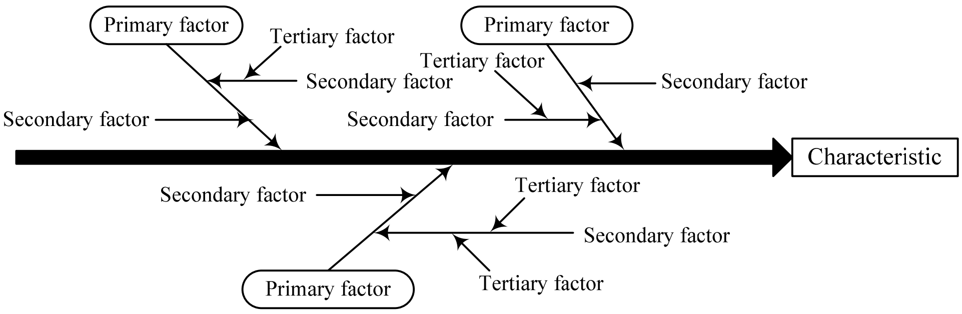
R control chart



Area graph

Window lock	✓
Stove main valve	✓
Air conditioner switch	✓
Gas main valve	✓
Water heater main valve	✓
Wallet	
Commuter pass	
Room lighting	✓

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.)

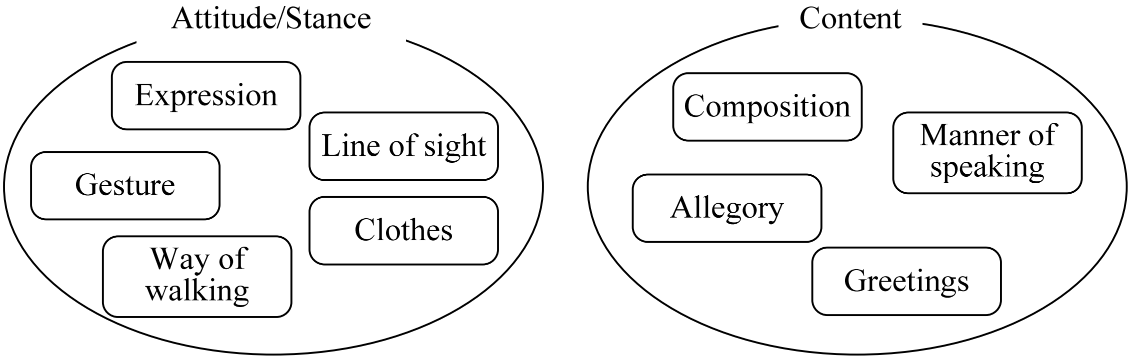
This is a diagram that uses arrows to display the flow of each activities, on the basis of its preceding activities. It is used to find the total number of days required, or key management activities, in scheduling.

(6) Tree diagram (Logic tree)

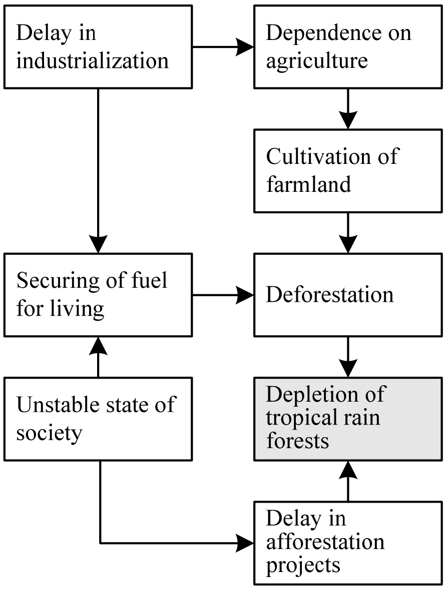
This is a diagram that seeks approaches or plans that are required to achieve objectives or goals, organizes the findings, and displays these in tree form. It is effective in uncovering the core of a problem and opening a path to a solution, while group members redraw the relation diagram with reaching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



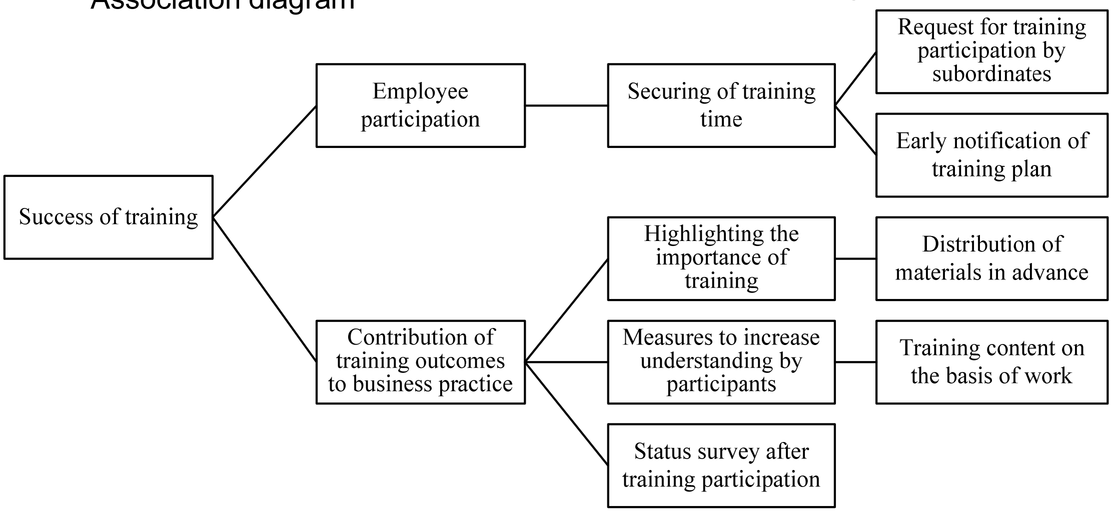
Affinity diagram



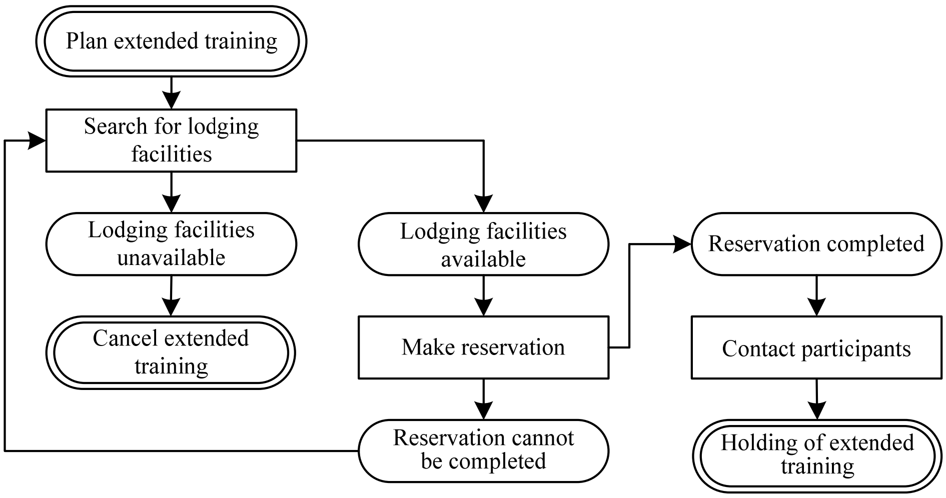
Association diagram

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



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 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

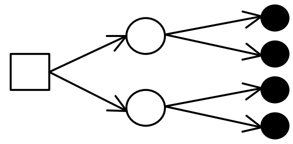
A decision table summarizes actions or processes according to conditions, in tabular form.

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.

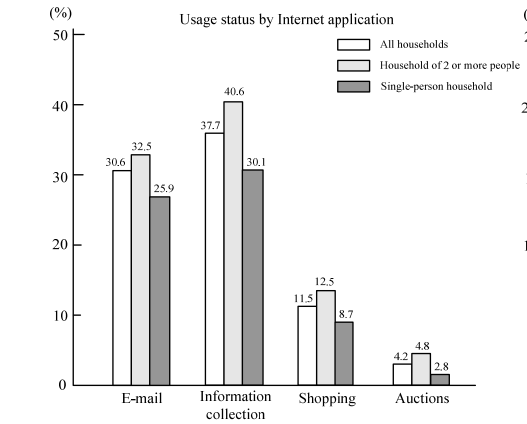
"For a business travel of at least 500 km one way, a per-diem allowance of $30 will be paid for a one-day trip. An additional lodging expense allowance of $50 will be paid for an overnight stay. Meanwhile, for a business travel of at least 200 km but less than 500 km one way, a per-diem allowance of $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>

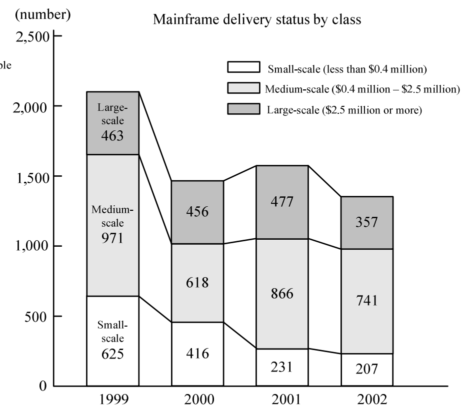
At least 500 km one-way	Y	Y	N	N	N
At least 200 km but less than 500 km one-way	N	N	Y	Y	N
Less than 200 km one-way	N	N	N	N	Y
One-day business trip	Y	N	Y	N	–
Pay a per-diem allowance of $10	–	–	X	X	–
Pay a per-diem allowance of $30	X	X	–	–	–
Pay a lodging expense allowance of $50	–	X	–	X	–

(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.

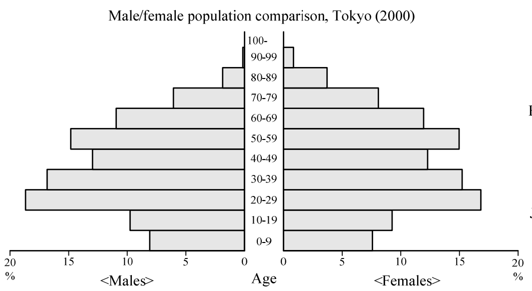


Compound bar chart

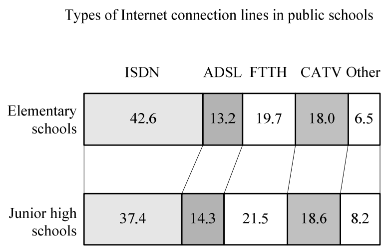


Cumulative bar chart

(Source: Informatization White Paper)



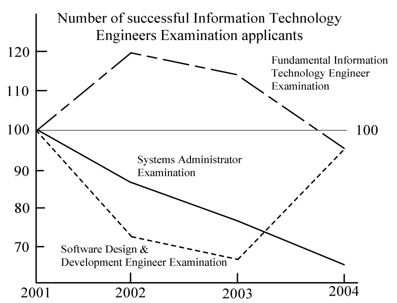
Pyramid graph



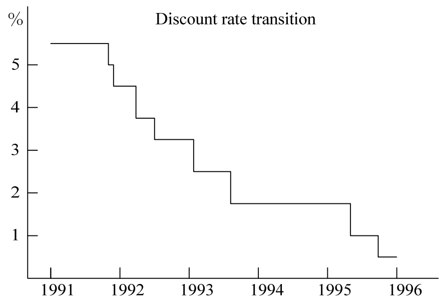
Percentage bar graph

(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.



Fan chart

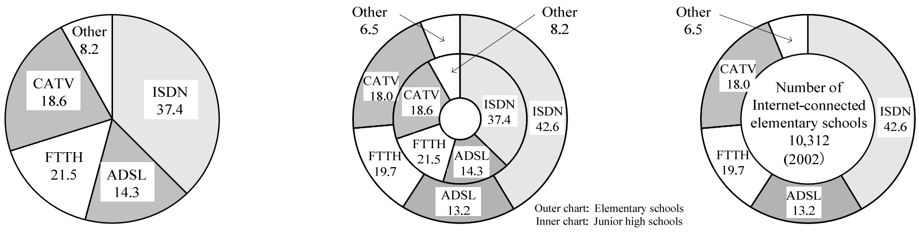


Step graph

(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)

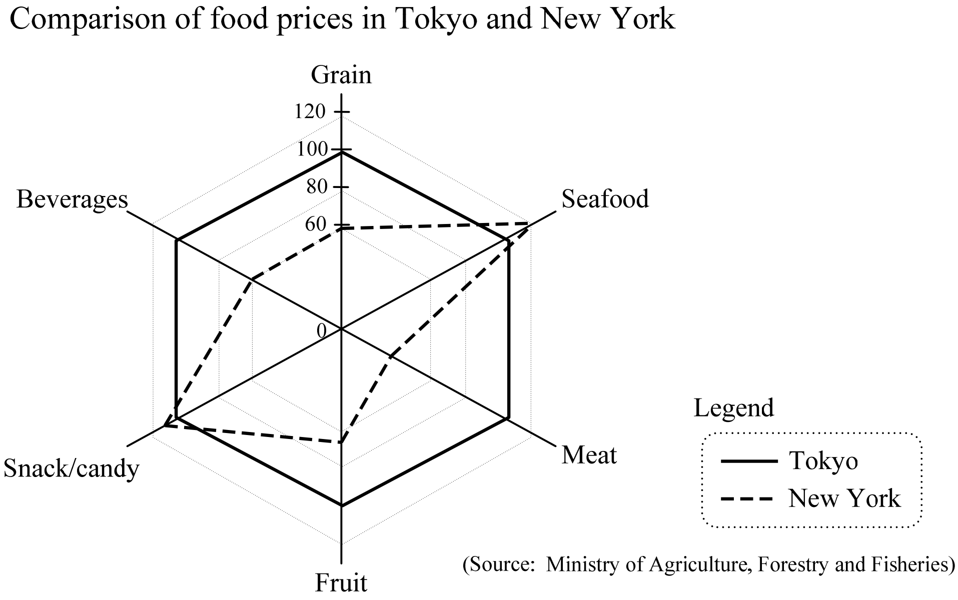


Pie chart Double pie chart Donut chart

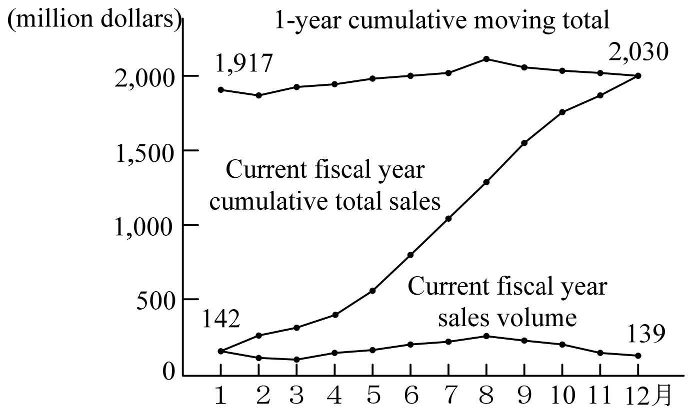
(5) Chart

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.

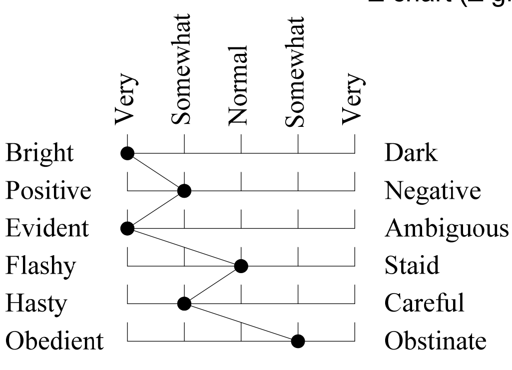
- Radar chart
  This is a chart that sets a standard form for multiple evaluation items, plots ratios against those standards, and represents the balance among items by a polygonal shape connected with lines. For example, when food prices in Tokyo are set to 1 (i.e., 100%) for displaying food prices 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.



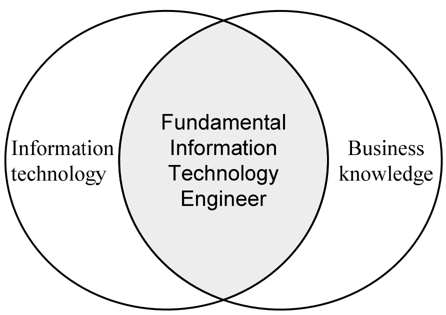
Radar chart



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

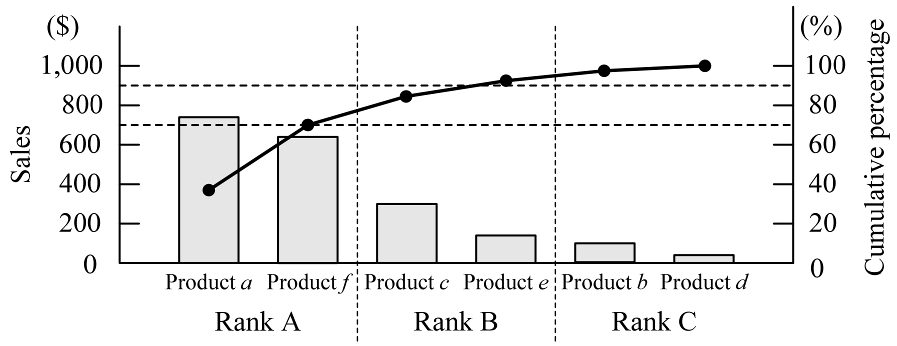
Example: When sales by product are indicated by values in the table, find the results of ABC analysis.

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

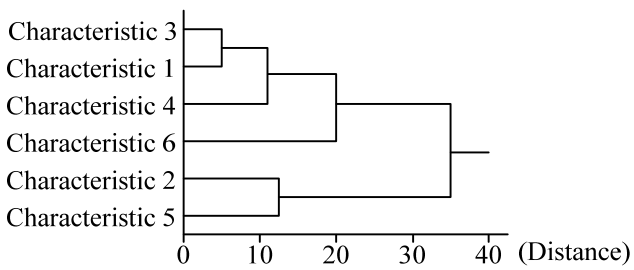
2) Create Pareto chart.



(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.

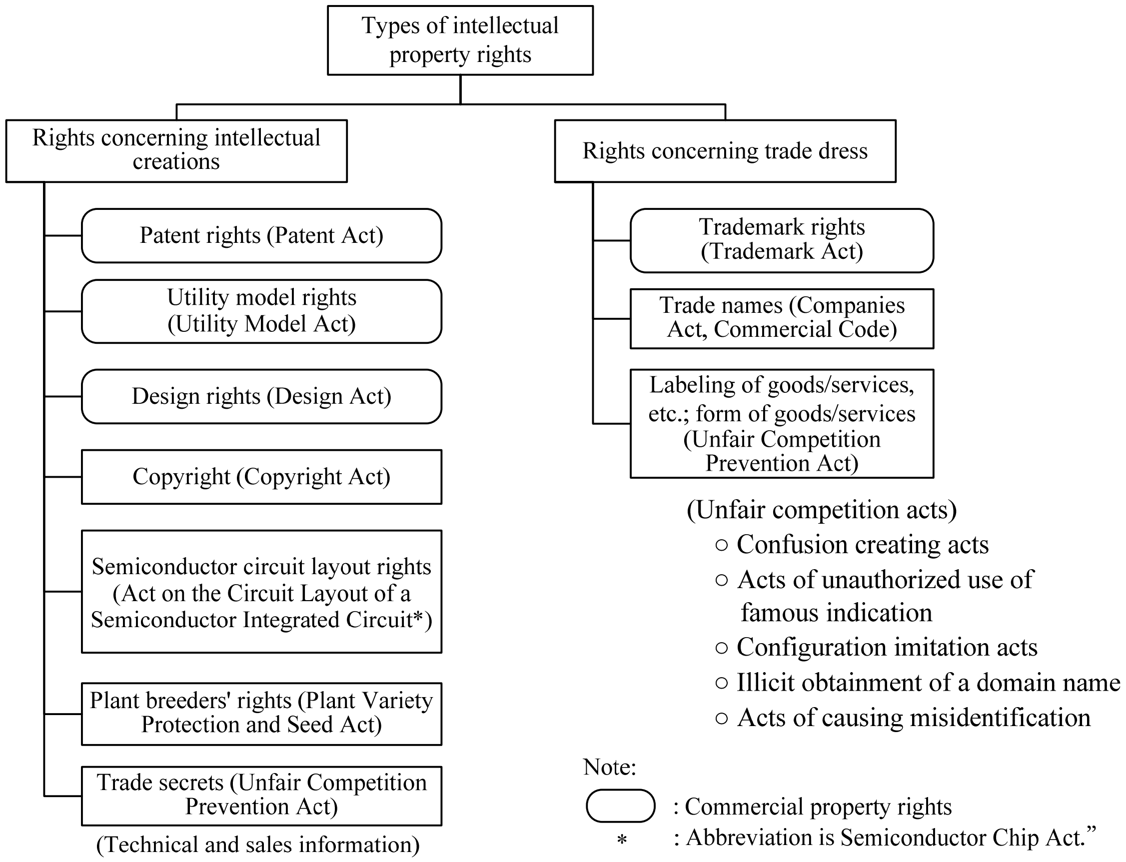
Note: In regards to legal affairs, basic concepts of laws and regulations are common in many countries, but the actual laws and regulations are inevitably domestic. On the other hand, guidelines and standards may be domestic or international. Most of the descriptions from 4-1 to 4-5 in this section are 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.



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.

<table>
<tr><th>Private</th><th colspan="2">Public bodies</th></tr>
<tr><td rowspan="3">Act on the Protection of Personal Information</td><td>Act on the Protection of Personal Information Held by Administrative Organs</td><td>Act on the Protection of Personal Information Held by Incorporated Administrative Agencies</td></tr>
<tr><td colspan="2">Act for Establishment of the Information Disclosure and Personal Information Protection Review Board</td></tr>
<tr><td colspan="2">Act for establishment of related laws and regulations</td></tr>
<tr><td colspan="3">Basic Policy on the Protection of Personal Information (Cabinet decision)</td></tr>
</table>

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."

[Terminology related to the Electronic Signature Act]

- Electronic signature <Digital signature>
  An electromagnetic record that can confirm the identification of the person who created the information and whether or not any alternation of the information has been performed
- Certification service <Issuance of digital certificates>
  A service that certifies digital signatures as legitimate
- Accredited certification business operator <Certificate authority>
  A business operator that is accredited by the competent minister to perform accreditation service (i.e., designated certification service) for electronic signatures that conform to standards specified by the ordinances and notifications of competent ministries.

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.

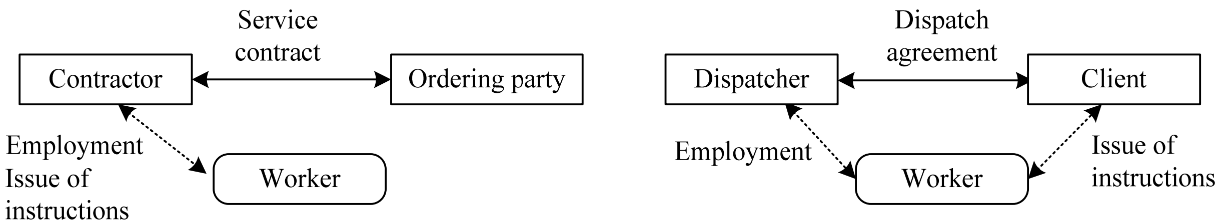
- Service contract

  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.

(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.

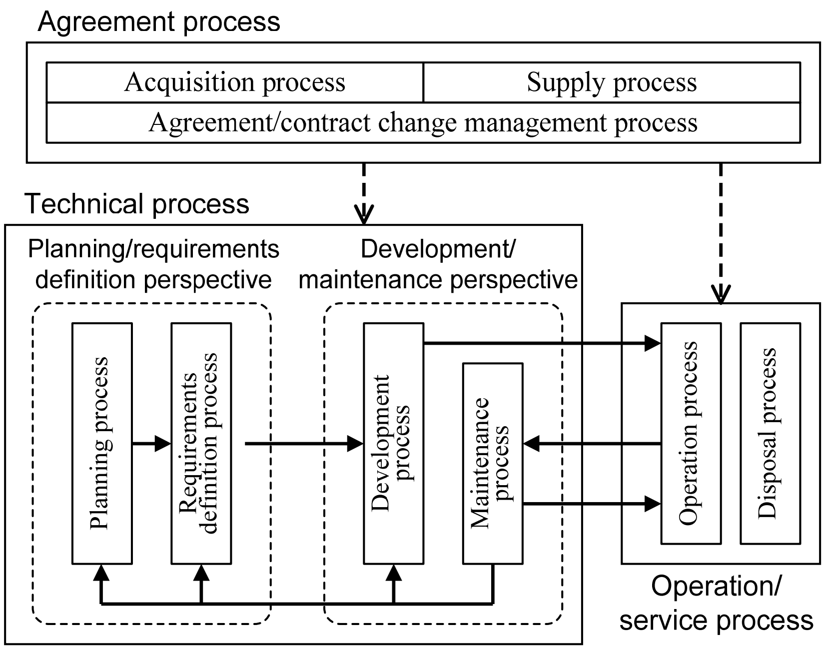
[Standardization bodies related to de facto standards]

- **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.

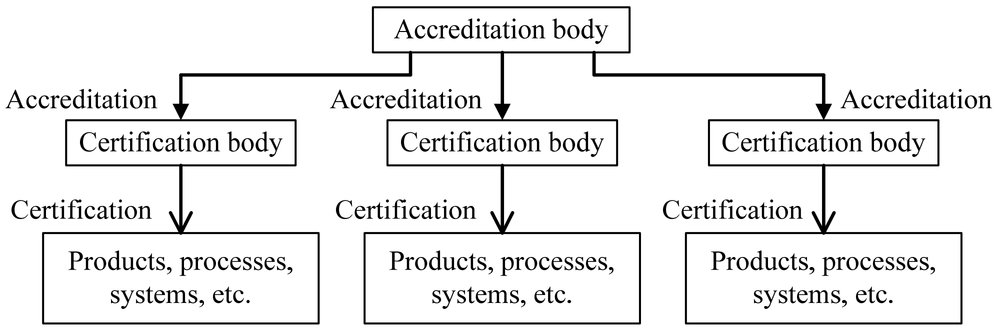
[Implementation scheme for conformity assessments]

- 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.

Q7

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

Q8

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) $(S-T)\cap(T-R)$

Q9

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.

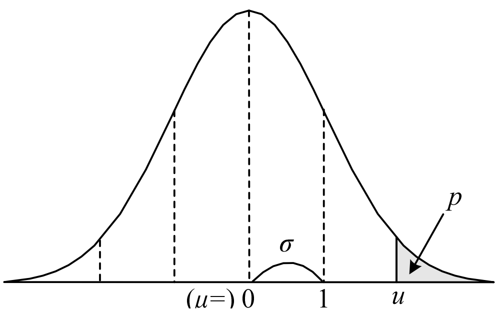
Q10

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

Q13

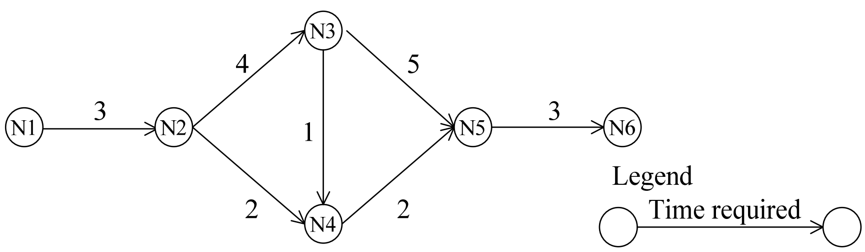
Every day, store T makes sweets K and L that are then packaged and sold as products M and N respectively. The combination of packages and the profit per product are as shown in the table. The maximum manufacturing capacity of sweets K per day is 360 units, and 240 units for sweets L. What is the profit 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

Q14

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

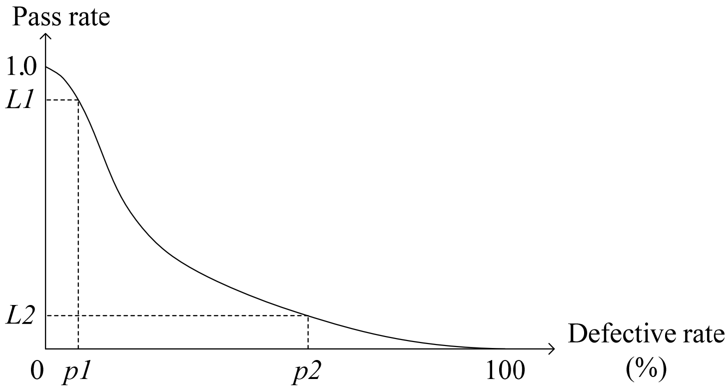
Which of the following is an appropriate explanation of the work sampling method?

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

Q23

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

Q24

<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

Q25

<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.>

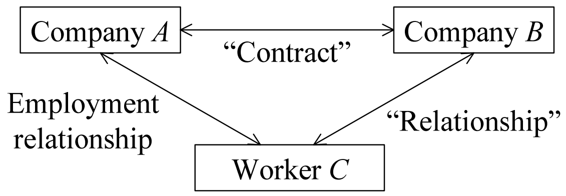
Which of the following is an appropriate explanation concerning the discretionary labor system?

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

<Informational: this question is applicable in Japan only.>

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

<Informational: this question is applicable in Japan only.>

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.

Q34

<Informational: this question is applicable in Japan only.>

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

Q35

<Informational: this question is applicable in Japan only.>

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.

Chapter 2
Business Strategy

1 Business Strategy Management

The purpose of business strategy management is: to operate and develop management resources, such as people (human resources), objects (physical resources), money (funds), and information, and also operations in a more effective manner; and to effectively manage and operate the business strategy for making the business successful by adapting it to the external environment.

1 - 1 Business Strategy Techniques

1-1-1 Business Strategy

Business strategy is a strategy that is created to attain the business objectives of a company on the basis of the corporate philosophy (or management philosophy). In order for a company to attain its business objectives, it is important how the company strengthens the business status in the market and dominates the market. Therefore, in the environment surrounding the company, the business strategy theory theoretically indicates what must be done and in what way in order to carry out a business successfully. This theory was proposed by Michael E. Porter in the 1980s.

In business strategy, management innovation is positioned at the top. Management innovation is a strategy that a company revises its past direction and puts efforts into new corporate activities.

[Concept of management innovation]

- Benchmarking

  This refers to a qualitative and quantitative understanding of products, services, and operation through comparison of the management of a company with the strongest competitor or more advanced company. On the basis of the comparative analysis with best practice, benchmarking is used in the management innovation of a company.

- Diversification

  This is a management innovation that promotes the growth of business by foraying into new fields that are different from previous products and markets. Business administration involving extensive management of several businesses is called diversified management. The following synergy effect is expected as a result of a foray into new fields.

Name	Expected synergy effect
Sales synergy effect	Effect on sales activities that involve sharing of distribution channels, such as commodity distribution, and brand images
Production synergy effect	Effect of reducing the cost of production activities by sharing facilities and human resources, and by purchasing a large volume of raw materials in bulk.
Investment synergy effect	Effect of reduction in various investments, such as facilities and equipment, and development and research expenses of new products
Management synergy effect	Effect on management activities that is obtained through sharing of the experience, knowledge, and knowhow of the management

1-1-2 Corporate Strategy

Corporate strategy is a strategy that is created to show the management direction of the whole company according to the corporate philosophy (i.e., management philosophy).
In corporate strategy, the number one objective in most cases is to establish corporate superiority by strengthening the position of a company in the market. The position of a company in the market is determined through competitive positioning analysis, and a strategy suitable to the current position is created.

- Competitive positioning analysis

  This is a technique of analyzing the position in the market through the quality and quantity of management resources to be invested. The position of a company is analyzed by creating a matrix in which the "quantity" that represents the capacity of management resources is plotted on the horizontal axis, and the "quality" that represents the uniqueness of management resources is plotted on the vertical axis.

Relative management resources		Quantity	
		Large	Small
Quality	High	Leader	Nicher
	Low	Challenger	Follower

  - Leader

    Leader holds the top share of the industry with management resources that have excellent quantity and quality. The leader employs an omnidirectional strategy of covering the entire market and securing the maximum share.

- Challenger

  Challenger holds the second- to fourth -largest share of the industry that is qualitatively inferior to the leader although the management resources are quantitatively excellent. The challenger aims at the leader and employs a differentiation strategy including the share pursuing that is necessary to attack a leader.

- Nicher

  Since the management resources are qualitatively excellent, the nicher dominates a specific market (or product) but is quantitatively inferior to the leader. The nicher employs the specialization strategy that aims at specialization of products and market. There is also a concept of niche strategy, where business is developed by aiming at the gaps in the market that does not satisfy the needs of the customer from the beginning and by focusing on the nicher of a specific business.

- Follower

  Since the management resources have an inferior quantity and quality, the follower trails behind the leader. The follower employs the imitation strategy of quickly responding to the market opportunity by bringing down the price through cost reduction while it imitates the products of the leader.

Core competence management is the strategy used for achieving competitive superiority. This refers to the management that is conducted to concentrate and invest management resources in the proprietary technologies and knowhow (i.e., core competence) of a company that are superior to those of the competitors. In such a case, the products and services improve CS (Customer Satisfaction) by bringing in a special value to the customers, and thus, the competitive superiority of a company is established in the market.

Moreover, sometimes the competitive superiority of a company may be difficult to achieve with management resources alone, or sometimes it may be rational to make use of external resources. In such a case, a strategy called alliance, which creates a mutual cooperative system between several companies, is applicable.

- Weak alliance (strict alliance)

  This is an alliance without capital involvement and refers to tie-ups between companies, including business tie-ups and technological tie-ups. As globalization of business progresses, the development of new business models and technologies is achieved through tie-ups that extend beyond competitive relationships and industries

- Strong alliance

  This is an alliance with capital involvement. It operates as an enterprise group by incorporating other companies. The creation of a business strategy for such an enterprise group and managing it as one enterprise is called group management.

- M&A (Mergers and Acquisitions)

  This is the strongest alliance by which other companies are absorbed and governed through merger and acquisition of companies, or stock purchase and business transfer using TOB (Take-Over Bid or Tender Offer Bid), which involves declaration of the buying price and period and purchase of stocks from several unidentified stockholders. Sometimes, measures such as MBO (Management Buy-Out) may be taken for an unfriendly M&A that is performed without the consent of the company to be merged or acquired.
- Vertical integration / Horizontal integration

  This is a company integration performed between companies of the same industry. While vertical integration extends from the process of manufacturing to sales, horizontal integration refers to integration that incorporates competitors performing the same process. In the case of horizontal integration, as far as the production quantity and cost of industrial products are concerned, if the production quantity increases, the total cost per unit decreases. This results in the scale economy alliance that the profit margin rises because of an increase in the production quantity. The relationship between the production quantity and cost at this time is represented by an experience curve.

While it is not strictly a company integration, outsourcing which outsources the specific business of a company to an external company, is also seen as a type of alliance from the viewpoint of cooperation with an external company.

[Forms of outsourcing]

- Fabless manufacturing

  This is a form that no manufacturing plant is set up in own company, and rather only the planning of products is performed. Manufacturing is outsourced to other company. Manufacturing and supply by the outsourced company on the basis of the trademark and brand of the partner is called OEM (Original Equipment Manufacturing).
- Offshore outsourcing (Offshoring)

  This is a form that business is outsourced to an overseas company where the price of commodities and labor cost are cheap. While a reduction in cost can be expected, one disadvantage is that long-distance control is difficult to perform.

In addition, the business strategies (i.e., corporate strategies) that are used to construct a new relationship between companies include the following.

- Shared service

  This is a form that a company is set up to perform the business operations common to several companies in a specialized and independent manner. The company provides business services to each company. For example, a specialized company is set up and delivers products in collaboration with a company from a different industry, as a part of logistics. This is a comprehensive activity for optimizing commodity distribution.

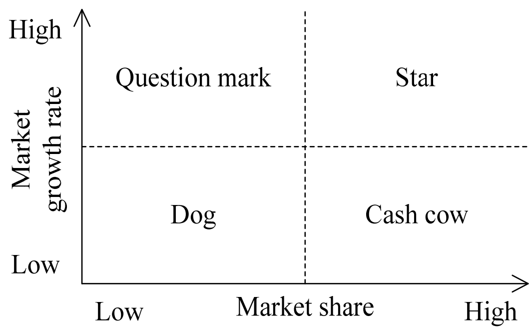
- Incubator

  This is a system or organization that supports entrepreneurs, such as venture businesses with new products and services as the main constituent. By supporting entrepreneurs, profits are acquired and new company relationships are established.

In corporate strategy, the business areas (i.e., business domains) and products in which to compete are also examined. Therefore, the type of business results that a business or product yields are compiled in a portfolio chart (e.g., business portfolio, product portfolio), and the respective business or product is analyzed.

- PPM (Product Portfolio Management)

  This is a technique of analyzing the characteristics of a business and a product from the relationship between the market growth rate and the market share. The characteristics are analyzed on the basis of a PPM matrix in which the market growth rate is plotted on the vertical axis. The market share is plotted on the horizontal axis, and the whole area is divided into four regions.



  - Question mark

    This is a region in which investments are deficient with respect to the market growth. Refraining from making additional investments or withdrawing from the market is considered.

  - Dog

This is a region where basically withdrawal must be performed because there is no future.

- Cash cow

  This is a region where cash flow (i.e., flow of funds/cash) is generated even without any additional investment. The funds acquired here are invested in "Question mark" and "Star."

- Star

  This is a region where investments must be continued depending on the market growth.

1-1-3 Enterprise Strategy

Enterprise strategy is a strategy that is created as a basic framework for competing under the environment of each enterprise. It includes strategies specific to each function field, such as business operations, development, and production, and strategies specific to each region. The enterprise strategy not only breaks down the corporate strategy, but rather it possesses a bidirectional aspect of expanding the possibilities of the corporate strategy from the enterprise strategy, and performing feedback.

Enterprise strategy is a competitive strategy for establishing competitive superiority in the individual enterprise unit. The typical competitive strategies include the basic strategies (e.g., cost leadership strategy, differentiation strategy, focus strategy) proposed by Michael E. Porter and the blue ocean strategy.

- Cost leadership strategy

  This is a strategy of establishing competitive superiority through lower cost than competitors. This is expected to bring the effect of reducing competitors' competitiveness by providing products at a lower sales price than that of the competitors' products, and the effect of securing a higher profit margin than that of the competitors by increasing the market share.

- Differentiation strategy

  This is a strategy of establishing competitiveness by improving customer satisfaction through the brand image of the product, uniqueness of technology, quality and design of the product, customer service, and sales channel that help the customer recognize special value.

- Focus strategy

  This is a strategy of achieving low cost and/or differentiation by concentrating and investing management resources (e.g., cost) in a specific product, or establishing competitive superiority. In either case, the purpose is to compete more effectively and efficiently than the competitor by narrowing down the targets.

- Blue ocean strategy

  This is a strategy of establishing competitive superiority before the advancement of competitors by providing low cost and high value to customers in the blue ocean (i.e., an unknown market that has unlimited potential).

In order to create the enterprise strategy, it is necessary to skillfully apply various surveys and analysis techniques, and understand the current situation of the company and business. In order to conduct such surveys and analyses, the financial information of a company and the market information are collected, and office tools such as spreadsheet software and database software are used.

(1) SWOT analysis

SWOT analysis is an analysis technique that clarifies the enterprise strategies of “attack” and “defense” by analyzing the internal and external factors of a company. The initial letters of “Strength” and “Weakness” of the internal factors, and “Opportunity” and “Threat” of the external factors are taken and referred to as SWOT analysis.

- Internal factors

  The products, cost base, sales force, technical power, reputation, brand, finance, human resources, and decision-making of a company are compared with those of the competitors, and the results (e.g., merits and demerits) are classified.

  - Strength: Points in which a company is superior to its competitors
  - Weakness: Points in which a company is inferior to its competitors

- External factors

  The macro factors (e.g., politics and economy, social conditions, technical progress, legal system) and micro factors (e.g., market size and growth possibility, customers’ sense of values, price trend) are classified.

  - Opportunity: Factors that are advantageous to the company (motivating factors)
  - Threat: Factors that are disadvantageous to the company (obstructive factors)

(2) Value chain analysis

Value chain analysis is an analysis technique that divides corporate activities into primary activities and support activities, and clarifies that the added value of the products and services provided by the company is generated through which activity. This analysis makes it clear that the points that can compete advantageously in each industry and market are different. This method proves to be effective in detecting the success factors (i.e., KFS (Key Factor for Success)) in the industry. Through the survey, analysis, and evaluation of the value chain, the structure of the industry, highest income business of a company, and the strong points and weak points of a company in the industry and market are clarified, and as a result, the value chain is systematically organized and the competitive strategy is created.

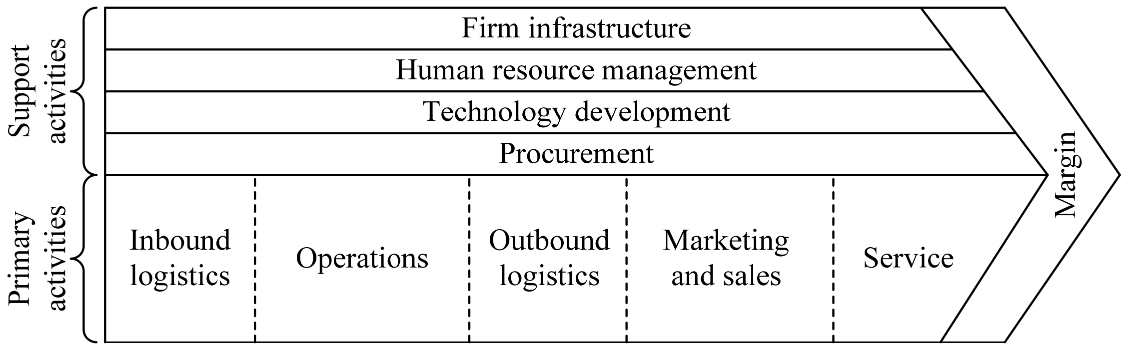


Figure 2-1　Schematic diagram of value chain

(3)　Growth matrix analysis

Growth matrix analysis is an analysis technique that uses the Ansoff growth matrix that shows the direction of growth of a company. The growth matrix is a strategy planning model that is used when the enterprise strategy for promoting the growth of the company is examined.

		Market (Customer)	
		New	Existing
Product (Business)	New	Diversification	Product development
	Existing	Market development	Market penetration

Figure 2-2　Ansoff growth matrix

1 - 2　Marketing

Marketing refers to business activities concerning the overall corporate activities, such as survey and analysis of market and customers, product development and design, advertising and public relations, business operations, distribution, sales promotion. In other words, marketing activities range from an accurate understanding of the needs of the market/customer through survey and analysis, and planning of new product development, up to technical development performed according to the plan, designing and manufacturing of developed products, and sales and evaluation in the target market. In marketing, a marketing theory is employed. This is a theory that compiles the techniques for selling and providing products and services to the market and consumers.

1-2-1 Marketing Theory

Marketing theory is a theory that the practices of marketing are systematically organized. According to the marketing theory, the marketing strategy is created and executed as per the below-mentioned procedure.

Marketing analysis

Formulation of the marketing strategy

Implementation and evaluation of the marketing strategy

(1) Marketing analysis

Marketing analysis refers to the analysis of the market size, customer needs, management resources and performance of a company, and competitive relationships with other companies. The typical marketing analysis techniques include the following.

(i) 3C analysis

This is a technique of analyzing the 3Cs – namely Customer, Competitor, and Company. Its purpose is to find out the gap between the KFS (Key Factor for Success) of the business and the analysis results of a company, and then understand the business environment.

In customer analysis, the LTV (LifeTime Value) acts as the indicator. Lifetime value refers to the amount of money used by the customer throughout his/her life or the degree of contribution. It is an indicator used to improve cost effectiveness while opportunity loss is avoided, and to control a balance between CS (Customer Satisfaction) and profits. A strategy used to improve the lifetime value is the brand strategy that improves the brand image of the company brand and product brand. This strategy leads to an improvement in the loyalty (i.e. customer loyalty) and commitment of the customer with respect to the products and services of a company. The effect of gaining a long-term repeater can be expected.

(ii) 5F analysis (5 Forces Analysis)

This is a technique of analyzing the positioning of a company in the industry from the five viewpoints of suppliers, new entrants, customers, substitute products, and hostile relationships between competitors.

- Viewpoint of suppliers
  The negotiation capability of suppliers (i.e., sellers) becomes stronger when a small number of suppliers hold monopoly in the industry, or when the supplied product that is being handled is special.
- Viewpoint of new entrants
  The threat of new entrants becomes smaller when the barrier for new entrants is thick as a result of protection by the country's regulations and laws, and also when a large amount of capital investment is required.
- Viewpoint of customers
  The negotiation capability of customers (i.e., buyers) becomes stronger when the products and services to be sold are not special and can be selected from the products and services of several competitors.
- Viewpoint of substitute products
  The threat of substitute products increases when there are substitute products that are different from the existing products and services but have a higher value.
- Viewpoint of hostile relationship between competitors
  The hostile relationship between competitors becomes stronger in the case of an industry characterized by a large number of companies in the same trade or having the same size, where withdrawal is difficult.

(iii) PEST analysis

This is a technique of analyzing the external environment of "Politics", "Economics", "Society", and "Technology".

(iv) Marketing research

This is a technique of investigating and analyzing market (i.e., customer) trends. Since it is realistically impossible to conduct a marketing research focusing on all customers, the investigation results collected from specific sampled customers (i.e., focus group) are analyzed statistically.

[Method of customer survey]

- Questionnaire
  This is a method of questioning the customers through questionnaires and interviews, and collecting their opinions and thoughts.

• Observation method

This is a method of getting the customer to use products on a daily basis and then collecting information by observing the status of use.

• Experimental technique

This is a method of collecting information that is related to a hypothesis from the activity of customers under a specific situation for verifying information in line with a certain assumption.

(2) Creation of the marketing strategy

In most cases, the marketing strategy is created through the procedure of STP analysis. According to STP analysis, the marketing strategy is created on the basis of the concept that "Rather than targeting all customers, it is more effective to specify only those customers who enable effective expansion of business as compared with competitors."

[Procedure of STP analysis]

1) Segmentation

The customer market is classified on the basis of the needs and customer layer (e.g., age, sex, occupation).

• RFM analysis

This is a technique of classifying customers by analyzing three aspects: Recency (i.e., last purchase date), Frequency (i.e., purchase frequency), and Monetary (i.e., total purchase money).

2) Targeting

The target market is selected from the classified customer markets.

3) Positioning

The method and means are decided to be used to show the value of a company to appeal to customers for the selected target market. (The marketing strategy is created.)

When the marketing strategy is created on the basis of Positioning of STP analysis, the following concept is used.

(i) Marketing mix

This is a combination of several elements necessary for a company to achieve its objectives in the target market. This includes the seller's perspectives (4P) and the buyer's perspectives (4C).

Seller's perspectives (4P)	Buyer's perspectives (4C)
Product	Customer value
Price	Customer cost
Place	Convenience
Promotion	Communication

What is important at the time of using marketing mix is a planning and management activity called merchandising. This involves the provision of products matching the needs of the target customers with appropriate pricing and timing.

(ii) Consumer behavior model

This is a model that systematically organizes the behavior of consumers and is used as a policy at the time of appealing to the target (i.e., customers).

Model	Content
AIDMA	General purchase model (Attention, Interest, Desire, Memory, Action)
AMTUL	Customer fixed model (Aware, Memory, Trial, Usage, Loyalty)
AISAS	Net purchase model (Attention, Interest, Search, Action, Share)

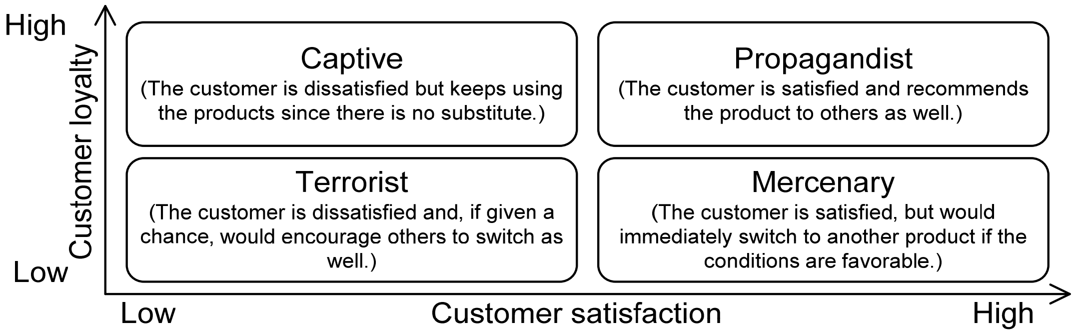
(iii) Innovator theory

This is a theory of classifying or analyzing the product purchase approach of customers in order of the earliest purchase time of new products. In this regard, an early adopter has an important existence as he/she plays an important role in the penetration of a new product in the market as an opinion leader who has a large power of influence on others.

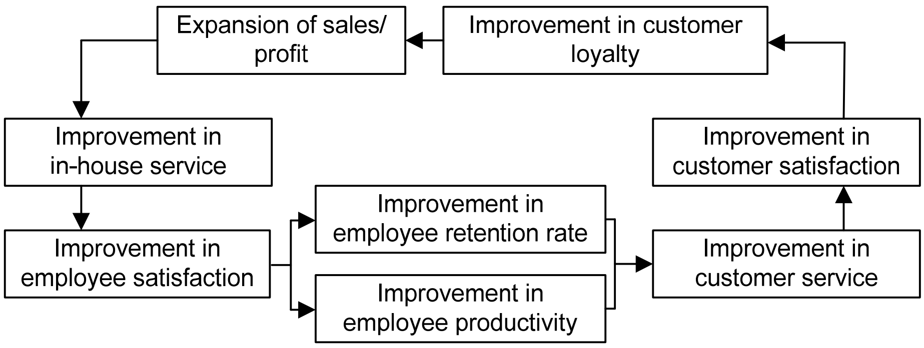
Name	Targeted person
Innovators	An innovator who likes novel things
Early adopters	An early adopter who is sensitive to prevalent things
Early majority	Relatively cautious early majority
Late majority	Somewhat skeptical late majority
Laggards	Most conservative laggards

(iv) Service profit chain

This is a model that was advocated by James L. Heskett on the basis of his idea that "customer satisfaction and employee satisfaction have a close relationship." Heskett classified customers into the following four categories and explained the importance of improving customer satisfaction.



According to the service profit chain, it is advocated that an improvement in employee satisfaction based on an improvement in the in-house service will result in an improvement in customer satisfaction.



(3) Implementation and evaluation of the marketing strategy

The created marketing strategy is implemented, and the result is evaluated. While the evaluation procedure and evaluation viewpoint differ depending on the industry and business, these are generally evaluated on the basis of the sales volume, market share, and sales quantity. Even in the case of marketing, since the PDCA cycle is repeated, the execution result is evaluated, and a new marketing strategy is created on the basis of the evaluation result.

1-2-2 Marketing Strategy

Marketing strategy is a strategy that is created on the basis of Positioning of STP analysis. This subsection describes the strategy that is in line with the seller's perspectives (4P) in the marketing mix.

(1) Product strategy

Product strategy is a strategy related to products, such as the functions, quality, design, brand, product line, services, and guarantee. Brand strategy is also one of the product strategies.

In the product strategy, the market growth rate and market share of the product are analyzed on the basis of the product portfolio, and the main policies are decided depending on the stage of the product life cycle in which the product is at the moment.

- PLC (Product Life Cycle)

  This is the cycle from the time of introduction of a product into the market until its withdrawal, which is classified into four stages.

  1) Introduction stage: This is the stage when a product has entered the market only a short while ago and profits cannot be expected.
  2) Growth stage: This is the stage when the product has been accepted by customers and the profits keep increasing.
  3) Maturity stage: This is the stage when the demand is saturated and both the growth rate and profits become stagnant.
  4) Decline stage: This is the stage when the product deteriorates functionally and the profits start declining

(2) Price strategy

Price strategy is a strategy that is related to price, such as the retail price, wholesale price, standard price, discounted price, trading conditions, payment due date, margin transaction conditions, and allowance (e.g., support money for advertising objective).

In the price strategy, the sales price of products is decided according to the following price setting methods.

Type	Setting method	Sales price setting method
Cost-oriented	Cost plus approach	The price is set by adding a fixed profit to the cost.
	Markup approach	The price is set by adding a profit to the cost price.
Competition-oriented	Market price following approach	The price is set by focusing on the market price range.
	Price leader following approach	The price is set according to the price of the company that leads the industry.
Demand-oriented	Price differentiation	Several prices are set depending on the condition.
	Prestige price approach (premium pricing)	A high sales price is set by using the consumer psychology that high

		quality equals a high price.

At this time, the price setting that satisfies both the consumer needs and the desired profit of the company between a high pricing policy (i.e., fast recovery of cost) and a low pricing policy (i.e., penetration in the market) is called value pricing. Moreover, since the sales price is closely related to product satisfaction (i.e., cost performance/cost effectiveness), matching it with the customer needs through discount amount and payment terms is also examined. Stable purchasing power regardless of the price implies a low price elasticity.

(3) Distribution strategy

Distribution strategy is a strategy related to distribution, such as the sales area, selection of goods, store location conditions, inventory, delivery, and distribution base.

The distribution strategy must correspond to the form (i.e., distribution structure) in which products are delivered to the consumer. The distribution structure is not just limited to in-store sales, but is diversified, including mail orders and electronic transactions using the Internet, and franchise chain. A franchise chain is a company integration that the head office provides the goodwill or trademark usage rights, and opening and providing management knowhow to the member stores, and in exchange collects loyalty (i.e., membership fees).

A mutually dependent organization concerning distribution (a process that enables the acquisition or consumption of products and services) is called a distribution channel (or marketing channel). There is also a concept called channel integration by which the entire distribution channel is perceived in an integrated manner. Channel integration is a technique of providing better distribution services (e.g., right product, right time, right quantity) to the customer.

(4) Promotion strategy (advertising strategy)

Promotion strategy (i.e., advertising strategy) is a strategy related to sales activities, such as advertising, PR activities, sales promotion, direct mail, and over-the-counter sales.

Promotion strategy is an advertising strategy and sales promotion activity for informing the consumer about the characteristics of the product and increasing intention to buy. Moreover, publicity (e.g., reporting on products and services) in various types of media is also an important element. With regard to advertising, it becomes important to create an organizational and management structure to ensure that infringement of the below-mentioned rights does not happen.

- Portrait right

  This is the right to a portrait. This is considered a part of privacy. When a person's portrait and name are published without permission, it is regarded as an infringement of personal rights.

- Publicity right

This is the right to monopolize the use of a portrait or name. For example, the use of the photograph and name of an entertainer, whose appearance is like a product, is restricted, and photography and recording in concerts are generally prohibited. The civil law is applicable to the case of infringement of publicity rights that may correspond to personal rights and property rights.

(5) Marketing concept

The marketing concept is a concept that marketing is positioned as a core function of corporate activities because acquisition and retention of customers is the main focus of corporate activities. This is also referred to as the concept of complying with the customers' needs by offering a favorable environment surrounding the products rather than considering the production of good products as the core activity. Therefore, the marketing strategy includes not only the product strategy, but also the price strategy, distribution strategy, and promotion strategy.

1-2-3 Marketing Techniques

Marketing techniques are techniques concerning the overall marketing activities with respect to the market and customers. These techniques are based on two concepts: the concept of implementing marketing according to the marketing strategy; and the concept of creating the marketing strategy according to the marketing techniques.

[Typical marketing techniques]

- Mass marketing

This is a technique of performing large-volume production and large-volume distribution for all customers. Advertising is also performed simultaneously with a focus on mass advertising through media, such as television, newspapers, and magazines that are expected to be viewed and heard extensively.

- Segment marketing

This is a technique of appealing to customers in line with the needs of the customer segments that are created through segmentation of the market. Marketing activities (e.g., advertising initiative matching the needs of the customer segment) that are more precise than mass marketing can be implemented.

- One-to-one marketing

This is a technique of appealing individually in line with the likes of each individual customer. Improved customer satisfaction can be expected by handling customers individually and extending the most appropriate marketing activities to each individual.

- Relationship marketing

  This is a technique of attaching importance to the relationship with customers. Its purpose is to acquire long-term repeaters by improving customer loyalty through the construction of a favorable relationship with customers.

- Direct marketing

  This is a technique of directly approaching customers by using direct mail and e-mail magazines. The concept of direct promotion is important. It also includes direct marketing using mass media.

- Test marketing (Market test)

  This is a technique of performing test sales by restricting the sales period and sales region before full-scale market entry. Generally, the results of test marketing are analyzed, and this proves to be useful in creating a strategy for mass marketing.

- Push strategy

  This is a technique (i.e., strategy) of working on distributors by applying conditions, such as kickbacks and rebates, and thus promoting the demands of consumers.

- Pull strategy

  This is a technique (i.e., strategy) of eliciting the demands of consumers by using advertising. This type of strategy includes the brand strategy that is used to improve the brand image of a company or product, and the advertisement strategy that uses mass advertising.

1 - 3 Business Strategy and Goals and Evaluations

Business strategy is a specific strategy of the business operations level that is set up on the basis of the management strategy and marketing strategy.

[Procedure of setting up a business strategy]

1) Setup/confirmation of the company vision

   Clarify the form (i.e., direction) that a company must have on the basis of the management philosophy.

2) Analysis of the business environment

   Clarify the position of a company in the market and consumer needs, and also the relationship with competitors.

3) Creation of the business strategy

Define the strategy objectives and clarify the specific strategy at the business operations level.

4) Extraction of CSF (Critical Success Factor)

Clarify the CSF (Critical Success Factor) that has a definitive impact on the achievement of strategic objectives.

5) Setup of an implementation plan

Set up a concrete implementation plan for accomplishing the objectives. At this time, set up the two indicators for evaluating the level of accomplishment of objectives, and create an evaluation plan as well.

- KGI (Key Goal Indicator)

  This is an indicator for quantitatively evaluating the level of accomplishment (i.e., result) of objectives. It uses the sales volume, profit margin, number of agreements, sales quantity, and so on.

- KPI (Key Performance Indicator)

  This is an indicator for quantitatively evaluating the means (i.e., process) of accomplishing objectives. It uses the number of references, the number of customer visits, the number of claims, and so on.

Note: According to another method, the specific strategy for accomplishing the CSF that is extracted in step 4 is taken into consideration in step 3. The order of the two is reversed here.

(1) Business environment analysis techniques

- Needs/wants analysis

  The consumers' needs (i.e., things whose absence would create a problem, and indispensable things) and their wants (i.e., things whose absence would not create a problem, but where possessing them would be beneficial) are surveyed and analyzed.

- Competitive analysis

  The technologies, knowhow, financial status, share, and selection of goods (i.e., product lineup) of competitors are surveyed and analyzed.

- Positioning analysis

  The relative positioning of the products and services of a company in the market is surveyed and analyzed.

(2) Typical business strategies

- VE (Value Engineering)

  This is a strategy (or technique/activity) of analyzing the value of products and services, and working toward an improvement in the value with the lowest cost according to a systematically organized procedure. It is a coordinated activity that clarifies the functions that are required by customers and improves the value without affecting the performance, reliability, and quality.

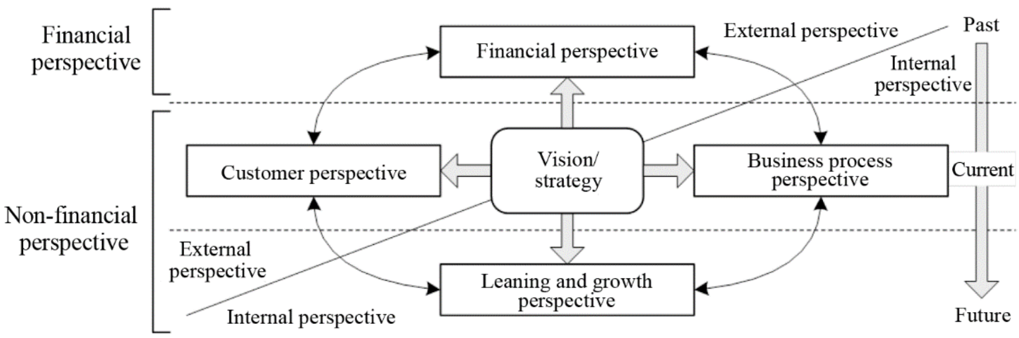
- TQM (Total Quality Management)

  This is a management technique (or strategy) according to which TQC (Total Quality Control) is applied to the management strategy and reflected in business operations and management. It uses Six sigma, which controls the variation by using the standard deviation σ (sigma) that represents the variation and sets the range from the center of normal distribution up to 6σ as the upper-limit value and the lower-limit value.

(3) Business strategy evaluation techniques

- BSC (Balanced ScoreCard)

  This is an evaluation technique that a wide-range evaluation standard is set, and it clarifies difficult-to-evaluate aspects, such as the level of satisfaction of customers and the intention of employees. The CSF, KGI, and KPI matching the strategy of each individual and department are set by using the "financial perspective (past)," "customer perspective (external)", "business process perspective (internal)," and "learning and growth perspective (future)." And then monitoring is performed according to the PDCA cycle. On the basis of the result, the following are promoted: improvement in business processes, improvement in the skills of individuals, and improvement in the business operations of the company.



- Scoring model

This is a method of evaluation in which qualitative evaluation is represented with numerical values. The evaluation standard is defined for each evaluation item (i.e., objective), and evaluation is performed in an integrated manner in view of the weight of each item.

Evaluation item	Weight	Evaluation content	Score
Objective 1	0.2	Almost as desired	80 points
Objective 2	0.5	As desired	100 points
Objective 3	0.3	Partially improved	40 points

As desired: 100 points
Almost as desired: 80 points
Partially improved: 40 points
Same as before: 0 points

Total evaluation score = 80 points × 0.2 + 100 points × 0.5 + 40 points × 0.3 = 78 points

1 - 4 Business Management System

Business management system is an integrated system for achieving optimization and high efficiency of business. This is composed of a system that targets the entire company, a system that targets a specific business or department, a system that supports decision-making of the management and such other system.

(1) ERP (Enterprise Resource Planning)

ERP (Enterprise Resource Planning) is a concept for achieving higher efficiency of business through integrated management of corporate activities from the viewpoint of effective utilization and optimal distribution of management resources.
In companies, mostly there is an integrated business management system based on an ERP package that centrally controls management resources. However, in order to introduce an ERP package, internal consensus and policy-making by the management are necessary for revising the current business operations in view of the prerequisite business operation model, and redesigning the business process of the company as a whole.

(2) SCM (Supply Chain Management)

SCM (Supply Chain Management) refers to the management of the flow of product supply from procurement of material and components up to manufacturing, distribution, and sales as a “supply chain” mainly in the manufacturing industry and distribution industry.
Through sharing and management of information with related departments and other companies, the SCM system helps achieve total optimization of the business process (e.g.,

shortening the time for delivery, reducing dead stock).

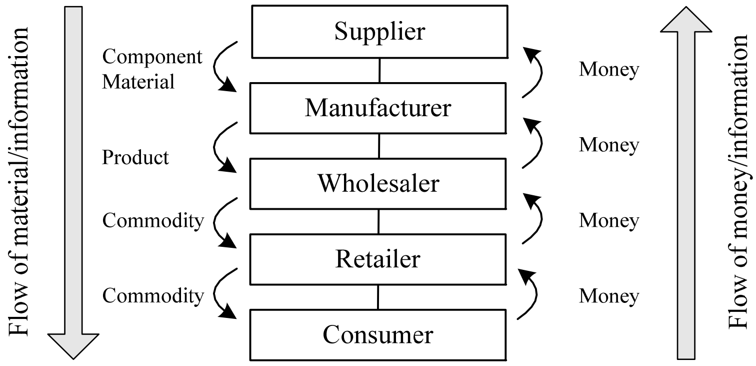


Figure 2-3 Supply chain in a manufacturing industry

[SCM-related terminology]

- CRP (Continuous Replenishment Program)

  This is a method by which the suppliers replenish only the required amount at the required time. By supplying products according to the sales quantity, shortage of products can be prevented.

- TOC (Theory Of Constraints)

  This is a concept that it is necessary to perform intensive management or improvement of the process that acts as a bottleneck in the overall schedule of the manufacturing process, because the bottleneck process is a constraint.

(3) CRM (Customer Relationship Management)

CRM (Customer Relationship Management) refers to the management of the relationship with customers. This is a concept that the most important aspect of a business strategy is to value the current customers and to retain them, because the cost of maintaining an acquired customer is much less as compared with the cost of developing a new customer.

The CRM system is a system that performs centralized and continuous management of customer information in order to retain and manage a favorable relationship with the existing customers. It should be noted that the CRM system is rarely used alone, but is mostly used as part of the ERP package or SFA.

(4) KM (Knowledge Management)

KM (Knowledge Management) is a technique by which the management and employees accumulate and share the knowledge and knowhow acquired from business activities, and the knowledge scattered within the company, such as the creativity, behavioral ability, and ideas

of employees, and use it for problem solving as a management resource (i.e., knowledge) of the entire company.
In the KM system, in addition to the use of the knowledge database (or knowledge base) in which the internal information of the company is accumulated, artificial intelligence is also used.

- AI (Artificial Intelligence)
  This is a collective term for the techniques and studies performed to make a computer work in the same manner as a human brain. AI uses learning (i.e., acquiring knowledge from the collected information) based on the learning theory and inference (i.e., deriving new knowledge from several knowledge bases). Moreover, knowledge engineering, which involves technological handling of information accumulated in the knowledge database, is also an application example of artificial intelligence.
  - Expert system
    This is a system that uses the expert knowledge accumulated in the knowledge database, and it takes the decisions that are necessary for problem-solving in the inference engine. Logic programming that describes the "facts" and "rules" in a program is suitable for the development of an expert system.
  - Neural network
    This is a model that simulates the movement and characteristics of human brain cells (i.e., neurons) on a computer. It is capable of learning pattern recognition such as an output for an input.
  - Fuzzy computer
    This is a computer that uses the fuzzy theory, which is one of the research areas of artificial intelligence. The fuzzy theory is a theory used on a general computer that represents ambiguity (or fuzziness) by using an intermediate value (e.g., 0.6) with respect to a binary theory, such as true/false or 0/1.

(5) SFA (Sales Force Automation)

SFA (Sales Force Automation) is a support activity that aims at improving the efficiency and quality of sales activities by using IT, and thereby increasing the sales and profit. There are many cases where the sales staff has a large number of tasks outside the company, which makes it difficult to manage the schedule and sales activities. Thus, a system that supports sales activities by making use of a mobile PC and cellphone becomes necessary.
In the SFA system, there are mostly the following five functions of the support activity that improve the productivity of sales activities.

- SPM (Sales Process Management) function

  This is a function that aims at an improvement in efficiency by standardizing the sales processes of business talks, proposals, and acceptance of orders.
- TM (Time Management) function

  This is a function that performs schedule management and time management.
- CRM (Customer Relationship Management) function

  This is a function that manages the sales progress status and the relationship with customers by sharing the customer information and case-related information. It is also called the contact management function.
- KM (Knowledge Management) function

  This is a function that accumulates and manages the sales-related knowledge, such as case examples of proposals, information about business talks, and product information.
- Other support functions

  These are functions that support various tasks associated with sales activities, such as creation of different types of documents on sales activities including sales reports, and adjustment of transport fees.

(6) DSS (Decision Support System)

DSS (Decision Support System) is a system for supporting the decision-making of corporate management. It is composed of the OLAP (On-Line Analytical Processing) system, which performs analysis of data accumulated in a huge database (i.e., data warehouse) for information analysis, an expert system, and so on.

(7) EIP (Enterprise Information Portal)

EIP (Enterprise Information Portal) is a system that integrates the information of various systems (i.e., business management systems) and databases that exist in the company, and enables its consolidated display and search on the computer screens of employees (i.e., users). It incorporates the functions of a portal site, such as a search engine, into the business system, and is quickly in widespread use.

2 Technological Strategy Management

In the conventional business strategies, “technology” was used as a management element. However, in recent times, management focusing on technology has emerged, and this is called MOT (Management Of Technology).

2 - 1 Creation of a Technology Development Strategy

MOT (Management of Technology) is management based on the concept that a company that expands its business by focusing on technology promotes innovation by investing in technological development, and develops a sustainable business.

- Process innovation
  This refers to the innovation of business processes, such as the product development process, in order to continue with and expand business.
- Product innovation
  This refers to the development of new innovative products to achieve differentiation from other companies. The techniques of product innovation include the concept-oriented technique in which the required technology is derived from a concept, and the technology-oriented technique that utilizes the unique in-house technology (i.e., core technology).

Technology development strategy is a strategy whose main objective is product innovation. The creation and implementation procedure of a general technology development strategy are as follows:

1) Survey and analysis of the technology trend/product trend
   “In what direction and at what speed is technology progressing?” or “In what way does the progress in technology affect the market?” is analyzed and estimated by using the technology portfolio, Delphi method, or such other method, and the core technology is ascertained.
   Information is also collected on successful cases of technology development and idea creation.
2) Creation of a technology development strategy
   A technology development strategy is created in consideration of the balance between the two aspects of “What product to research and develop” and “What is the status of the market of the products to be researched and developed?” At this time, if the technologies possessed by a company alone is insufficient, the

strategy is created with a view to technology acquisition that uses external resources.

3) Creation of a technology development plan

A technology development plan is created on the basis of the management strategy and technology development strategy, and a road map which has a scientific backing and has reached a consensus, is created as a specific scenario.

4) Implementation

The R&D (Research and Development) department takes the lead in performing research and development according to the technology development plan. Evaluation is also performed on the basis of monitoring, side by side.

2 - 2 Technological Strategy Management Techniques

(1) Technology acquisition

Technology acquisition refers to the procurement of technologies from outside (e.g., other companies) when the technologies possessed by a company alone are insufficient. The techniques of technology acquisition include the following.

- Technology tie-up

  This refers to sharing of technologies and joint development through partnership agreements between several companies. It is also called a technology-based alliance between companies.
- Technology licensing

  This refers to the permission to apply the technologies possessed by other companies. Compared with a technological tie-up in which an equivalent relationship exists, there exists a somewhat hierarchical relationship in most cases.
- Industry-academia-government collaboration

  This refers to a type of technology acquisition by which a company (industry) develops new technologies or new products, and sets up new businesses, in collaboration with a university (academia) possessing technology and high-level expert knowledge, and a public research organization (government), such as a governmental agency, independent administrative agency, research institute, or laboratory.
  - TLO law (Technology Licensing Organization Law; Act on the Promotion of Technology Transfer from Universities to Private Business Operators)

    This is a law that aims at promoting transfer the research results or technologies of a university to a private company venture in order to utilize the results or technologies. The country supports the industry/university mediation activities to support the acquisition of patents and the transfer of technologies for an organization that has been approved and accredited by the TLO law.

(2) Technology development strategy

Technology development strategy is a strategy that is created to secure future competitiveness in the market. The typical technology development strategies include the following.

- Patent strategy (Intellectual property right strategy)
  This is a strategy that improves the superiority of the technologies of a company by preventing imitation by another company through the acquisition of a patent for the technologies. In some cases, the objective of this strategy is to generate profits by obtaining patent license fees in the future.
- Standardization strategy
  This is a strategy that one tries to establish the technologies of a company as de facto standards (or industry standards). It includes activities that increase the share in the industry through free publication of technologies, and activities that standardize the technologies of a company through a forum with other companies.
- Coordinated strategy
  This is a strategy according to which technologies are supplemented through technology alliance with other companies and technology licensing when the technologies of a company alone are insufficient. Recently, as a result of the trend of globalization and technology integration, the number of companies employing a coordinated strategy within and outside the industry is increasing.

(3) Technology development plan

Technology development plan is an implementation plan that is created in view of the implementation method, protection of the technologies possessed, and implementation organization on the basis of the business strategy and technology development strategy. In the technology development plan, the plans described below are created and optimal distribution of management resources is performed.

- Technology development schedule
  This refers to planning of the technology development. No matter how superior a developed technology is, it has no meaning unless there is a market need. Therefore, concurrent engineering that several processes are implemented simultaneously in

parallel in order to shorten the period, or pilot production that involves test manufacturing of a product by using a new technology, are also examined.

- Technology development investment planning

  This refers to planning of the cost necessary for technology development. No matter how superior a developed technology is, it has no meaning unless the development cost is recovered and profits are gained. Therefore, an investment plan must be created in consideration of the return on investment (i.e., cost performance).

- Technology development site planning

  This refers to planning of the sites for conducting technology development. The following are examined: setting up research and development centers, or establishing joint facilities with a technology alliance partner.

- Human resources planning

  This refers to planning of the technology development staff. Since human affairs affect other activities, it is important to create an integrated plan from the employment of human resources up to their education and training.

- Intellectual property right management planning

  This refers to planning of the management of intellectual property rights that arise as a result of technology development. A patent application plan is created in order to prevent the intellectual property of a company from being copied or imitated.

(4) Road map

A road map is a chart (or tool) that represents the routes during a particular period (e.g., approximately 5 to 10 years). The road maps concerning technology development are as follows:

- Technology road map

  This is a chart that represents the route of technological progress. It serves as a policy of research and development of a specific technological field or product.

- Product application road map

  This is a chart that represents how a developed technology can be spread to products.

- Market road map

  This is a chart that represents the trend of market needs.

- Patent acquisition road map

  This is a chart that represents the acquisition of a utility model and patent.

3 Business Industry

A business industry is the one related to the information system that is used in the business operations of a company, or the one that uses the information system. This section describes business systems that are used as the information system of a company, engineering systems that are used in the industrial field, e-business that makes use of IT, consumer appliances that are used by consumers, and industrial devices that are used by a company in its business operations.

3 - 1 Business System

Business system is a collective term for the information systems used in the business operations of a company. Various business systems are provided depending on the usage purpose.

3-1-1 In-house Information System

In-house information system is an information system used in in-house business operations. The typical kinds of in-house information system are as follows:

- Bookkeeping/accounting/financial system / Human resource/payroll system / Sales support system
  Each is a system used to implement or support in-house business operations. There are also commercial systems available as operations-specific packages that can be used commonly in various industries and business types.
    - XBRL (eXtensible Business Reporting Language)
      This is a markup language that is used in the description of financial statements of companies. This is based on XML that is also a markup language, and the specifications are established by XBRL International (an industrial organization composed of companies and groups related to finance, audit, accounting, and computers).
- Groupware
  This is software that supports joint activities of groups and organizations with the help of a communication tool and schedule management function, and is used to improve work efficiency.
- Workflow system
  This is a system that automates routine processes. It includes systems that transmit computerized applications and reports according to a predetermined work procedure,

and also perform approvals.

- Video conference system

  This is a system that uses a network to enable remote participants of a conference to exchange their opinions in real-time on a television screen. A video conference system that uses a web camera and the Internet is particularly called a web conference system.

3-1-2 Mission-critical Business Support System

Mission-critical business support system is a collective term for a system that supports a mission-critical business forming the center of corporate activities. Mission-critical business support systems include those that use a commercial software package, such as an ERP package, and those that are specially designed and developed. Software packages (i.e., business packages) developed with the purpose of usage in the business field are classified as shown below.

- Operations-specific package

  This is a software package that supports common business operations in several industries or business types.

  Example: Sales management system, ordering management system, inventory control system, customer management system, production management system, etc.

- Industry-specific package

  This is a software package that supports exclusive business operations in a specific industry or business type.

  Example: Distribution information system, logistics information system, financial information system, medical information system, etc.

The typical mission-critical business support systems are shown below. Such systems can be seen everywhere around us, and these systems (i.e., computers) cooperate mutually to achieve ubiquitous computing that supports our daily lives.

- POS (Point Of Sale) system (point of sale management / over-the-counter sale management)

  This is a system that manages the sales status of products in retail stores, such as convenience stores. Product barcodes are read with the help of a POS register (i.e., POS terminal) on which a barcode scanner is attached, and data collection, aggregation, and issuance of receipts is performed with the help of a store sales management subsystem called a store controller. This is used in inventory and ordering management, and trend analysis in order to identify the hot-selling products.

- EOS (Electronic Ordering System)
  This is a system that automatically accepts and places orders. By linking this system with the POS system, effective inventory management can be performed.
- Electronic banking system
  This is a system that connects the information system of a banking facility and the computer of the business partner over a network, and performs data exchange. It includes firm banking in which a banking facility and business partner company are connected over a network, and home banking in which a banking facility and individual customer are connected over a network.
- Electronic medical records system
  This is a system by which the health care information, such as diagnosis and treatment records (i.e., medical chart), are computerized, and then stored and updated. It is used in EHR (Electronic Health Record) that is exchanged and shared between medical institutions, and PHR (Personal Health Record) that includes health information of an individual.

3-1-3 Administration System and Public Information System

(1) Administration System

The approach to the administration system was indicated as an "Early realization of e-Gov (e-government)" in the e-JAPAN initiative in the year 2000 by the then-Prime Minister. Thereafter, it has been inherited in the "steady promotion of e-Gov and electronic local governments."

- Basic Resident Register Network System
  This is a system that operates with the purpose of improving the public services and efficiency of administrative affairs. It is linked with the electronic application and notification system.
- GPKI (Government Public Key Infrastructure)
  This is an authentication infrastructure that is used when applications and notifications to an administrative body are to be sent electronically.
- LGWAN (Local Government Wide Area Network)
  This is a network exclusive to the government that mutually connects the networks within a local government organization and is set up with the purpose of high-level

usage through smooth communication and sharing of information, and helps retain high-level security.

- EDINET (Electronic Disclosure for Investors NETwork)

  This is an electronic disclosure system for disclosure documents, such as the annual securities report.

(2) Public information system

Public information system is a collective term for systems with a strong public presence. In a public information system, it is necessary to remove the social and economic disparity (i.e., digital divide) that arises as a result of the existence of information literacy and the differences in the IT usage environment. This is performed by taking into consideration a universal design that provides an environment and services that can be used easily and comfortably by all human beings.

- GPS (Global Positioning System) application system

  This is a system that uses the positioning system (i.e., GPS) of a man-made military satellite. Currently, it is being used in navigation support of airplanes and in car navigation in combination with GIS (Geographic Information System).
- ETC (Electronic Toll Collection system)

  This is a system that performs fare adjustment by enabling wireless exchange of the necessary information between a vehicle and the tollgate system when the vehicle passes through an exclusive gate installed at the tollgate.
- AMeDAS (Automated Meteorological Data Acquisition System)

  This is a system that automatically performs observations of the weather conditions in detail, both temporally and geographically.
- Smart grid

  This is a power network that enables prevention of electricity failure and adjustment of electric power transmission through a unique power supply and demand control by installing a power controller in the computer.

3 - 2 Engineering System

Engineering system is a collective term for systems that support the production of industrial products. An engineering system can be of various types, ranging from a business processing system that manages the production information, through to a control system for industrial machines and industrial robots.

3-2-1 Production Management

Production management involves the creation and management of a production plan stating what is to be produced, when it is to be produced, and in what quantity. When a production plan is created, it is important to select an appropriate production system.

[Typical production systems]

- Build-to-order production system
  This is a system (or form) that an order is received and the ordered quantity is produced.
- Build-to-stock production system
  This is a system (or form) that the quantity for stock replenishment is produced on the basis of the production plan.
- Continuous production system
  This is a low-mix high-volume production system that the same product is produced continuously for a fixed period of time.
- Individual production system
  This is a high-mix low-volume production system that carries out production according to each individual order.
- Lot production system
  This is a system that the production quantity is compiled according to the product type, and several products are produced alternately in units of lots. This production system is positioned somewhere in the middle of continuous production and individual production.
- Cell production system
  This is a production system that a single operator or several operators are in charge of all processes of production. It is suitable for varied and flexible high-mix low-volume production.
- Line production system
  This is a production system that each operator is in charge of only a part of the assembly line of the production process. Although division of work is necessary on the basis of standardization, simplification, and specialization, it is suitable for low-mix high-volume production of products whose specifications do not change over a long period of time.
- JIT (Just In Time) production system
  This is a system that the required products are produced at the required time and only in the required quantity.
- Process production system
  This is a system that products are manufactured by means of the chemical reaction

of the raw materials. It is suitable for low-mix high-volume production when the setup frequency is extremely low.

Moreover, in order to evaluate the production plan, it is necessary to decide beforehand various productivity indicators, such as labor productivity and capital productivity.

3-2-2 Production Process

In the production process, the production line is organized according to the production plan, and products are thus manufactured. At this time, the activities that are performed manually and those that can be substituted by machines are clearly identified. The productivity should be improved by performing automatic production management as much as possible.

[Example of automatic production management]

- NC (Numerical Control) machine tool
  This is a machine tool that is controlled by giving instructions on the usage path of the tool for a work piece and the work process necessary for processing on the basis of corresponding numerical information.
- Automatic monitoring equipment
  This is equipment for monitoring the operational status and production status (e.g., whether or not the production quantity is as planned) of a production line automated by industrial robots.
- Automated guided vehicle
  This is a vehicle (e.g., fork lift) that performs unmanned transport of raw materials and products by using a magnetic marker (i.e., a mark that emits magnetism) installed on the floor area.
- Automated warehouse
  This is an unmanned warehouse that automatically controls the equipment (e.g., belt conveyors) used to transport goods in the warehouse. It also includes warehouses that link with the inventory management function and manage the actual number of pieces.

3-2-3 Production System

Production system is a collective term for systems that support the production management and the production process of products. The general system chart of a production system is as shown in Figure 2-4.

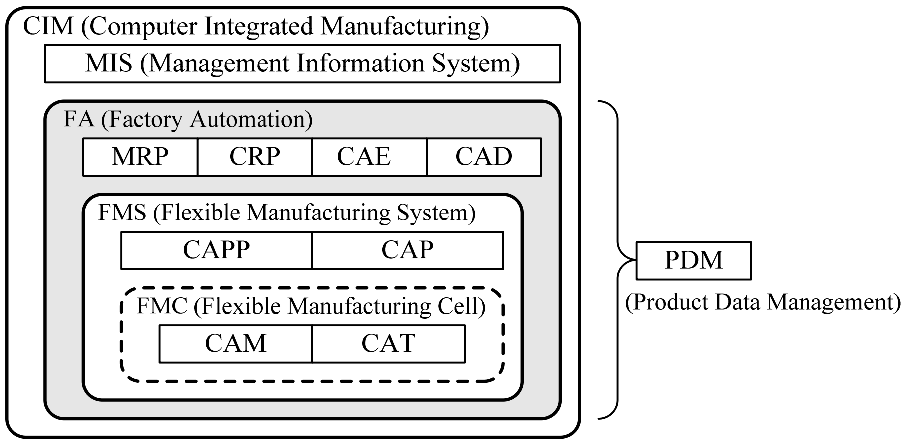


Figure 2-4 System chart of production system

- CIM (Computer Integrated Manufacturing)

  This is a system by which processes from creation of business strategy up to production are performed in an integrated manner.

  - MIS (Management Information System)

    This is a system through which information on corporate management is managed.

- FA (Factory Automation)

  This is a system that aims to improve work efficiency by promoting automation of the machines and equipment in the factory through the use of computers.

  - MRP (Material Requirements Planning)

    This is a system by which the flow of resources from the raw material necessary for production up to the finished product is planned and managed on the basis of the production plan. The net requirement of the necessary resources is determined on the basis of the bill of materials, and the procurement plan of resources is created.

  - CRP (Capacity Requirements Planning)

    This is a system that creates and manages the work plan of the process unit on the basis of the performance load of the devices that is used in each process.

  - CAE (Computer Aided Engineering)

    This is a system that supports research (e.g., intensity, mechanism) related to the product.

  - CAD (Computer Aided Design)

    This is a system that supports activities related to the design of the product. Techniques that are used in this system include computer graphics and geometric modeling.

- FMS (Flexible Manufacturing System)
  This is an automated manufacturing system by which the manufacturing process from management of resources up to management of processes is integrated and controlled.
  - CAPP (Computer Aided Process Planning)
    This is a system by which the manufacturing procedure and processes of the machines used are planned.
  - CAP (Computer Aided Planning)
    This is a system by which the schedule of activities and machines for manufacturing is planned.
- FMC (Flexible Manufacturing Cell)
  This is a system that automatically controls the cell, which is the unit of processing and assembly at each stage of the manufacturing process, with the help of a computer.
  - CAM (Computer Aided Manufacturing)
    This is a system that supports the production activities of the product. It instructs the work process to the NC machine tool with the help of an NC program, and performs automatic operations.
  - CAT (Computer Aided Testing)
    This is a system that automatically tests whether or not the product shape and the functions are according to the design.
- PDM (Product Data Management)
  This is a system that performs consolidated management of various types of data of all processes, from production planning and research development up to manufacturing, during the design and the manufacturing of industrial products.

3 - 3 e-business

E-business refers to the overall business techniques that actively make use of IT, such as computers and networks.

3-3-1 EC (Electronic Commerce)

EC (Electronic Commerce) is a mechanism by which a company, organization, or individual performs sales, commodity distribution, advertising, and payment services by using a network.
Depending on the form of transaction, EC can be classified as shown below.

Name		Form of transaction
B to B	Business to Business	EC between companies
B to C	Business to Consumer	EC between company and individual consumer
C to C	Consumer to Consumer	EC between individual consumers
B to E	Business to Employee	EC between company and employees
G to B	Government to Business	EC between the government/local authorities and companies
G to C	Government to Citizen	EC between the government/ local authorities, and citizens

(1) Electronic ordering system

EOS (Electronic Ordering System) is a term for systems that support acceptance and placement of orders using a network, such as the Internet.

- Online mall (cyber mall, virtual mall)
  This is a site that is a collection of retail stores and mail order houses on the Internet. It is a "B to C" form of transaction including online shopping where customers buy the products of their choice.
- Electronic procurement system
  This is a system through which, when a company or a public organization procures external resources, a decision is made concerning the supplier by performing electronic bidding via the network after the required conditions have been provided. Procurement between companies is performed in the "B to B" form, and electronic bidding. such as public works, is performed in the "G to B" form.
- e-marketplace (Electronic marketplace, Internet business center)
  This is a site that is a collection of seller companies and buyer companies on the Internet. It is a "B to B" form of transaction in which products are traded on a site.
- Electronic auction (Internet auction)
  This is an auction that is performed over an Internet site. It is a "C to C" form of transaction in which the seller (i.e., individual) exhibits its products on an auction site, and buyers (i.e., individuals) perform bidding, with the person offering the highest price becoming the successful bidder. Another type of auction is a reverse auction, where a buyer indicates the object(s) he/she wants to buy and the purchase conditions, and either an individual or several sellers respond to this demand.

(2) Electronic payment system

Electronic payment system is a collective term for systems by which a transaction is settled electronically (for example, charges are given and received). The typical electronic payments used in EC are as shown below. In an electronic payment system, the security of communications is ensured through SSL (Secure Sockets Layer).

- Internet banking
  This is a mechanism by which financial trading is performed with a bank by using the Internet, and it is used in account transfers and payment of transaction charges through account transfers. Since a dedicated terminal or dedicated software is not needed as in the electronic banking system, this system is used not only by corporations such as companies, but also by individual consumers, in large numbers. Moreover, net banks with Internet banking as their main component are also seen.
- EFT (Electronic Fund Transfer)
  This is a mechanism by which funds are transferred (i.e., paid) electronically between banks and between accounts according to instructions from the requesting person. Generally, this method is used for payment between companies.
- Electronic money
  This refers to money that is exchanged as electronic data instead of conventional money, and is used for payment by an individual consumer. The main electronic money services include the prepaid type known as Edy and the postpaid type known as iD.

A mechanism of implementing a transaction that does not use conventional money with the help of an electronic payment card is also an electronic payment system. The cards that are used include credit cards used for deferred payments, prepaid cards that involve advanced payments, and debit cards (cash cards) where the payment amount is immediately withdrawn from the bank account. Examples of other cards are Suica, PASMO, ICOCA, TOICA, Kitaca, and SUGOCA, which are used for transport facilities and can also be used for shopping.
A card system that uses the cards described below to record electronic information is used in the electronic payment system.

- Magnetic card
  This is a card in which information can be recorded in the magnetic strip of the card. Since there is no mechanism for preventing unauthorized writing/reading, the reliability of this card is low.
- IC card (Smart card)
  This is a card in which information can be recorded in an IC chip embedded in the card. Since data can be encrypted and access control is possible, this card has a high

level of reliability.

- RFID (Radio Frequency IDentification)

  This refers to a contactless automatic recognition technology that uses radio waves or electromagnetic waves. Information is exchanged without contact by using an IC chip equipped with an antenna called an IC tag. Since RFID is resistant to dust and can read the recorded information even from outside the package, it is applicable in traceability systems that trace the path from production to distribution of products, product management, and entry and exit control for a building.

(3) e-business utilization techniques

In addition to EC, various forms and techniques are also used in e-business. This subsection describes the techniques and the concepts of promoting e-business.

- Internet business

  This is a collective term for business models, including EC, which uses the Internet. There are various business models, including the content model that provides attractive contents and ensures sufficient customers, and the portal model that manages portal sites, such as Yahoo! and Google, which act as entry points on the WWW.

- SEO (Search Engine Optimization)

  This is a technique or a service by which the website of a company is displayed at the top of the search results when a keyword search is performed using a search engine.

- Recommendation system

  This is a system that provides a service (i.e., recommendation) and displays the information in which a user may be interested, on the basis of the already registered purchase history of the user on the top page.

- Long tail

  This is a concept where, by continuing with high-mix low-volume sales, a large profit can be achieved even when the sales quantity of each type of product is small. In certain cases, this indicates that it is impossible to ignore the ratio of the sales total of a product with poor sales in relation to the overall sales.

- Internet advertising

  This is a collective term for corporate advertising on the Internet.

  It includes affiliate (i.e., result-reward type advertisement) in which a company advertisement or a link to a website is posted on the web page of an individual and remuneration is paid according to the derived results; opt-in mail advertisement in which e-mails are sent to the persons who have given their consent to receiving advertisements (i.e., opt-in mails); banner advertisement in which the link to a website is posted on a large portal site; pop-up advertisement that is displayed automatically in a separate window by adware; interstitial advertisement that is displayed on the search result page of a search site; and listing advertisement (i.e., keyword targeted advertisement) that is associated with a search keyword.

- Escrow service

This is a service in which a provider serves as a mediator between a seller and a buyer in a C to C form of service, such as an Internet auction.

- Drop shipping

This is a sales form in which, upon receiving an order for a product, the operator of a net shop contacts a wholesaler to send the product to the ordering person. This enables the operator of the net shop to perform sales without keeping an inventory of the product, and on the other hand, the wholesaler can assign the sales activity to the net shop.

3-3-2 EDI

EDI (Electronic Data Interchange) is a mechanism by which the data type and data format of business transactions, such as EC, are consolidated, and the quotations, acceptance and placement of orders, and payments are exchanged electronically between companies. The EDI that uses the Internet without the use of a leased line for the exchange of data between companies is called Web-EDI.

In the past, the data type and data format of EDI and the form of network connection was different in each industry in most of the cases, which made it difficult to convert a transaction to EDI. Thus, there have been ongoing standardization efforts mainly in the U.S. and Europe, and in the year 1988, the United Nations adopted EDIFACT (EDI For Administration, Commerce and Transportation) as an international standard protocol for EDI. In addition, standardization techniques, such as XML-EDI and XBRL (eXtensible Business Reporting Language) which are based on XML (eXtensible Markup Language), are incorporated as the data type or data format in which the Web browser is the standard interface, and standardization and open technology are being promoted beyond the industry and business type.

In EDI, the protocols are decided as described below, depending on the hierarchical level.

Convention	Content
Level 1 Information communication protocol	This is an agreement (i.e., communication protocol) concerning the type of line and the transmission control procedure, which is used to communicate information by using the network.

Level 2 Information representation protocol	This is an agreement concerning the rules of the message format and the representation method, which is used for proper exchange of information.
Level 3 Task operation protocol	This is an agreement concerning the system operation time and the countermeasures at the time of the occurrence of an error, which is used for exchange of information.
Level 4 Basic transaction protocol	This is an agreement concerning the transaction contract details and the contract, which is used to establish the legal validity of a transaction.

In addition to the above, the following protocols are also related to EDI.

- JIS X 7011-1
  This is an electronic data interchange (EDIFACT) protocol for administration, business, and transportation.
- JIS X 7012-1
  This is a syntax rule (i.e., CII syntax rule) for administration/industrial information interchange. It corresponds to the information representation protocol of level 2.
- STEP (STandard for the Exchange of Product model data)
  This is a standard for the representation and exchange of the product data model that is defined by ISO.
- Japanese Bankers Association protocol
  This is a standard (i.e., communication protocol) for the electronic banking system that is defined by the Japanese Bankers Association.
- JCA (Japan Chain Stores Association) procedure
  This is a communication protocol defined by JCA.

3-3-3 Social Media

Social media refers to a website (or media) that promotes communication through posting or sharing of information between Internet users. It is a mechanism by which many users connect over the Internet, and information is propagated widely.

- SNS (Social Networking Service)
  This is a closed user group service that provides the chance of communicating with friends and of becoming acquainted with new people on a community website for individuals. Currently, it is also being used as a place for companies to exchange

information, or as a place for communication between employees or between the company and its customers. A typical example of an SNS is Facebook which is a service that requires registration with one's real name.

- Electronic bulletin board

  This is a website where members can freely post or browse through specific topics on the Internet.

- Blog (Weblog)

  This is a website for posting information that can be set up easily by an individual on the Internet. It is also often used by companies as a place for reporting activities.

- Mini-blog

  Although this is a website for posting information similar to a blog, information is posted in the form of short text on a mini-blog. A typical example of a mini-blog is Twitter, where daily tweets are posted.

- Video sharing system

  This is a website where an individual can create and post a video to be viewed and listened to by an unspecified number of persons. A typical example of a video sharing system is YouTube. There is also a service that is used for the live broadcast of videos in place of text information as found on a mini-blog.

- Chat

  This is a mechanism by which text information is shared between individuals in real time. Currently, it is being used for conversations between players during online games.

- CGM (Consumer Generated Media)

  This is a collective term for media (or websites) used to accumulate information created and sent by a consumer in the database, and then post the information. SNS and blogs can also be referred to as consumer generated media. Since it plays the role of grapevine communication by publishing information (e.g., reviews) concerning products and services which is provided by consumers, it is considered to be part of the Share process of the net purchase model, which is referred to as AISAS (Attention, Interest, Search, Action, Share) according to the current marketing strategy. While there is a possibility of a major success from such consumer generated media, it is necessary to note that stealth marketing devised intentionally by a company leads to a major degradation of the image of the company from the viewpoint of morals.

3 - 4 Consumer Appliances and Industrial Devices

3-4-1 Embedded System

An embedded system is a small system that is embedded in home electric appliances or industrial products, and controls the device.
The typical hardware and software configuring an embedded system are of the following types.

- Microprocessor (Microcomputer)
  This is a small processor (or small computer) that controls the embedded system. Generally, a dedicated embedded OS is used, but sometimes either a general OS may be used, or the hardware may be controlled directly by embedded software without the use of an OS.
- Sensor
  This is a device that analyzes analog waveforms, which are measurement values, and performs A/D conversion which converts them into electrical signals by performing signal processing such as filtering.

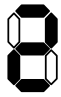
Sensor name	Use
Optical sensor	This is a sensor that uses light.
Infrared sensor	This is a sensor that uses infrared rays.
Magnetic sensor	This is a sensor that uses magnetism.
Accelerator sensor	This is a sensor that measures changes in speed.
Gyro sensor	This is a sensor that measures the rotation speed and the rotation angle.
Ultrasonic sensor	This is a sensor that uses ultrasonic waves.

- Actuator
  This is a device that performs D/A conversion that converts electrical signals into movements.
- Firmware
  This is embedded software that is recorded in ROM to control the hardware. Although rewriting was not originally a prerequisite for this software, it is currently recorded on flash memory and may be rewritten after shipment.
- System LSI
  This is a circuit in which the main electronic circuits of the embedded system are integrated into one chip.
- MEMS (Micro-Electro-Mechanical Systems)

This refers to micro-electro-mechanical elements of a few nanometer (10^{-9} meter) units, and their manufacturing technology. This is a device in which the sensors, actuators, and electronic circuits are integrated into one infrastructure, and it is also used in printer heads and electronic paper.

- Seven-segment LED

This is a device composed of seven segments. The ON/OFF process of each segment is controlled individually, and it corresponds to one bit. Therefore, numeric characters from 0 to 9 can be represented in seven-bit information.



When an event, such as turning ON/OFF of a switch or a reception of an electrical signal from the sensor, occurs in the basic embedded system, the actuator is controlled by performing signal processing.

For example, in a household air-conditioner, the signals (e.g., the temperature setting information) sent from the remote control are received by the air-conditioner. If there is a difference between the room temperature that is measured by the temperature sensor and the set temperature, a temperature adjustment signal is sent to the actuator to control the compressor.

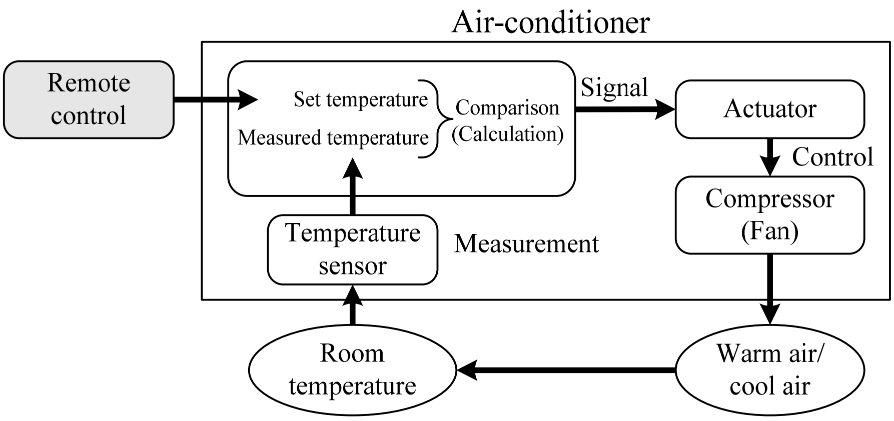


Figure 2-5 Air-conditioner control

An embedded system requires real-time control that poses strong restrictions to the response time. In a life-related hard real-time system, it is especially essential to use a real-time OS to ensure that the processing is completed within the expected time.

Such a control system for an embedded system includes the following types.

- Feedback control

This is a method of detecting the effect of disturbances (i.e., external factors disturbing the control) on the actual measured value, and then correcting the deviation from the desired value.

- Feed-forward control

This is a method of performing a corrective operation beforehand by predicting and estimating the disturbances.

- Sequence control

  This is a method of gradually proceeding with control according to the predetermined procedure.

- Multivariable control

  This is a method of determining several information items to be controlled in an integrated manner, and then controlling each item.

- Fuzzy control

  This is a control method for an ambiguous status, such as "a somewhat large number," "slightly."

- PWM (Pulse Width Modulation) control

  This is a method of performing control by changing the pulse according to the input signal in a fixed cycle.

A method by which the result (i.e., output) is reflected in the next control process, such as in feedback control, is called closed loop control. A method by which the result is not reflected in the control process, such as in feed-forward control and sequence control, is called open loop control. Whether these controls are being performed properly can be verified by testing the response characteristics and the control stability through a diagnostic program.

3-4-2 Consumer Appliances

A consumer appliance is a household electrical appliance or computer-associated equipment for the general consumer. It may also include job-oriented equipment (e.g., POS register) used by individuals.

In modern society, computers (or embedded systems) are incorporated into a wide range of products. These computers cooperate mutually to achieve ubiquitous computing that supports our daily lives. In addition, consumer appliances are being made smaller and lighter, and privately owned (i.e., personalized) information devices and wearable computers that can be worn on the body and carried around are becoming the norm. Wearable computers have become the basic technology of ubiquitous computing by being combined with a sensor network, which is a wireless network for extracting data by connecting together several terminals equipped with a sensor. In such a situation, interactivity (i.e., bidirectionality) over the network is now being required more than ever before.

(1) AV (Audio and Visual) system

AV system is a collective term for devices that handle video images and music. Most AV systems are loaded with a large volume storage optical disc, such as CD, DVD, or Blu-ray disc.

- Stereo

  The majority of current stereos can handle digital data. Optical discs such as CDs, DVDs and Blu-ray discs are used as content storage media.
- Portable headphone stereo

  From the initial cassette tapes through CDs and DVDs, currently mainstream headphone stereos use semiconductor memory, such as flash memory. Products that are linked with the Internet, such as the Apple iPod that enables music contents to be acquired through the Internet, are also available in the market in large numbers.
- Television

  While conventional televisions made use of a computer in part of the control circuit, televisions that support digital broadcasting include products in which bidirectional communication and the Internet can be used, and computers are now playing the main role of a TV. Moreover, the screen also has moved on from a cathode ray tube to liquid crystal and plasma types.
- Picture recorder

  The use of video tapes (i.e., a type of magnetic tape) for recording pictures was prevalent in the past, but recently, recording data is being digitalized so that it can be handled in computers as well, and products in which recording can be performed on a hard disk drive or an optical disc are becoming popular. Recording picture data in a digital format (e.g., MPEG) has the advantage that the recorded data does not deteriorate, but problems relating to copyright and reproduction are becoming an issue.

(2) Household electrical appliances

Household electrical appliances is a collective term for the equipment that exists around us, such as air-conditioners, refrigerators, washing machines, electric rice cookers, and microwave ovens. An embedded system is used to control these household electrical appliances. Some household electrical appliances can be operated from a remote place when connected to the Internet. In particular, devices that support DLNA (Digital Living Network Alliance), which is an industry specification for a home LAN, and automatically becomes usable when it is connected to the network. Household electrical appliances that possess the functions of a computer are referred to as digital household electrical appliances or information household electrical appliances.

(3) Personal information equipment

Personal information equipment is a collective term for PCs and PDAs (Personal Digital Assistants), smartphones and cellphones, or tablet terminals. Among these, devices that possess a communication function are also referred to as consumer communications terminals. In particular, products that significantly improve the performance and the functions of cellphones and smartphones, and support the music playback function and digital terrestrial broadcasting (ISDB-T (Integrated Service Digital Broadcasting-Terrestrial)) called one seg (whose formal name is one segment reception service for cellphones and mobile terminals) are also available.

(4) Education and entertainment devices

Computers have long been used as education and entertainment devices. For instance, the gaming machine known as the "Family Computer" that was launched by Nintendo in 1983 is a representative example. The most recent gaming machines surpass computers in their performance, and some recent gaming machines even use high-performance processors. Moreover, these machines are used not only for entertainment, but can be purchased with software for other purposes including dictionaries and learning, cooking recipes, and health management.

(5) Computer peripherals / OA equipment

Computer peripherals is a collective term for equipment, such as displays, printers, and image scanners. On the other hand, OA equipment is the collective term for the copiers and facsimile machines used in offices, which are now also commonly being used in households. These devices include an increasing number of products that can be connected to the network, and the construction of a home network (i.e., home LAN) is also becoming common.

(6) Job-oriented terminal devices

A job-oriented terminal device is a terminal device connected to a system like a POS terminal of a convenience store, or a credit card reader used in shops.

3-4-3 Industrial Devices

Industrial devices refers to job-oriented devices used in companies and organizations. As with consumer appliances, an embedded system is used in most industrial devices.
In industrial devices, detailed analysis, measurements, and control are performed by an embedded system to promote labor-saving and automation. Moreover, industrial devices are also required to possess interactivity (i.e., bidirectionality) over the network.

- Communication equipment

  This is a collective term for network devices, wireless communication devices, and public phone line equipment. Typical examples of communication equipment include routers and switching hubs used in networks, and digital switching facilities of telephone lines.
- Transportation equipment and construction equipment

  Transportation equipment includes vehicles, railways, and airplanes, and construction equipment includes construction material processing machines in addition to large equipment, such as cranes. A malfunction of this kind of equipment can lead to accidents or loss of life. Therefore, both hardware and software are required to be of high quality and high reliability, and a failsafe design is incorporated.
- Industrial control devices, FA equipment, and processing devices

  This refers to devices used in the engineering system, such as industrial robots. The computer control of production lines and assembly robots of large factories, processing devices, and automated warehouses are widely becoming standard at the existing industrial product manufacturing sites.
- Equipment

  This refers to the air-conditioners and devices for management and security protection of the entrance and the exit used in buildings and factories. This equipment is managed in a consolidated manner by a central management center, and most of the equipment is controlled by a dedicated computer. For example, the security protection system performs consolidated management of the security of the overall building and disaster prevention equipment, and is connected with the police station and the security company through a dedicated network to be able to communicate immediately in case of an emergency.
- Medical devices

  This refers to devices used in medical treatment, such as patient monitoring equipment. As a result of the development in computers and technology, the performance and the functionality have improved exponentially. Since medical devices are directly related to life, they are required to have a high quality, high reliability, and a failsafe design.

- **Analytical instruments and measuring instruments**

  As a result of the development in computers and technology, the performance and the functionality of analytical instruments and measuring instruments have also improved exponentially. These instruments are indispensable not only in the industrial field but also for constructing an advanced disaster information system, such as AMeDAS of the Japan Meteorological Agency and a seismic observation system.

- **Other devices**

  Various automatic vending machines and ATMs (Automated Teller Machines) are also examples of industrial devices.

Chapter 2 Exercises

Q1

Which of the following is an appropriate explanation of core competence?

a) It is a technological innovation that promotes the growth of a company by foraying into new fields.
b) It is the fundamental spirit and action guideline of management activities.
c) It is the position of a company in the market that is decided through the quality and quantity of management resources.
d) It is a management resource that acts as the source of differentiation from other companies.

Q2

Which of the following is a description of OEM that is a form of tie-up between companies?

a) Technological tie-up
b) Capital tie-up
c) Production tie-up
d) Sales tie-up

Q3

Which of the following is an explanation of “Star” in the context of PPM (Product Portfolio Management)?

a) It indicates products that have a high market growth rate and a high market share. These products require heavy investments to grow, so the money creation effect is not necessarily large.
b) It indicates products with a low market growth rate and a low market share. The money creation effect is small, and the amount of cash flow is also small.
c) It indicates products with a high market growth rate and a low market share. Although long-term possibilities can be expected, the extent of the money creation effect is not known.
d) It indicates products that have a low market growth rate and a high market share. These products have a large money creation effect, and act as the support for a company by being the source of capital.

Q4

Which of the following is a technique for analyzing the superior points, inferior points, advantageous factors, and disadvantageous factors of a company in order to develop a business strategy?

a) SWOT analysis
b) Competitive position analysis
c) Growth matrix analysis
d) Value chain analysis

Q5

Which of the following is an explanation of marketing mix?

a) It is a purchase model of the customer, and is composed of attention, interest, desire, memory, and action.
b) It is a standard for classifying customers, and is composed of the last purchase date, purchase frequency, and total purchase money.
c) It is an analysis perspectives of the business environment, and is composed of customer, competitor, and company.
d) It is a means of satisfying the market needs, and is composed of product, price, place, and sales promotion.

Q6

Which of the following is a marketing technique of approaching all customers simultaneously by using advertising media, such as television and magazines?

a) Segment marketing
b) Test marketing
c) Mass marketing
d) One-to-one marketing

Q7

Which of the following is an appropriate explanation of CSF?

a) It is an important performance indicator for evaluating the means of achievement of strategic objectives.
b) It is an important goal indicator for evaluating the level of achievement of strategic

objectives.

c) It is an important factor of the success for achievement of strategic objectives.

d) It is overall quality management by which quality management is applied to the business strategy.

Q8

Which of the following is a purpose of CRM?

a) An improvement in the efficiency of sales activities and an increase in sales and profits

b) Acquisition of customer loyalty and maximization of lifetime value of customers

c) A reduction in sales opportunity loss because of insufficient inventory

d) An effective utilization of management resources by integrated management

Q9

Which of the following is management that invests in technology development in order to promote innovation, and expands the growth of the company?

a) M&A b) MOT c) R&D d) TLO

Q10

Which of the following is a technique that records the sales information when a product is sold in a shop, and collects, stores, and manages the product sales information per piece of the product?

a) EOS b) PHR c) POS d) XBRL

Q11

Which of the following is an appropriate description of a production system?

a) In a cell production system, a single operator or several operators are in charge of all processes.

b) In a process production system, the required products are produced at the required time and only in the required quantity.
c) In a build-to-stock production system, the production of a product is started after an order is received from a customer.
d) A continuous production system is suitable for a high-mix low-volume production.

Q12

Which of the following is a system which configures FA that performs the design and the drafting task in an interactive and automatic manner by using a graphic display or an automatic drafting machine?

a) CAD b) CAE c) CAM d) CAT

Q13

Which of the following is a "B to C" form of transaction in EC (Electronic Commerce)?

a) e-marketplace
b) Online mall
c) Electronic auction
d) Electronic procurement system

Q14

Which of the following is an appropriate explanation of the affiliate that is a type of Internet advertising?

a) It is a software-driven advertisement that is displayed automatically by adware.
b) It is a search-driven advertisement that is displayed in association with a search keyword.
c) It is an e-mail advertisement that is sent to the persons who have given their consent to receiving advertisements.
d) It is a result-reward type advertisement in which remuneration is paid according to the derived results.

Q15

Which of the following is defined in the information representation protocol for EDI implementation?

a) Contract details for transactions between companies
b) System operating hours
c) Transmission control procedure
d) Message format

Q16

Which of the following is an appropriate case example of feedback control?

a) When the room temperature becomes higher than the set temperature, the cold blast function of the air-conditioner is activated automatically to bring down the room temperature to the set temperature.
b) When an automatic dishwasher switch is pressed after dishes are loaded, the operation is performed in order of washing, rinsing, and drying.
c) A washing machine automatically adjusts the amount of detergent and the washing time by detecting the level of soiling as "very dirty" or "slightly dirty."
d) If a timer is set, the amount of hot water is adjusted and the water heating function is activated so that the hot water in the bath tub reaches the appropriate volume within the set time.

Q17

Which of the following is an industry specification for a home LAN that is used in household electrical appliances?

a) ATM   b) DLNA   c) ISDB-T   d) PDA

Chapter 3

Information Systems Strategy

1 Overview of Information Systems Strategy

In corporate management, an information systems strategy (or information strategy) is a policy or a set of guidelines for the construction of information systems that specifies "how to use information systems to effectively carry out business strategy and enterprise strategy."

1 - 1 The Process of an Information Systems Strategy

A company creates an information systems strategy (or information strategy) in order to implement its business strategy, which is created on the basis of a corporate philosophy (i.e., management philosophy). In other words, an information systems strategy can be described as a consideration of how information systems should be deployed in order to achieve business objectives.

An information systems strategy is created with total computerization plan at its core, and is approved by a CIO (Chief Information Officer). After an information systems strategy is approved, its implementation is managed and monitored in information systems strategy implementation management, and the results are evaluated. The results of evaluation are used not only for the modification and improvement of the information systems strategy, but are also used to provide feedback to maintain consistency with the business strategy.

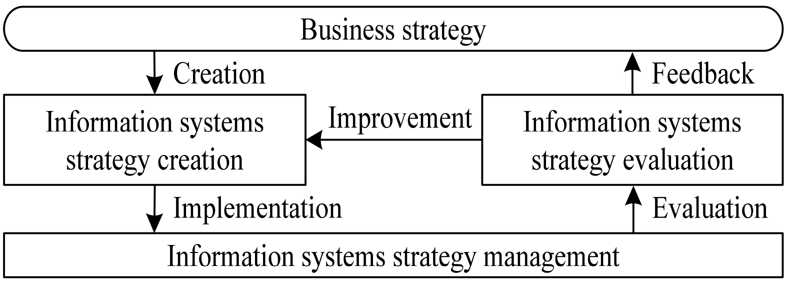


Figure 3-1 The process of an information systems strategy (PDCA cycle)

The general procedure for creation of an information systems strategy is as follows:

1) Confirmation of business strategy
2) Survey and analysis of business operations environment
3) Survey and analysis of business operations, information systems, information technology
4) Creation of basic strategy
5) Creation of new image of business operations
6) Selection of scope and creation of investment objectives

7) Creation of proposals for information systems strategy
8) Approval of information systems strategy

Since an information systems strategy must be created in consideration of consistency with a business strategy (e.g., corporate strategy, enterprise strategy), the business strategy must always be confirmed first. After this, the survey and analysis of the current state of affairs are performed, and the required information systems strategy becomes clear.

1-1-1 Total Computerization Planning

A total computerization plan is a plan that specifies how information systems are implemented across organizations, such as companies. A total computerization plan is formed from a total optimization policy and a total optimization plan that is based on this policy.

(1) Total optimization policy

A total optimization policy is a policy that indicates the direction that business and systems should proceed in for the overall organization. System Management Standards (i.e., practical guidance that establishes information systems strategy, designs and implements appropriate control to improve the effectiveness of IT investment, and reduces the risks), which was provided by the Ministry of Economy, Trade and Industry (METI) in Japan, covers the six points below concerning the policies and purposes of total optimization.

(1) Policies of IT governance should be clarified.
When IT governance (i.e., the organizational capability of a company to control the creation and implementation of IT strategy and lead the organization in the desired direction with the aim of creating competitive superiority) is established, the policy for this must be clearly specified.

(2) Principles concerning decisions on the investments and initiatives of computerization should be defined.
In order to ensure that overall optimization plan is consistent from start to finish, it is necessary to define general rules for decisions on the investments and initiatives of computerization.

(3) The optimization purpose of the overall information system should be set on the basis of business strategies.
In order to plan an information system that fulfills the business objectives, it is necessary to create a purpose for optimization that is consistent with business strategies.

(4) The clear vision of the information system for the overall organization should be determined.

Since the information system of an overall organization effectively and efficiently fulfills its objectives by organically linking individual information systems and ensuring mutual consistency, the overall optimization plan needs to define a clear vision (i.e., to-be model) of the information system

(5) Policies on changes, which are made in organizational structure and business operations as a result of computerization, should be clarified.

In an overall optimization plan, it is necessary to clearly specify the policies on the establishment, restructuring, and abolishment of organization and business operations, in sync with the (re)construction of an information system.

(6) Policies on information security should be clarified.

Security measures, such as the fraud prevention, protection of confidentiality, and protection of privacy, are the foundation of sound promotion of business activities, and so it is necessary to clearly specify the policy for information security measures in the overall optimization plan.

In point (4), concerning the ideal model (i.e., business operations model or business model) of overall business operations, the kind of information system (i.e., information systems model) that is required is clearly specified by using methods, such as EA.

- EA (Enterprise Architecture)

  This is a technique in which the overall business operations and systems of an organization are divided into four categories (or architectures), analyzed and modeled, and then reviewed from the perspective of total optimization. In EA, modeling is performed in the order of an as-is model (i.e., current model), which lays out and analyzes the current situation, a to-be model (i.e., ideal model), which forms the objective, and a realistic next generation model that compares the current situation and the objectives.

  - BA (Business Architecture)

    This is a business architecture that shows standardization and streamlining concerning the details of business operations, the implementing bodies, and the workflow.

    [Deliverables] Business description, DMM (Diamond Mandala Matrix), DFD (Data Flow Diagram), WFA (Work Flow Architecture), UML (Unified Modeling Language), etc.

  - DA (Data Architecture)

    This is a data architecture that shows the details of information (i.e., system data) that is used in individual business operations and systems, and the associations between information.

[Deliverables] Data definition table, information systemization summary chart (UML class diagram), ERD (Entity Relationship Diagram), etc.

- AA (Application Architecture)

  This is an applied processing architecture that shows the form of the most appropriate information system for a business process (e.g., centralized-type, distributed-type, SOA).

  [Deliverables] Information system relationship diagram, information system function configuration diagram, etc.

- TA (Technology Architecture)

  This is a technology architecture that is used in the construction of a system. It shows the technological elements of the configuration, security infrastructure, and so on.

  [Deliverables] Hardware configuration diagram, software configuration diagram, network configuration diagram, etc.

EA is a technique that enables the user department itself to clarify the necessary business operations and information by showing the current situation (i.e., as-is model), the ideal model (i.e., to-be model), and the migration plan (i.e., target) in an easy-to-understand way for the user department.

[EA frameworks]

- Zachman framework

  This is an EA framework that is proposed by John Zachman. It uses a 6×6 matrix with perspectives (i.e., stakeholder perspectives) on the vertical axis and the subject (i.e., 5W1H) on the horizontal axis. It is used to gain an understanding of the overall structure of an organization.

- TOGAF (The Open Group Architecture Framework)

  This is a framework that includes EA's best practices (i.e., efficient techniques, methods, processes, and the best examples for the achievement of a goal).

(2) Total optimization planning

A total optimization plan is a medium- and long-term overall plan for computerization that integrates the information systems and rules that are created for each department of an organization such as a company on the basis of a total optimization planning policy in order to improve efficiency and effectiveness. The "System Management Standards" contains the following seven points that are related to the development of the overall total optimization plan.

(1) Create the overall optimization plan on the basis of policies and goals.
(2) Consider compliance in the overall optimization plan.
(3) Clarify policies on IT investments and necessary resources in the entire optimization plan.
(4) Clarify how to measure the return and risks of IT investments in the overall optimization plan.
(5) Clarify rules for standardization and quality management policies for system development and operations in the overall optimization plan.
(6) Clarify rules to specify the priority of each development plan in the overall optimization plan.
(7) Consider the use of external resources in the overall optimization plan.

A total optimization plan can also be called a plan that clearly specifies the ideal information system for the overall organization on the basis of a total optimization policy. The "System Management Standards" contains the following six points as an example of a procedure for the creation of a total optimization plan.

1) Understanding of business environment
Understand the external environment (e.g., economic circumstances/industry/new technology trends, revisions to laws) and the internal environment (e.g., organizational goals, business strategy, business objectives, management environment).
2) Creation of business model
Understand the business operations of the organization overall and the surveys of information that is used, the relation between businesses operations, the relation between business operations and information, and the relation between information, and then make plans for the standardization and integration of business operations.
3) Creation of information systems framework
Make plans for integration of the individual systems that constitute the information system of the overall organization through the creation of a database model and data standardization.
4) Interview (information collection)
Obtain opinions from top management and the head of each department in order to understand management policy, business objectives, problems and computerization needs in each department.
5) Identification of development issues for information systems

Identify information systems development issues in terms of information needs for management and business operations, and then clarify the necessity for information system development.

6) Creation and documentation of medium- and long-term plan

Document the results of creation of the total optimization plan, as a medium- and long-term plan.

1-1-2 Computerization Investment Planning

A computerization investment plan (or IT investment plan) is a plan that is created according to the computerization investment policy that is defined in the total optimization policy and specifies how investment (i.e., budget) is made in order to construct an information system for the overall organization. The "System Management Standards" contains the following six points that are related to computerization investments.

(1) Ensure that the IT investment plan is created in consideration of consistency with corporate strategies.

(2) Compare multiple IT investment plan alternatives on the basis of impact, effects, schedule and feasibility.

(3) Execute IT investment budgets properly.

(4) Establish the standard methodology for estimating the return on IT investments.

(5) Assess financial performance of the overall information system and individual projects, and take necessary actions to solve any problems.

(6) Review whether IT investments have been properly executed or not.

In (4), the quantitative calculation methods below are applied to calculate the investment effect.

- ROI (Return On Investment)

  This is an index that measures the profit that is created from invested capital.

  Return on investment = profit ÷ invested amount

- PBP (PayBack Period)

  This evaluates the investment effect by calculating the number of years in which an invested amount can be recovered through the yearly increase in cash inflow without taking into consideration the value of time.

- NPV (Net Present Value)

  This calculates, for the entire period from acquisition to disposal, the increase or decrease in cash inflow on the basis of an investment for each year with a discounted present value.

- IRR (Internal Rate of Return)

  This calculates the rate of discount (i.e., internal income ratio) for which the total present value of the annual cash income that is generated by an investment becomes equal to the total present value for the cash expense that is required for this investment, and evaluates the investment effect by using the magnitude of the internal income ratio.

After the IT investment plan is created, IT investment management in which management and evaluation are performed is implemented to ensure that effective investment activities are continuously implemented. There is also the IT management power index that was created by METI (Ministry of Economy, Trade and Industry) and is an index that indicates whether the level of a company's IT usage has increased as a result of IT investment. The IT management power index measures the level of IT utilization in four stages.

Stage	Company group name	Details
Stage 1	Companies with poor IT investments	IT not utilized
Stage 2	Departmentally optimized companies	Utilized in specific operations/departments
Stage 3	Organizationally optimized companies	Utilized by the organization overall
Stage 4	Companies with company/industry-wide utilization	Utilized at the company/industry level

1-1-3 Implementation of Information Systems Strategy

(1) Structure for computerization promotion

A structure for computerization promotion is an organizational and operational structure for the implementation of an information systems strategy. In order to achieve overall optimization for an information system on the basis of a business strategy, executives (i.e., executive board) establish an information computerization committee to promote the implementation of the information systems strategy. Generally, the senior members of the committee are executives, and the members that actually run the committee are formed from the leaders of each department that are led by the CIO (Chief Information Officer). The information computerization committee is granted the appropriate authority and given the appropriate responsibility, and its mission is made clear. The information computerization committee monitors activities concerning information systems and revises/improves them, and then establishes appropriate information infrastructure.

Furthermore, as a structure that performs information systems planning, development, operation, and maintenance, the committee decides an appropriate organizational form for organizations including functional organizations, divisional organizations, matrix organizations, and project organizations. It also decides the responsible persons including the system owner, who is responsible for an information system, and the data owner, who is responsible for the data that the information system handles.

(2) Creation of a computerization plan

A computerization plan is the individual computerization plan for each information system that is created according to the total computerization plan. Information systems include mission critical systems that form the core of corporate activities, systems that perform integrated management of an overall company or business activities, and systems that contributes to unified operation between companies. These systems are developed from scratch in some cases, but it is necessary to consider the use of packaged systems as in business management systems, or such other systems.

[Typical business management system]

- ERP (Enterprise Resource Planning) system
  This is a system that manages resources on business in an integrated way.
- SCM (Supply Chain Management) system
  This is a system that optimizes the entire supply chain.
- CRM (Customer Relationship Management) system
  This is a system that manages customer information in a centralized and continuous way.
- KMS (Knowledge Management System)
  This is a system that accumulates, shares, and utilizes knowledge and knowhow.
- SFA (Sales Force Automation) system
  This is a system that supports sales activities.

Note: The creation of a computerization plan is performed as part of the information systems planning that is explained in the next section. The explanation in this section is to ensure understanding of the flow in which the overall plan is broken down into sections and implemented.

(3) Program management

Program management refers to activities that flexibly adapt the execution capabilities of an organization in response to changes in the external environment in order to fulfill overall mission (e.g., implementation of information systems strategy). The programs in the scope of program management are businesses in which multiple projects are organically integrated. When computerization is promoted according to an information systems strategy, multiple information system implementation (or development) projects are carried out at the same time. Program management is a series of activities that optimizes the relationships and integration between these projects to raise the overall value, and aims to fulfill the overall purpose.

- PMO (Program Management Office)
  This is a department that is dedicated to performing program management, or a business operator that provides program management as a service.

(4) Framework

A framework is created in order to achieve a goal. In implementing an information systems strategy, efficient and effective promotion becomes possible through the use of a variety of frameworks.
Typical frameworks include those described below.

- COBIT (Control OBjectives for Information and related Technology)
  This is a collection of practical IT governance where the best practices concerning information technology management are systematically compiled. It defines the KGI (Key Goal Indicators) and KPI (Key Performance Indicators) for the purpose of increasing IT process maturity level. The "System Management Standards" was created with reference to COBIT.
- ITIL (Information Technology Infrastructure Library)
  This is a manual that contains systematically compiled best practices for the purpose of efficiently providing and managing IT services. It is a de facto standard for IT service management.
- SLCP (Software Life Cycle Process)
  This is a common frame that defines base activity items in order to optimize software development and the related transactions.

In order to implement an information systems strategy, it is necessary to construct a process framework and control framework in business operations. A process framework is a standard framework for business processes, and a control framework is a framework for internal control (i.e., activities that define business standards and rules, and perform management, monitoring, and assurance in order to eliminate internal violations of law and fraudulent behavior, mistakes, and errors, and ensure that a company is run soundly and efficiently).

(5) Quality control

Quality control refers to organizations, structures, and a series of activities (management processes) to ensure quality in an information system by using quality control frameworks and such other things to ensure compliance with standards concerning information systems and continuously monitoring the status of conformity.

(6) Information systems strategy implementation management

Information systems strategy implementation management refers to a series of activities that monitors the implementation status of an information systems strategy and ensures the implementation of the information systems strategy. It involves the evaluation and verification of information system utilization when an information systems strategy is implemented according to a medium- and long-term plan, and the evaluation of the information systems strategy from perspectives of changes in the environment that a company faces, IT technology trends, profit, and so on.

[Evaluation points of information systems strategy]

- Monitoring indicators such as the KGI (Key Goal Indicators) and KPI (Key Performance Indicators) that are obtained from a total optimization policy, and so on
- Variance analysis for the difference between the budget proposed in the computerization investment plan and the actual resulting values
- Response to risks, which are expected or unexpected

(7) System utilization promotion and evaluation

Even if information systems are implemented according to an information systems strategy, they will contribute little to management unless they are used effectively. Therefore, it is important to continuously implement system utilization promotion to improve the information literacy (i.e., the ability to use IT in order to utilize information securely, effectively, and efficiently) of employees, and in addition, to evaluate, investigate, and improve the usage situation of the information systems.

- Data utilization

  This provides an understanding of the usefulness and importance of analyzing the data that is accumulated in an information system and using it to make operational improvements and resolve problems in responsible business operations.
- Popularization and awareness raising

  This refers to activities that improve information literacy, such as education for the utilization of information systems. Included are ensuring understanding of system user manuals and business operations manuals, and human resource development plan such as e-Learning and seminars. In addition to use these activities for system utilization promotion, they can also reduce the digital divide.
- Evaluation and verification of information system utilization

  This evaluates the usage status of information systems through log analysis. The purpose of this is to clarify the direction of improvements and such other things through evaluation, but if the end of the system life cycle is judged to be reached, the information system is disposed of after data is erased according to the information security policy.

1 - 2 Business Process and Solution Business

A business process is the flow of each business operation in a company. Prior to the creation of an information systems strategy, the business operations environment and business processes are investigated and analyzed, and the existing organizational structure and business processes are reviewed. In addition, the optimization of business operations and system is considered along with the effective use of a system. At the same time, consideration is given to the use of a solution business, which provides a mechanism for problem resolution.

1-2-1 Business Process Improvement

Business process improvement refers to the improvement in efficiency of a business process. Among business process improvements, the analysis of current business operations and the identification and resolution of problems are referred to as business improvement.

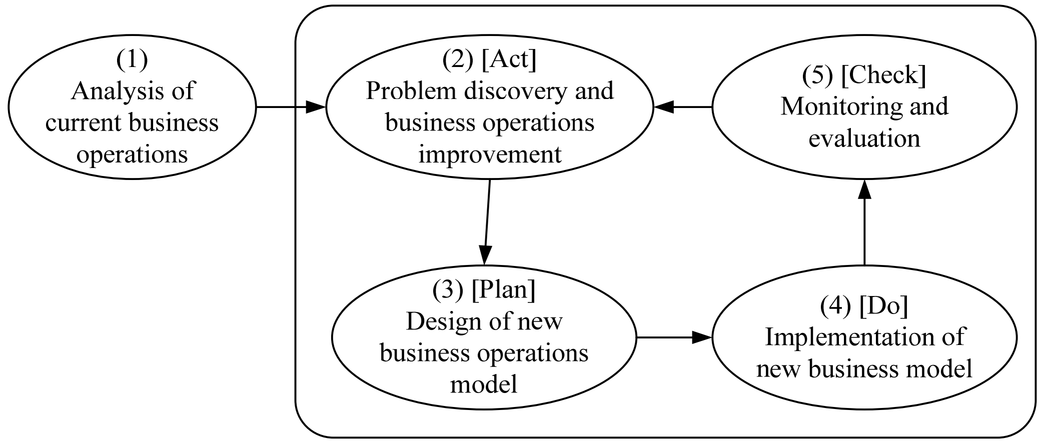
[General procedure of business improvement]

Step 1	Confirmation of improvement objectives	Clarify the objectives of the improvement.
Step 2	Identification of problems	Identify the business problems according to the objectives.
Step 3	Setting of improvement goal	Set the improvement level (i.e., goal) of problems.
Step 4	Creation of improvement proposals	Create the proposals for problem resolution.
Step 5	Evaluation of improvement proposals	Evaluate improvement proposals, and decide on their pros and cons.
Step 6	Implementation and confirmation of effects	Implement improvement proposals, and make a measurement of effects.

In the "Identification of problems," the methods that are explained in Chapter 1 are used to analyze business operations.
In "Creation of improvement proposals," consideration focuses on streamlining by using computers for business operations. However, this does not mean that computers must be used. This allows the implementation order of an operation to be changed and the discovery of activities that can be performed in parallel to improve efficiency.
In "Evaluation of improvement proposals," and "Implementation and confirmation of effects," as many quantitative evaluation items as possible are used. Generally, the evaluation items that are used are person-hours/work time, workload per unit of time, cost, and so on. For qualitative evaluation items, evaluation is performed with digitization (i.e., quantification) using overall rating (i.e., scoring model) or such other method.

BPR (Business Process Reengineering) or reengineering refers to performing a drastic review of the current business process, and reconstructing by improving the flow of business operations and the details of individual business operations. BPR also has the potential to lead to the discovery of new business models. However, as BPR is generally a one-time business process improvement, a reconstructed new business process may become obsolete because of changes in the external environment. Therefore, the approach of BPM (Business Process Management) in which management is performed by using the PDCA cycle (Plan→Do→Check→Act) can be applied with the aim of continuous improvement in a business process.

[PDCA cycle of BPM]



(1) Analysis of current business operations
The current business operations are analyzed (analysis of business operations) and modeled.

(2) Problem discovery and business operations improvement [Act]
The modeled current business operations are reviewed and improved (business improvement).

(3) Design of new business operations model [Plan]
On the basis of the improved business operations, a new business operations model is designed (business operations design).

(4) Implementation of new business operations model [Do]
The new business operations model is implemented.

(5) Monitoring and evaluation [Check]
The new business operations model is monitored and evaluated. (If there are any problems, improvement is carried out again from (2).)

The platform for implementing BPM is called a BPMS (Business Process Management System). A BPMS optimizes business processes by performing the design, implementation, and management of business processes.

In addition, the methods below for improvement of business processes also exist.

- BPO (Business Process Outsourcing)
  This is a form of business in which the internal business processes themselves are outsourced to an external vendor along with information system operations management. For example, the business operations of a call center, which handle inquires about the products of a manufacturer, are comprehensively outsourced to a

vendor. Because of the recent expansion in the use of IT, the number of companies that outsource business processes, such as corporate accounting processes and Internet sales, along with information systems is also increasing. Offshore outsourcing is also used to subcontract business processes to overseas companies where the cost of living and labor costs are low.

- Workflow system

  This is a system that automates routine processes. It includes systems that follow a determined procedure to transmit digital application forms and notifications, and approve them. Recently, products that enhance sales support efficiency have been launched by combining an SFA system (i.e., sales support system) and a workflow system.

1-2-2 Solution Business

Solution business refers to a service that provides a mechanism (i.e., solution) to resolve business problems. There are many different solution businesses, such as security solutions that provide mechanisms for information security measures, and CRM solutions that provide mechanisms for customer management. A company that conducts this kind of solution business is called a SP (Solution Provider).

A solution business that collectively undertakes everything from the planning and design of an information system that meets business requirements to information system operations and management is called system integration. A vendor that considers support and improvement for problem resolution in business processes along with the customer, and makes proposals for a business system that fits the customer's business strategy and information systems strategy is called a system integrator. Many of such vendors do not focus on their own development business, and therefore, they also make proposals for the utilization of commercial software (i.e., business packages) that provides the required functions, such as accounting operations and sales management operations.

(1) Cloud computing

Cloud computing is a type of computer usage that is based on the Internet (like "cloud"). If a user has the minimum necessary environment, it is possible to use a service with high scalability (i.e., expandability) and availability over the Internet just by paying a service fee.

- SaaS (Software as a Service)

  This is a type of service that provides software components (i.e., information system functions) via the Internet. It is possible to use only the necessary functions of software when they are necessary.

- PaaS (Platform as a Service)

  This is a type of service that provides a platform for application execution via the Internet. The provider provides a virtualized application server on which users deploy and operate their own application.
- IaaS (Infrastructure as a Service)

  This is a type of service that provides infrastructure via the Internet. The provider does not provide software. It provides only a virtualized server on which the user installs the necessary OS, and so on.
- DaaS (Desktop as a Service)

  This is a type of service that provides a desktop environment for a terminal via the Internet. There is no OS or application on the client (i.e., thin client), and a virtualized desktop environment on cloud infrastructure is used over the Internet.

(2) SOA (Service Oriented Architecture)

SOA (Service Oriented Architecture) is a method in which the functions (i.e., software components) that are constructed and organized according to the service elements of a business process are made publicly available on a network and are linked together to construct an information system with superior expandability and adaptability. SOA is an "information system construction method" that constitutes information systems by combining software that has functions for a specific business process, and it can also be called a "business system construction method" that constitutes a business process by combining processing that is performed in the business process.

(3) ASP (Application Service Provider)

ASP is a service or a form of provision that provides application software over a network. ASP is a single tenant method that provides servers and databases for each user company. However, the difference between the single tenant method of ASP and the multitenant method of SaaS is not strictly differentiated in many cases. In ASP, the user company does not own the software that is used in business operations, so there is no need for initial investment in business software. Therefore, software is treated as a variable cost, and there are no costs for version upgrades or maintenance. Furthermore, it is simple to terminate use of the software and to change providers, so this means it can flexibly deal with changes in the environment.

(4) Hosting service/housing service

This is a service that is provided by a communications vendor such as an ISP. A hosting service is a service in which a user (e.g., corporate or individual) rents a server that is owned by a communications vendor, and a housing service is a form of service where the network devices and servers that a user owns are installed for use in the communication facilities of a communications vendor. (An installation space is "rented.") In a housing service, operation of the communication facilities is performed by the vendor, but operation of the system is performed by the user.

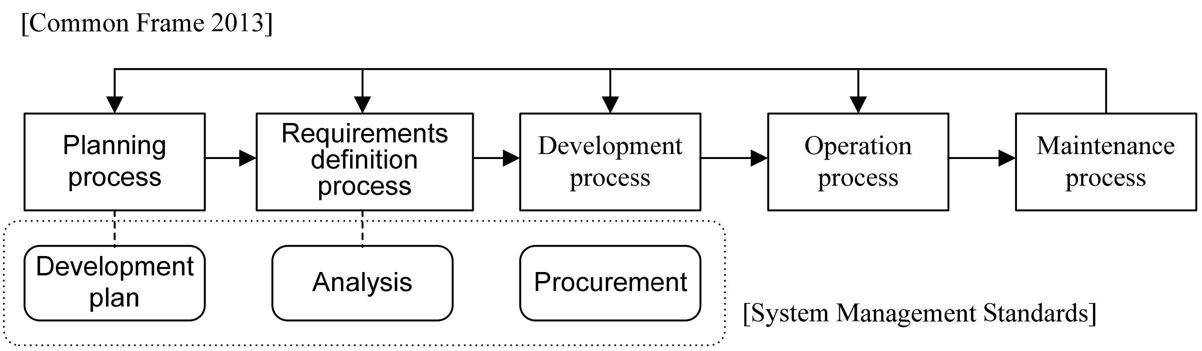
Service type / Information assets	Hosting service		Housing service	
	Communications vendor	User	Communications vendor	User
Ownership of server devices, etc.	✓			✓
Ownership of server installation location	✓		✓	
Ownership of applications		✓		✓

(5) Outsourcing service

An outsourcing service is a service in which an external vendor undertakes some business processes. A housing service can be called an outsourcing service that is provided by a service provider (i.e., communications vendor) to which the operation of communication devices is outsourced.

2 Information Systems Planning

Information systems planning refers to the preparatory process for implementation (or development) in which a computerization plan for each information system to be implemented (or developed) according to the total computerization plan is proposed. This corresponds to “planning work (i.e., development plans, analysis, procurement)” in the “System Management Standards,” and “perspectives of planning and requirements definition (i.e., planning process, requirements definition process) in Common Frame 2013 (SLCP-JCF2013).



2 - 1 Planning Process / Development Planning

The planning process/development planning refers to the creation of a computerization plan for each information system to be implemented (or developed).

[Purpose of planning process (excerpt from Common Frame 2013)]
The overall purpose of the planning process is to obtain a set of requirements and a computerization policy concerning the system that is necessary for achieving the business targets and objectives, and an execution plan for implementing the system.

[Development planning (excerpt from “System Management Standards”)]

(1) Obtain approval for the development plan from the top management of an organization.

(2) Establish the development plan in consideration of its consistency with the overall optimization plan.

(3) Define the development plan to specify its objective, target process, cost, system development structure, and investment effect.

(4) Define the development plan to include education and training programs for persons involved.

(5) Define the development plan to specify the roles of the user department and the

information systems department.

(6) Define the development plan to indicate the basis of the cost calculation for system development, operations, and maintenance.

(7) Define the development plan to specify conditions for setting system life cycle.

(8) Determine the formulation and the system development methodology in consideration of the system characteristics and the development scale when the development plan is made.

(9) Make and review feasible alternative plans so that the objectives of the information system can be achieved when the development plan is made.

In the planning process, "a set of requirements concerning the system and a computerization policy" is proposed as the computerization initiative, and "an execution plan for implementing the system" is proposed as the computerization plan.

(1) Planning of computerization initiative

Planning of computerization initiative refers to the reflection of a business strategy in information systems and the clear specification of a basic computerization policy to achieve competitive superiority.

[Purpose of the planning process for a computerization initiative (excerpt from Common Frame 2013)]
The purpose of the planning process for a computerization initiative is to make a proposal for a new overall operational image and the computerization initiative and promotion framework to achieve this on the basis of the current business environment in order to meet business needs and resolve issues.

The procedure from proposal to approval of "planning of computerization initiative" is as below.

[Proposal]
1) Identification of business needs and issues
2) Survey and analysis of business environment and business operations environment
3) Survey and analysis of current business operations and systems
4) Survey and analysis of information technology trends
5) Clarification of scope of business operations
6) Creation of a new overall image of business operations
7) Selection of scope and creation of investment objectives

[Approval]
1) Documentation and approval of computerization initiative

2) Establishment of computerization promotion structure

In order to make a proposal for a computerization initiative, business analysis, in which business needs and issues are analyzed appropriately and methods for problem resolution are set, is very important. For this, BABOK (Business Analysis Body Of Knowledge), which is a collection of best practices for business analysis, are utilized.

- In steps, such as "Survey and analysis of current business operations and systems," system optimization technique that is typified by EA (Enterprise Architecture) is used, and system design (i.e., the design of the system most suitable for business operations) is performed. By the implementation of EA, it is possible to confirm consistency between business operations and IT, share the future image (i.e., computerization initiative), and control the system technologies that are used.
- In "Survey and analysis of information technology trends," continuous efforts are made for information collection as changes occur rapidly in information technology. Special focus is given to the method of usage of information technology that creates competitive superiority or business opportunities.
- In "Clarification of scope of business operations," priority is assigned to the business operations in the scope by using elements such as operational objectives, effect, urgency, feasibility, budget, and framework on the basis of the results of analysis so far.
- In "Creation of a new overall image of business operations," in addition to the new overall image of business operations, the overall image of a new system is also created, and verification is performed to see whether the business functions is consistent with the organizational model and the new system.

(2) Planning of computerization

Planning of computerization refers to the creation of a specific schedule for the implementation (or development) of an information system in consideration of consistency with the total optimization plan.

[Purpose of the planning process for computerization (excerpt from Common Frame 2013)]
The purpose of the planning process for computerization is to make a specific computerization plan and a project plan, in which the feasibility of operations and effects is taken into consideration, and to gain the agreement of stakeholders, in order to make the computerization initiative in reality.

The procedure from creation to approval of "planning of computerization" is as below.

[Proposal]
1) Confirmation of the basic requirements for computerization planning
2) Confirmation of the details of business operations in the scope
3) Definition of system issues for business operations in the scope
4) Analysis of system in the scope
5) Survey of technology and techniques to be applied
6) Creation of business operations model
7) Identification of system functions and creation of systems architecture
8) Determination of basic policy concerning supplementary functions and supplementary facilities
9) Determination of basic policy concerning service level and quality
10) Setting of project goal
11) Feasibility study
12) Overall scheduling of development
13) Determination of policy for systems architecture selection
14) Estimate of cost and system investment effect
15) Creation of project promotion framework
16) Verification of consistency with business enterprise strategy, information strategy, and computerization initiative

[Approval]
1) Documentation and approval of computerization plan
2) Documentation and approval of project plan

In the computerization planning, a computerization plan and a project plan are created as deliverables.

Plan name	Details
Computerization plan	Prerequisites concerning basic requirements such as the development, operation, maintenance person-hours, cost, schedule and environmental improvement, education and training (i.e., staff training plan), and quality for the system to be made in reality
Project plan	The required organization, resources, activity items (including activity items to be outsourced), schedule, and so on, for system development, operation, and maintenance

In the planning of computerization, an individual computerization plan is made for each individual information system according to the total computerization plan.

- In "Confirmation of the basic requirements for computerization planning," the prerequisites of a computerization plan are confirmed, which include objectives, means, staff, period, delivery date, facility, cost, activity allocation, and division of responsibility.

- In "Confirmation of the details of business operations in the scope" and "Definition of system issues for business operations in the scope," the operations in the scope that were specified in the planning of computerization initiative are confirmed, and the system application scope is defined. If a system is actually operated for the business operation in the scope, the relations between the system in the scope, the business operations in the scope, and other related systems are identified.
- In "Creation of business operations model," reconfiguration of business operations functions is performed, and the business operations functions and organization are modeled. In the creation of a business operations model that models the overall image for business operations, the business process is defined, data classes are defined, the business model is defined/analyzed, and review/decision making are performed.
- In "Determination of basic policy concerning service level and quality," the service levels such as the reliability, performance, and security demanded of the system are clearly determined, and the basic requirements concerning the system quality and quality management structure on the basis of these are clearly determined.
- In "Setting of project goal," the project (i.e., business and business operations that are launched at irregular intervals in order to resolve a specific problem or achieve a specific goal) for the actual implementation (or development) of the information system is clearly specified, and target values and priorities are set for the quality, cost, and delivery date that are used as the basis for the project implementation.
- In "Overall scheduling of development," a broad outline for the implementation (or development) schedule for the overall system is decided. If a computerization plan is split into multiple projects, a schedule is created for each project.
- In "Estimate of cost and system investment effect," estimates are made for the development/operation/maintenance period, framework, and person-hours of the system, and quantitative/qualitative estimates are made for the cost and the effect. Since the cost and the effect are estimated by using the system life cycle (i.e., plan, development, operation, maintenance), it is necessary to clearly specify the conditions that determine the system life.

- IT portfolio

  This applies the idea of a portfolio to the field of IT investment. The recommended model ensures consistency between the organizational strategy and IT investment by managing the investment ratio in each of the four categories of "strategy," "information," "transactions," and "infrastructure."
- Decision making on investment

  In computerization planning, this is a decision making method to evaluate the return on development investment and determine the investment. Such methods include PBP, NPV, IRR, and DCF.

- DCF (Discounted Cash Flow)
  This is a method that uses the present value to evaluate the future income (i.e., cash flow) that an investment project will generate.

It is also necessary to analyze and evaluate the risks that are caused by the implementation of a new system with information system implementation risk analysis.

2 - 2 Requirements Definition Process / Analysis

Requirements definition process/analysis is to identify the stakeholders in an information system to be implemented (or developed) and the business operations in the scope, define stakeholders' needs and demands as stakeholder requirements, and then obtain stakeholders' agreement.

[Purpose of the requirements definition process (excerpt from Common Frame 2013)]
The purpose of the requirements definition process is to define the requirements for a system that can provide the services needed by users and other stakeholders in a defined environment.

[Analysis (excerpt from "System Management Standards")]

(1) Obtain approval of responsible personnel from the user department, the system development department, the system operations department and the application maintenance department for the defined requirements based on the development plan.

(2) Define target, scope, and methodology for user requirement survey.

(3) Analyze the present states of information systems with personnel who are familiar with the business process from the user department, the system development department, the system operations department and the application maintenance department.

(4) Ensure that user requirements are documented and confirmed by the user department.

(5) Analyze potential risks that are generated by introducing the information system.

(6) Ensure that business processes, management structures, and rules/procedures, which are affected by installing the information system, are reviewed and assessed.

(7) Assess the effectiveness of installing the information system from both

qualitative and quantitative perspectives.

(8) Ensure that suitability for user needs is assessed before the use of software packages.

Note: The requirements definition process was changed in Common Frame 2013 to be specialized for the software life cycle process. The purpose of the requirements definition process prior to the change is to "clearly specify the requirements for the new system or business operations to be constructed (or reconstructed), and on the basis of this, to specifically define the scope of computerization and the functions."

According to Common Frame 2013, in terms of the requirements definition process, "the following activities should be implemented according to applicable organization policies and procedures."

Activity		Overview
a	Preparation of process implementation	Create requirements definition rules and an implementation plan.
b	Identification of stakeholders	Identify the system stakeholders or their classes.
c	Identification of requirements	Make clear specification of requirements for the system.
d	Evaluation of requirements	Analyze and evaluate elicited requirements.
e	Agreement of requirements	Feedback requirements to stakeholders, and establish agreement.
f	Recording of requirements	Record the stakeholders' requirements in a form suitable for requirements management, and maintain traceability.

(1) Requirements analysis

Requirements analysis refers to analyzing the diverse requirements of stakeholders, performing an investigation into solutions/feasibility analysis, and making a proposal for a new business operations model and workflow.

User requirements are collected with user needs studies such as questionnaires, interviews, and a field study, and current state analysis is performed on the basis of the functions and performance of the current system, the definition of problems/issues, and the consistency with business processes, and the usage status. This information is analyzed and organized, and a requirements specification document which compiles feasible solutions is created as a new business operations model/workflow.

(2) Requirements definition

Requirements definition is to determine the overall framework of the system and business operations, and also define the scope of computerization and the system functions as stakeholders' requirements, in order to fulfill the requirements described by the requirements specification document. In the requirements definition, how the requirements are fulfilled is defined with the three sets of criteria below.

- Operational requirements

  These are requirements that should be fulfilled in terms of business operations, such as operational details (e.g., procedure, input/output information, organization, responsibility, authority) and operational characteristics (e.g., rules, restrictions).
- Functional requirements

  These are requirements for system functions that are necessary to fulfill the operational requirements, such as the flow of information (i.e., data) between the functions that make up business operations, the scope of implementation for the relevant activities/system functions, and interfaces including information exchange with other systems.
- Non-functional requirements

  These are requirements other than functional requirements that are necessary to fulfill the operational requirements, such as quality characteristics (i.e., functionality, reliability, usability, efficiency, maintainability, portability), technical requirements (i.e., system implementation method, system configuration, system development method (e.g., language), development standards, development environment), operational requirements, and migration requirements.

In the requirements definition, the structured analysis method and the object orientated analysis method are used to consider implementation in the system. The structured analysis method that focuses on functions is a POA (Process Oriented Approach), and its results can be organized into a DFD (Data Flow Diagram) or a decision table. On the other hand, the object oriented analysis method is a DOA (Data Oriented Approach) that focuses on data, and its results can be organized into UML. (The details of this will be covered in Chapter 4.)
The results of requirements definition are established as stakeholders' requirements when the approval of the stakeholders is obtained. Therefore, it is necessary to sufficiently verify the feasibility and validity of defined requirements and the consistency with the information systems strategy. During this verification, if the verification is vague or the stakeholders

compromise on anything, a large problem may occur later. Therefore, it is important to sufficiently utilize facilitation (e.g., technology/methods/acts to promote proactive conferences and meetings) and obtain the agreement of the stakeholders.

2 - 3 Procurement

Procurement refers to the acquisition of the required system resources (e.g., funds, human resources, hardware resources, software resources, network resources) in the implementation (or development) of an information system. Only for the procurement of systems, software products, or software services, the acquisition process of Common Frame 2013 is also applied.

[Purpose of acquisition process (excerpt from Common Frame 2013)]
The purpose of the acquisition process is to obtain the products and/or services that satisfy the needs stated by the acquirer.

[Acquisition (excerpt from "System Management Standards")]

(1) Define acquisition requirements from the development plan and user needs. Obtain approval of the responsible personnel from the user department, the system development department, the system operations department, and the maintenance department.

(2) Select hardware, software, and networking products on the basis of the procurement requirements.

(3) Prepare necessary staff members, budgets, facilities and, periods for completing system development.

(4) Clarify the skills required for staff members.

(5) Procure hardware, software, and networking products in accordance with procurement rules.

(6) Manage acquired resources in accordance with acquisition rules.

In the procurement of an information system, an appropriate procurement method is first selected on the basis of the requirements definition from methods that include purchase of existing products or services, in-house system development (i.e., internal development), and outsourced system development. In the case of internal development or outsourced development, the relationship between the user (i.e., customers) and the provider (i.e., supplier) is as below. The standards for deciding on either internal or outsourced development are called internal and external development criteria (or internal and external manufacturing criteria).

Construction method	User (customer)	Provider (supplier)
Internal development	Executive level, user department, etc.	Internal systems department
Outsourced development	User company	IT vendor (e.g., software development company)

After the procurement method is decided, the scope of procurement, the procurement requirements, and the procurement conditions are defined. The procurement requirements sufficiently take into account consistency with the computerization plan and the requirements definition, and make arrangements for the necessary items for system construction. At this point, it is necessary to check whether or not the system functions, system performance, and system quality fulfill the requirements definition.

A procurement plan is created on the basis of these results, and procurement is performed. For this, Software Supply Chain Management is sometimes used. SCM is an approach that manages the flow of product supply in the manufacturing and distribution industries, but this technique is applied to software (or information systems) to optimize the overall process by sharing and managing information between departments or companies concerning software (or information system) orders placed (or orders received), development, and supply.

In the case of outsourced development, the general procedure up to the selection of a vendor is shown below.

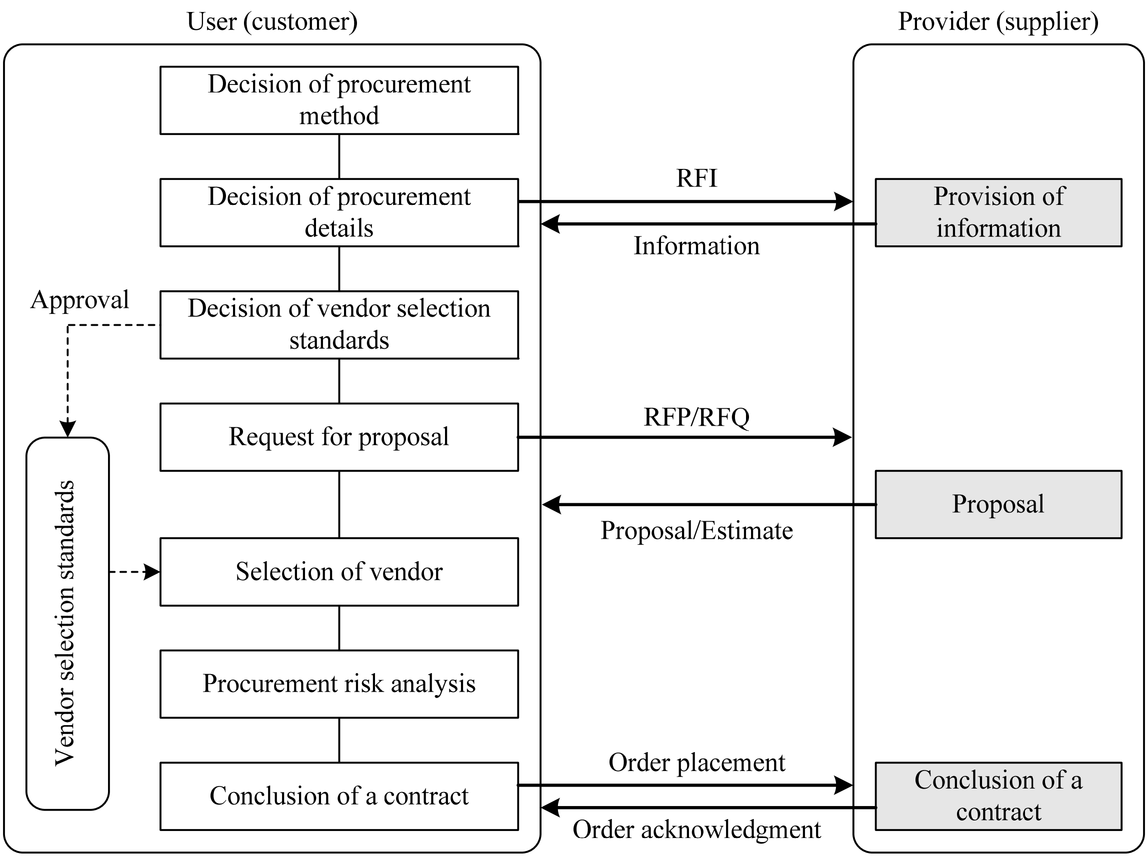


Figure 3-2 The procedure up to the selection of a vendor

(1) Decision of procurement method

This decides the procurement methods such as internal development and outsourced development. In cases such as outsourced development, if a vendor (i.e., subcontract company) is selected from multiple candidates, it is necessary to decide the bidding method.

- **Proposal competition bidding**
  Participants in the bidding are requested to submit a plan, and an order is given to the company with the highest score.
- **Open bidding**
  Participants in the bidding are requested to submit an amount, and the order is given to the cheapest company.

(2) Decision of procurement details

This decides the details of the procurement such as what is in the scope of procurement, procurement requirements, and the procurement conditions. In some cases, an RFI (Request For Information) is issued to candidate vendors that describes the purpose of the computerization, the details of business operations, and other information, in order to request the provision of information such as development experience of similar systems and the latest information technology. A candidate vendor that receives an RFI provides as much information as possible. The information is used for an investigation into the user's (or customer's) procurement details.

(3) Decision of vendor selection standards

As a vendor selection standard, the weighting for proposal evaluation standards and conformity with requirements is decided, and the approval of executives is obtained.

(4) Request for proposal

In order to make the details of the business contract clear, an RFP (Request For Proposal) that specifies the basic policy and procurement details (e.g., a scope of procurement, requirement items, conditions) for a system is issued, and the submission of a proposal is requested. At this time, an RFQ (Request For Quotation) is also issued, and a request for the submission of a quotation is made.

- Proposal
  This is a document that provides responses (e.g., system configuration, development method) with regard to the request.
- Quotation
  This is a document that indicates the estimated amount (i.e., price) for the RFQ.

(5) Selection of vendor

The proposal or quotation is evaluated and selected by using vendor selection standards to examine the development certainty, reliability, cost break-down, schedule for each process, the final delivery date, and other aspects, and then the approval of the executives is obtained.

(6) Procurement risk analysis

From perspectives including internal control, compliance, CSR (Corporate Social Responsibility), and green procurement (i.e., product/service procurement in which a favorable evaluation is gained if proactive measures are taken in consideration of the environment), the risk that is involved in procurement is analyzed and evaluated, and measures are investigated.

(7) Conclusion of a contract

An official contract is concluded on the basis of agreement with the vendor. A contract (purchase order/order acknowledgment) is created according to the type of contract such as a (quasi-)mandate contract or service contract on the basis of the software development outsourcing basic contract model (proposed by JISA (Japan Information Technology Services Industry Association)) or the "information system/model transaction contract" (proposed by METI (Ministry of Economy, Trade and Industry)), and so on. At the same time, other agreements are concluded, such as an intellectual property right license agreement.

(8) Delivery

Deliverables that are delivered by the final delivery date are subjected to an acceptance test (i.e. receiving inspection) and other measures to provide confirmation that the requirements are fulfilled.

Chapter 3 Exercises

Q1

When an information systems strategy is developed, which of the following should be given the most consideration?

a) Consistency with the business strategy
b) Usage status of the current system
c) Information systems strategy management
d) Net profit for the same quarter in the previous fiscal year

Q2

In the figure concerning enterprise architecture, which of the following is a term that is inserted into *D*? Here, the shaded part is not shown intentionally.

A	Architecture	… Architecture of business operations functions
B	Architecture	… Architecture of information that is used in business operations functions
C	Architecture	… Architecture of service groups that combine business operations functions and the flow of information
D	Architecture	… Architecture of ______ for the implementation of each service

a) Application   b) Data
c) Technology   d) Business

Q3

According to the "System Management Standards," which of the following is an item that an overall optimization plan clearly specify?

a) Basic policy concerning service level and quality
b) Total development scheduling
c) The ideal information system for the overall organization
d) Project promotion framework

Q4

Which of the following is an index that is used as a qualitative calculation method for the investment effect in a computerization investment plan, and is calculated by dividing the profit that is generated by cost reduction and sales increase that result from the implementation of an information system by the investment amount?

a) IRR b) NPV c) PBP d) ROI

Q5

Which of the following is an appropriate explanation of COBIT?

a) A collection of practical IT governance where the best practices are organized
b) A manual that contains systematically compiled best practices for IT services
c) A framework that defines activity items for software development
d) A vendor that provides program management as a service

Q6

There exists a scoring model as a method for quantifying qualitative evaluation items. If a scoring model for four-level evaluation is used, what is the percentage of the level of goal achievement for the overall system that is evaluated with the items as shown in the table?

Evaluation item	Weighting	Judgment details
Labor saving effect	5	As planned
Period reduction	8	No change
Information integration	12	Partial improvement

Points that is obtained by four-level evaluation
4: As planned
3: Almost as planned
2: Partial improvement
1: No change

a) 50 b) 52 c) 54 d) 56

Q7

Which of the following is a form of business in which an external vendor performs a whole business process of a certain department in a company including the operation of information systems?

a) BPM b) BPMS c) BPO d) BPR

Q8

Which of the following is an explanation of SOA?

a) An approach in which computer resources are provided over the Internet, and a user can easily use the desired resources when they are needed
b) An approach in which the functions of software that correspond to a single process in an operation are implemented as services, and an overall system is constructed by combining these services
c) An approach in which software is placed on a server in a network, and only the functions that are required by the user are provided as a service over the network
d) An approach in which all operations, such as the planning, construction, and operations of a system, are undertaken in situations, such as the construction of a system that uses a network

Q9

Which of the following is the most appropriate description of the effect that can be obtained by using a housing service?

a) It can reduce costs relating to the usage, implementation, and upgrade of a business application.
b) It can reduce server purchase costs and costs relating to operating load and network.
c) It can avoid update activities for the OSs and office software on servers and computers in a company.
d) It can reduce costs relating to the network and facilities that are required in order to provide a service with a company's servers.

Q10

Which of the following is defined in Common Frame 2013, as an item that should be implemented in the planning process?

a) Creation of a new overall image for business operations and an overall image for new systems
b) Evaluation of the achievement of each project from a financial perspective
c) Definition of rules for standardization and quality policies for system development and operations
d) Definition of information security policies

Q11

Which of the following is defined in Common Frame 2013, as an item that should be considered in the planning of computerization?

a) Integrating individual systems into a single project
b) Abstracting a computerization initiative, and enabling it to be used in multiple systems
c) Assuming the ideal system without consideration for feasibility
d) Estimating the effectiveness and investment effect of the information system

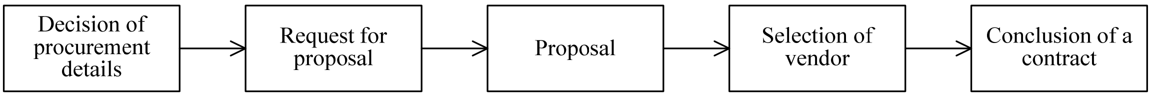
Q12

Which of the following is an appropriate description concerning requirements definition?

a) Functional requirements for which hardware restrictions occur are defined as non-functional requirements.
b) Functional requirements for which the approval of the stakeholders is not obtained are defined as non-functional requirements.
c) Operational requirements which are not included in the requirements for system functions are defined as non-functional requirements.
d) Stakeholders' requirements that have no direct relation to business operations are defined as non-functional requirements.

Q13

When the series of procurement processes from "Decision of procurement details" to "Conclusion of a contract" is defined as shown in the diagram, at which stage is an RFP issued?



a) Selection of vendor
b) Decision of procurement details
c) Proposal
d) Request for proposal

Chapter 4

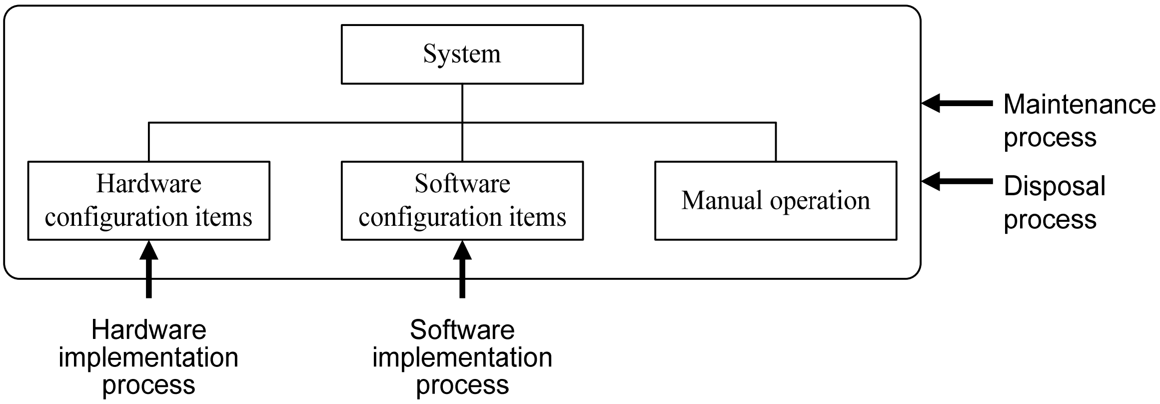
Development Technology

1 System Development Technology (SLCP)

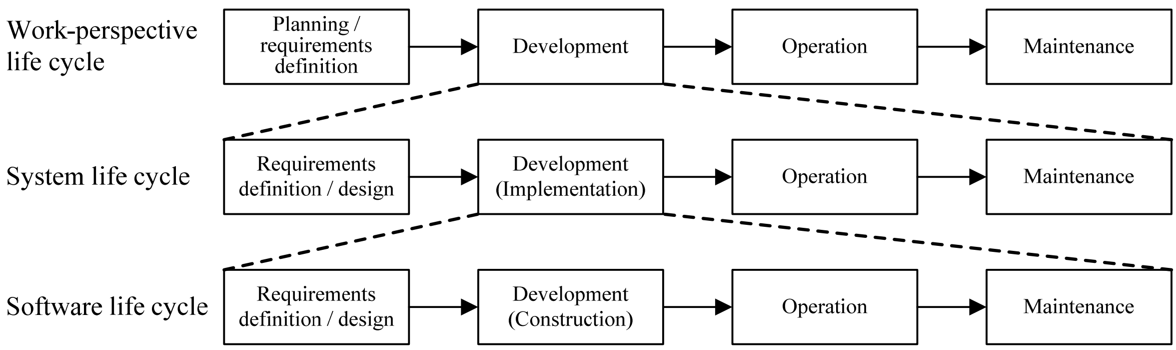
System development technology refers to technology for developing the individual information systems clarified in information system planning.
Common Frame 2013 (SLCP-JCF2013) defines processes for which engineers are the main entity within the system life cycle spanning the development to the disposal of a system as follows:

Process Name	Overview
System development process	Clarify system configuration items to be developed.
Hardware implementation process	Develop hardware configuration items.
Software implementation process	Develop software configuration items.
Maintenance process	Maintain developed systems.
Disposal process	Dispose of developed systems.

System development process



On the basis of this concept, the relationships among the work-perspective life cycle, the system life cycle, and the software life cycle can be summarized as shown below. In order to make the relationships easier to understand, feedback from maintenance is omitted here.



This section describes work items and techniques in the system development process, the software implementation process, and the maintenance/disposal process, on the basis of Common Frame 2013.

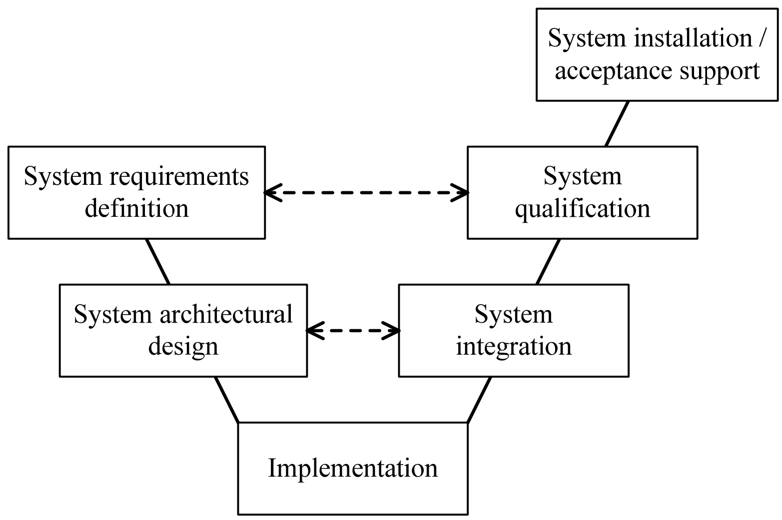
1 - 1 System Development Process

In the system development process, the hardware, software, and other configuration items that compose the system to be developed are clarified, and the target system is developed by combining the individual configuration items.

[Objectives of the system development process (excerpt)]
The system development process is aimed at the development of systems, software products, or services. It converts requirements into the system that matches customer needs.

[Processes within the system development process (excerpt)]

(i) System requirements definition process
(ii) System architectural design process
(iii) Implementation process
(iv) System integration process
(v) System qualification testing process
(vi) System installation process
(vii) System acceptance support process



Here, system installation refers to the delivery of a system by the supplier (i.e., developer) to the acquirer (i.e., purchaser). Furthermore, system acceptance support refers to support by the supplier to enable acceptance of the delivered system by the acquirer.

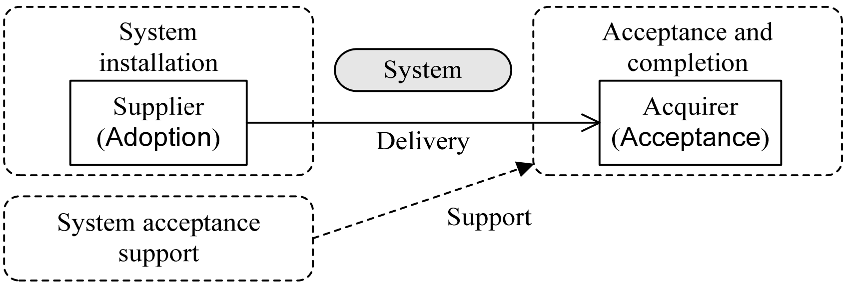


Fig. 4-1 Relationship between system installation and system acceptance support

1-1-1 System Requirements Definition Process

The system requirements definition process converts the defined stakeholder requirements to technical requirements (i.e., system requirements) that can be used in system design.

[Activities of system requirements definition]

(i) Definition of system requirements

(ii) Evaluation and review of system requirements

(1) Definition of system requirements

In definition of system requirements, the specific applications of the system to be developed are analyzed from the stakeholder requirements, and system requirements such as the following are clarified and documented in a system requirements definition document.

[System requirements]

- Objectives and scope of computerization (e.g., the targeted work, the targeted departments)
- Functions, capabilities, and life cycle of the system
  - Functions are summarized as functional requirements in system functional specifications.
  - Capabilities are clarified as performance requirements (e.g., response time, throughput).
- Business, organizational, and user requirements
  - User work processing procedures, input/output information requirements, database requirements, operation requirements, and other requirements from the business, organization, and users are clarified. In addition, test requirements to verify these requirements are also defined.
- Reliability, safety, security, human-factors engineering (i.e., ergonomics), interface, operations, and maintenance requirements
  - Security requirements, operational requirements (including education, training, and others), maintenance requirements (including fault handling and others) are clarified.
- System configuration requirements
  - Execution environment requirements, peripheral interface requirements, and others are clarified.
- Design constraints and qualification requirements
  - Design constraints are clarified as design constraint conditions. System configuration requirements can also be design constraints.
  - Qualification requirements are standards for verifying that a system is of usable quality, and are documented in a specification document of a system qualification test.
- Development environment
- Quality, expense, and expected effects
  - Quality is clarified as quality requirements.
- Migration requirements and validation requirements for system migration

(2) Evaluation and review of system requirements

Two tasks are executed in evaluation and review of system requirements.

(i) Evaluation of system requirements

Defined system requirements are evaluated, in consideration of the criteria of traceability to acquisition needs, consistency with acquisition needs, testability, feasibility of system architectural design, and feasibility of operation and maintenance.

(ii) Implementation of joint review of system requirements

A joint review by the development department (i.e., supplier) and stakeholders (i.e., acquirer) is conducted, and agreement is obtained concerning system requirements. In order to deepen mutual understanding, prototypes may be created to verify feasibility, or simulations may be conducted.

Review refers to verification and evaluation of the activity status and deliverables of a project by concerned parties. Typical types of review and review methods are as follows:

[Types of review]

- Joint review

  This is a review aimed at maintaining among stakeholders a shared understanding of progress toward agreed-upon objectives and shared understanding for the purpose of aiding confirmation that product development satisfies stakeholders.
- Design review

  This is a review aimed at discovering errors in design documents.
- Code review

  This is a review aimed at discovering errors (i.e., bugs) in source code (i.e., source programs). It can also be expected to improve the readability of programs.

[Review methods]

- Walk-through

  This is a review implemented by a creator and multiple concerned parties. It is implemented primarily for the purpose of early discovery of errors.
- Inspection (software inspection)

  This is a review conducted by a moderator (i.e., a person in charge of implementation). The moderator must bear responsibility for confirmation and correction of errors.

Typical implementing procedures for reviews are: Development of the review documents; implementation of review (i.e., determination of review methods, determination of review evaluation standards, selection of review participants); and reflection of review results in documents. Points for effectively conducting reviews include advance distribution of materials, conducting reviews in a short time, and not including persons in charge of personnel evaluations among the review participants.

1-1-2 System Architectural Design Process

The system architectural design process identifies how system requirements should be allocated to system elements (e.g., hardware, software).

[Activities of system architectural design process]

(i) Establishment of systems architecture

(ii) Evaluation and review of systems architecture

(1) Establishment of systems architecture

Three tasks are executed in establishment of systems architecture.

(i) Establishing the architecture at the top level of the system

The system is functionally divided into the items of hardware, software, and manual operation at the top level of the system. At this time, it is necessary to confirm that all system requirements be allocated to any items. Hardware configuration items, software configuration items, and manual operations are clarified from these items. The systems architecture and the system requirements allocated to each item are documented in a system architectural design document.

- In the functional decomposition, user work scope (i.e., manual operation) and others are considered from the perspective of operational efficiency, workload, and activity costs.
- In hardware architectural design, fault tolerant design (e.g., redundancy) is considered along with the functional allocation and reliability allocation of servers, and configuration is determined.
- In software architectural design, in-house development, use of software packages, middleware to be used, and others are considered, and configuration is determined.
- In system processing architectural design, centralized processing / distributed processing, web systems, client/server systems, and others are considered, and processing methods are determined.
- In database architectural design, the type of database to be used is determined from among RDB (Relational DataBases), NDB (Network DataBases), OODB (Object-Oriented DataBases), XML databases, and other databases.

(ii) Development of user documentation (preliminary version)

A preliminary version of user documentation is developed. User documentation is documentation delivered to users together with systems. Examples include systems operation manuals and business operation manuals.

(iii) Definition of test requirements for system integration

Provisional test requirements and a schedule for system integration are defined and documented. The scope of system integration test, test plans, test procedures, and other policies are determined. Then, a system integration test specification document is developed. This document includes test requirements to confirm whether the system fulfills functionality.

(2) Evaluation and review of systems architecture

Two tasks are executed in evaluation and review of systems architecture.

(i) Evaluation of systems architecture

The established systems architecture is evaluated, with consideration given to the criteria of traceability to system requirements, consistency with system requirements, appropriateness of design standards and methods used, feasibility of software items fulfilling their allocated requirements, and feasibility of operation and maintenance.

(ii) Implementation of joint review of system architectural design

A joint review by the development department (i.e., supplier) and stakeholders (i.e., acquirer) is implemented, and agreement is obtained concerning system architectural design.

1-1-3 Implementation Process

The implementation process implements the specified system elements (i.e., hardware, software). The software implementation process for implementing software is described in “1-2 Software Implementation Process.” Here, the hardware implementation process for implementing hardware is described.

[Overview of the hardware implementation process]

The purpose of the hardware implementation process is to produce a specified system element implemented as a hardware product or a service.

In the hardware implementation process, specified behavior, interfaces, and implementation constraints are transformed into a system element (i.e., a hardware configuration item) to be implemented as a hardware product or a service.

1-1-4 System Integration Process

The system integration process integrates system elements (including hardware configuration items, software configuration items, manual operations, and other systems, as necessary) in order to produce a complete system that satisfies the system design and the stakeholders' expectations described in the system requirements.

[Activities of system integration process]

(i) System integration

(ii) Evaluation and review of test readiness and system integration

(1) System integration

Three tasks are executed in system integration.

(i) Development of a system integration plan

Hardware configuration items, software configuration items, manual operations, and any other required systems are integrated, and an integration plan for turning these into system items is developed. In the integration plan, test requirements, procedures, data, responsibilities, plans, and others are to be documented.

(ii) Implementation of system integration test

Software configuration items are integrated, with hardware configuration items, manual operations, and other systems as necessary, into the system. System integration is tested against requirements according to the sequence of development, and the integration and the test results are documented in a system integration test report.

- Following the system integration test specification document defined in system architectural design, a test environment and test data are prepared and implemented according to the test plan.

(iii) Updating user documentation

User documentation is updated as required, including corrections to operation manuals.

Note: System integration test refers to testing that combines deliverables developed separately, in order to validate proper operation (i.e., that interfaces are correct). Integration testing is described in "1-2-5 Software Integration Process."

(2) Evaluation and review of test readiness and system integration

Three tasks are executed in evaluation and review of test readiness and system integration.

(i) Preparation of system qualification test

A set of tests, test cases (e.g., inputs, outputs, test criteria), and test procedures are developed and documented for conducting system qualification test.

(ii) Evaluation of system integration

The results of system integration are evaluated, with consideration given to the criteria of test coverage of system requirements, appropriateness of test methods and standards used, conformance to expected results, feasibility of system qualification test, and feasibility of operation and maintenance. The system is modified and documentation is updated, as required.

(iii) Implementation of joint review of system integration

A joint review by the development department (i.e., supplier) and stakeholders (i.e., acquirer) is conducted, and agreement is obtained concerning system integration.

Note: Concepts concerning evaluation of testing results are described in "1-2-4 Software Construction Process." Here, it is sufficient to understand the review as confirmation that all testing results are according to expectations for system requirements.

1-1-5 System Qualification Testing Process

The system qualification testing process ensures that the system is ready for delivery by testing the compliance of implementation for each system requirement.

[Activities of system qualification testing process]

(i) System qualification testing

(1) System qualification testing

In system qualification testing, seven tasks are performed.

(i) Implementation of system qualification testing

System qualification testing is conducted in accordance with the qualification requirements specified for the system in the system requirements definition. It is ensured that the implementation of each system requirement is tested for compliance and that the system is ready for delivery. The qualification test results are documented in a system qualification testing report.

(ii) System evaluation

The results of system qualification testing are evaluated, with consideration given to the criteria of test coverage of system requirements, conformance to expected results, feasibility of operation and maintenance, and appropriateness of the test methods and standards used. If the result of evaluation reveals areas that do not fulfill system requirements, tuning is conducted and documentation is updated, as required.

(iii) Implementation of joint review of system qualification testing

A joint review by the development department (i.e., supplier) and stakeholders (i.e., acquirer) is implemented, and agreement is obtained concerning system qualification testing.

(iv) Updating user documentation

User documentation is updated as required, including corrections to operation manuals. When system operators update user documentation, the necessary information is to be provided to the system operators.

(v) Support for audits

Audit refers to independent evaluation to assure that selected deliverables and processes conform to the corresponding requirements, plans, and agreements. In support for audits, the audit activities are supported, and the audit results are documented.

(vi) Preparation of deliverable systems

Deliverable systems are updated and prepared for the process of supporting system installation and system acceptance.

(vii) Preparation of systems to be taken over in operation and maintenance

From the created deliverables, deliverables to be taken over in operation and maintenance are organized and prepared.

In system qualification testing, whether the system has been achieved (i.e., implemented) according to system requirements is verified through testing listed below.

Name of Test	Content of Testing
Functional test (Functional requirement test)	Verifies whether functions defined in system requirements (functional requirements) are fulfilled, by using data used in business operations.
Non-functional requirement test	Verifies whether non-functional requirements other than functional requirements of the system (i.e., software) are fulfilled.

Performance test	Verifies whether performance requirements (e.g., response time, throughput) defined in system requirements are fulfilled.
Load test (Stress test)	Increases the volume of processed data or the number of programs executed simultaneously, in order to verify the maximum processable data volume or continuous operable time.
Security test	Verifies that security requirements defined in system requirements are fulfilled. In order to intentionally find issues of a security breach, verify strength against unauthorized access. Tests including penetration testing are performed.
Exception test	Verifies that appropriate operation (e.g., error processing) is performed, by using data that would be processed as exceptions in business operations.
Regression test	Verifies whether modifications to the system because of specification changes or others have impacts on non-modified portions of the system. In general, this is conducted in operation/maintenance.

1-1-6 System Installation Process

The system installation process installs a system that meets the agreed system requirements in the production environment (i.e., the actual operational environment).

[Activities of system installation process]

(i) System installation

(1) System installation

In system installation, two tasks are performed.

(i) Development of a system installation plan

Support the acquirer in drafting a plan for installation of the system in the production environment, and document an installation plan as designated in the contract.

(ii) Implementation of system installation

Assist the acquirer with installation of the system in accordance with the installation plan, and document the installation events and results.

In (i) described above, ahead of the drafting of the installation plan, the following two requirements are considered: migration requirements that outline how installation into the production environment and system migration is implemented; and installation requirements that outline points of note in data preservation (e.g., backups), impacts on business operations, and others, and how the installation schedule and installation structure is set. On the basis of the results, the acquirer must be supported in drafting a feasible installation plan, according to installation acceptance/rejection criteria.

In actual system installation described in (ii), the initialization of the system, software, and database is performed and the execution environment is prepared according to procedures defined in the installation plan, and after that, the system is installed. Ideally speaking, these installation operations are to be performed under the leadership of the user department and system operations department of the acquirer, with the supplier providing user support.

1-1-7 System Acceptance Support Process

The system acceptance support process supports the acquirer in confirming whether the system fulfills system requirements.

[Activities of system acceptance support process]

(i) System acceptance support

(1) System acceptance support

In system acceptance support, three tasks are performed.

(i) Support for the acquirer's acceptance review and acceptance testing

The acquirer's acceptance review and acceptance testing are supported. These are conducted in consideration of the results of the previously conducted joint review, software qualification testing, system qualification testing, and the audit. Their results are documented.

(ii) System delivery

The completed system is delivered along the lines of the acquirer's readiness for acceptance based on the contract.

(iii) Support for education and training of the acquirer

Initial and continuing training and support are provided to the acquirer as specified in the contract.

Acceptance testing refers to testing, which is performed by the acquirer according to

acceptance criteria, to verify that the delivered system fulfills system requirements. The acquirer performs acceptance testing and other tests according to acceptance procedures. If the results fulfill receiving inspection criteria, accepts the system as a finished product.
In "(ii) System delivery" described above, user documentation is also delivered. The user documentation includes the system operations manual / business operations manual that includes operational rules for the work that the acquirer should perform in operation, and the user manuals that are composed of system usage documents / software usage documents and tutorials (i.e., explanations of functions and operational procedures using examples).

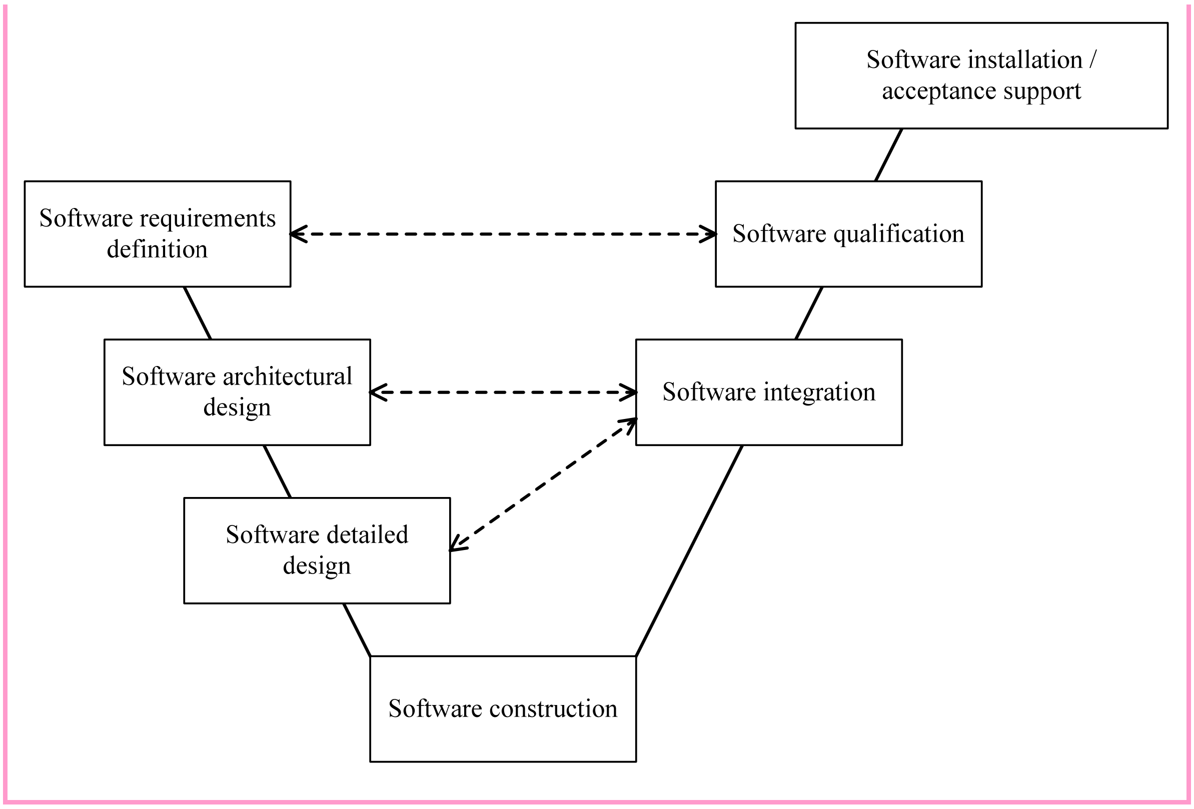
1 - 2 Software Implementation Process

In the software implementation process, the requirements are defined and software specifications are determined, for each individual software configuration item to be developed, and then the software is developed.

[Objectives of the software implementation process (excerpt)]
The purpose of the software implementation process is to produce a specified system element implemented as a software product or a software service.
The software implementation process transforms specified behavior, interfaces, and implementation constraints are transformed into a system element (i.e., a software configuration item) implemented as a software product or a software service.

[Processes of the software implementation process (excerpt)]

(i) Software requirements definition process
(ii) Software architectural design process
(iii) Software detailed design process
(iv) Software construction process
(v) Software integration process
(vi) Software qualification testing process
(vii) Software installation process
(viii) Software acceptance support process



In addition, one of the preparations for starting the software implementation process is preparation of a development environment. In preparation of the development environment, the work standards, methods, tools, and programming languages, which are documented and established in the organization, are appropriately selected, and then tailoring is performed as necessary, in order to conduct the software implementation process.

1-2-1 Software Requirements Definition Process

In the software requirements definition process, the requirements for software configuration items are converted to technical requirements (i.e., software requirements) usable in design of the software.

[Activities of software requirements definition process]

(i) Establishment of software requirements

(ii) Evaluation and review of software requirements

Note: In the Common Frame 2013 software implementation process, (i) and (ii) are treated as a single activity. In this textbook, they are separated for ease of understanding.

(1) Establishment of software requirements

In the establishment of software requirements, the requirements allocated to software configuration items are analyzed, software requirements are clarified as described below, and these are documented as software requirements definitions.

[Software requirements]

- Functional and capability specifications, including performance, physical characteristics, and environmental conditions under which the software item is to perform
- External interfaces of the software items
- Qualification requirements (development of the software qualification testing specifications)
- Safety specifications, including those related to methods of operation and maintenance, environmental influences, and personnel injury
- Security specifications, including those related to the leakage of information
- Human-factors engineering specifications, including those related to manual operations, human-equipment interactions, constraints on personnel, and areas needing concentrated human attention, that which sensitive to human errors and training
- Data definition and database requirements
- Installation and acceptance requirements of the delivered software product at the operation and maintenance sites
- User documentation requirements
- User operational and execution requirements
- User maintenance requirements

In the establishment of software requirements, a business model that portrays the business and a logical data model that portrays data to be handled are created. Determination of specifications for functions and capabilities required of the software is performed, along with interface design. At the same time, software qualification requirements, for confirming whether requirements are fulfilled, are defined. With regard to software requirements, it is considered advisable to also determine the order of implementation priority.
It is noted that quality characteristic specifications of the software to be developed are also included in software requirements. The software quality characteristics defined in ISO/IEC 9126 (JIS X 0129-1) are used as guidelines for specifying the quality characteristics of software.

Quality Characteristics	Overview
Functionality	The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions [Sub-characteristics] Suitability, accuracy, interoperability, security
Reliability	The capability of the software product to maintain a specified level of performance when used under specified conditions [Sub-characteristics] Maturity, fault tolerance, recoverability
Usability	The capability of the software product to be understood, learned, used, and attractive to the user, when used under specified conditions [Sub-characteristics] Understandability, learnability, operability, attractiveness
Efficiency	The capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions [Sub-characteristics] Time behavior, resource behavior
Maintainability	The capability of the software product to be modified. The capability to adapt the software product to corrections/improvements of functions, changes in environment, and changes in requirements specifications [Sub-characteristics] Analyzability, changeability, stability, testability
Portability	The capability of the software product to be transferred from one environment to another [Sub-characteristics] Adaptability, installability, co-existence, replaceability

In business operations modeling to create business models or data modeling to create logical data models, business analysis is performed by using methods described below.

- Hearing
  This is a method of hearing comments from users and others in order to clarify the requested particulars of software or work. Hearings are implemented on the basis of hearing planning that includes the subjects and objectives of the hearings, and the results are documented in hearing minutes.
- Use case

This is a method used to define the associations and relationships between systems and actors (e.g., outside persons or machines that boot the system, interact with information).

- Mock-up and prototype
  This is a method of verifying and evaluating validity of specifications, oversights, feasibility, and others by creating mock-ups or prototypes.
- Diagramming method
  This is a method of diagramming and verifying business processes and others. Typical diagramming methods include DFD, which focuses on the flow of data to represents business processes; E-R diagrams, which abstract the information handled in business to represent it as entities and relationships among entities; UML, which uses object-oriented concepts in representation; and decision tables, which summarize complex conditions and others in table format. (Details of diagramming methods are described in "2-2 Software Design Technique.")

In addition, form design and slip design, which define the forms and slips used in business in formats adapted to the system, may be performed in data modeling.

- Form design
  This designs the items and layout of forms (e.g., reports). In form design, the purpose of forms, the period of use, where forms will be used, and others are considered comprehensively. Then, necessary items and layouts are determined.
- Slip design
  This designs the items and layout of slips (e.g., sales slips). Since slips are used for data input into the system, and others, items and layouts are to be determined in consideration of ease of use (e.g., ease of understanding input items) for the user.

If necessary, code design may be performed at this time. (For example, in slip design, managing customers by customer code and entering the code may be deemed easier than entering a customer's name and address.)

- Code design
  This selects the target items with a code, and creates a code table for each target item. Since code includes sequence code, block code (or classification code), group classification code, mnemonic code, synthetic code, and many other types, appropriate code is to be selected.

However, data modeling is to be performed for the purpose of clarifying the functions and capabilities of software items, external interfaces, and others. For that reason, form design, slip design, code design, and others do not need to be rigidly performed at this time. Moreover, as database requirements and definition of the data to be clarified on the basis of these results are for the purpose of gaining a conceptual image of data to be used in the system, the file organization method for recording data, normalized database tables, and others do not need to be determined.

(2) Evaluation and review of software requirements

Two tasks are executed in evaluation and review of software requirements.

(i) Evaluation of software requirements

Defined software requirements are evaluated, with consideration given to the criteria of traceability to system requirements and system design, external consistency with system requirements, internal consistency, testability, feasibility of software design, and feasibility of operation and maintenance.

(ii) Implementation of joint review of software requirements

A joint review is conducted, and agreement is obtained concerning software requirements.

1-2-2 Software Architectural Design Process

In the software architectural design process, software requirements are implemented, and software design able to verify these is provided.

[Activities of software architectural design process]

(i) Software architectural design
(ii) Evaluation and review of software architectural design

(1) Software architectural design

Five tasks are executed in software architectural design.

(i) Architectural design of software structure and components

Requirements concerning the software configuration items are transformed into an architecture that identifies the software components that describe the top-level structure. At this time, it is confirmed that all software requirements are allocated to a software component and that they are refined to facilitate software detailed design, which is documented in a software architectural design document.

(ii) Architectural design of interfaces

A top-level design is to be developed and documented for the external interfaces of the software configuration items and for the interfaces between the software components.

(iii) Top-level design for the database

A top-level design for the database is to be developed and documented.

(iv) Development of user documentation (preliminary version)

A preliminary version of user documentation is to be developed and documented.

(v) Definition of test requirements for software integration

Preliminary test requirements and the schedule for software integration are defined and documented. The scope, test plans, test procedures, and other policies of software integration testing are to be determined. A software integration testing specification is to be developed. It includes test requirements to confirm whether the requirements for the software are fulfilled.

In software architectural design, software is partitioned into functional-level software components (hereinafter called components), and functional specifications of each component, and the processing procedures and relationships among components are made clear.

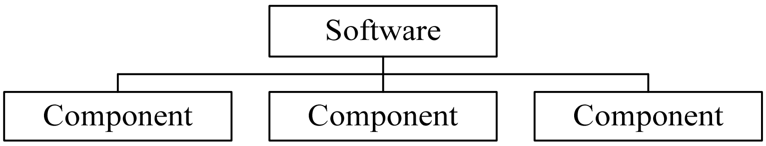


Fig. 4-2 Software and components

In (i) described above, when software is partitioned into components, the concept of structuring is often used to design functions in step-by-step detail and create a hierarchical structure. At this time, the criteria used for partitioning components include processing patterns for uniform records, differences in processing timing (i.e., processing cycle), differences in processing efficiency, simultaneously usable resources, characteristics of input devices, and such other factors. (As an example, the update processing for the same file is partitioned as one component.) Moreover, from the perspective of component partitioning, file integration or file partitioning may be used. (For example, when there are different functions for male and female customers, customer files may be partitioned into male customer files and female customer files, and the software is partitioned into components that process each file.) Functional specifications are determined for each partitioned component.

Components become programs that provide functions collected into a single function. Since programs can be reused by other software as components, partitioning is considered on the basis of criteria for ease of understanding, development productivity, operability, processing capability, maintainability, reusability, and such other factor. (This way of thinking is called "partitioning into components.") Furthermore, it is also important to consider the use of existing programs.

In "(ii) Architectural design of interfaces" (interface design) described above, top-level interfaces are to be made clear on the basis of the software requirements definition document, in consideration of operability, visibility, software functions, and processing method, according to interface design standards. Since screens, forms/slips, files, and others correspond to external interfaces, GUI-based screen design, form/slip design, and other input/output design (i.e., input/output conceptual design), along with logical data design, are to be performed. In top-level design, logical definitions such as items, layouts and screen transitions are created. Physical definitions that rely on hardware or specific methods are not created. This way of thinking is that same as that in "(iii) Top-level design for the database," and design that relies on specific DBMS products and others are not performed at the software architectural design stage.

In "(v) Definition of test requirements for software integration," checklists and others are to be used to verify that there are no oversights in test requirements. In addition, test requirements are to be created on the basis of criteria for black box tests. These tests verify that the relationships between input and output are correct. (Details of black box tests are described in "1-2-4 Software Construction Process.")

(2) Evaluation and review of software architectural design

Two tasks are executed in evaluation and review of software architectural design.

(i) Evaluation of software architectural design

Software architectural design is to be evaluated, with consideration given to the criteria of traceability to the requirements of the software configuration item, external consistency with the requirements of the software configuration item, internal consistency between the software component, appropriateness of design methods and standards used, feasibility of detailed design, and feasibility of operation and maintenance

(ii) Implementation of joint review of software architectural design

A joint review is to be conducted, with agreement obtained concerning software architectural design.

1-2-3 Software Detailed Design Process

The software detailed design process provides a design for the software that implements and can be verified against the software requirements and software architecture and is sufficiently detailed to permit coding and testing.

[Activities of software detailed design process]

(i) Software detailed design
(ii) Evaluation and review of software detailed design

(1) Software detailed design

Six tasks are executed in software detailed design.

(i) Detailed design of software components

Software components are refined into lower levels containing software units (i.e., a single unit, classes, and modules) that can be coded, compiled, and tested. It is confirmed that all software requirements are allocated from the software components to software units. This is documented in a software detailed design document (i.e., component detailed design document).

(ii) Detailed design of software interfaces

A detailed design is to be developed and documented for the external interfaces of the software configuration items, the interfaces between the software components, and the interfaces between the software units.

(iii) Detailed design for the databases

A detailed design for the database is to be developed and documented.

(iv) Updating user documentation

User documentation is to be updated as necessary.

(v) Definition of test requirements for software units

Test requirements and the schedule for testing software units are to be defined and documented. The scope, test plans, test procedures, and others of software unit test are to be defined, and a software unit test specifications document is to be developed. It is desirable that the test requirements include the stress test of the software unit at the limits of its requirements.

(vi) Updating of test requirements for software integration

The test requirements and the schedule for software integration are to be updated.

In software detailed design, software components (i.e., programs) are partitioned into the units of coding called software units.

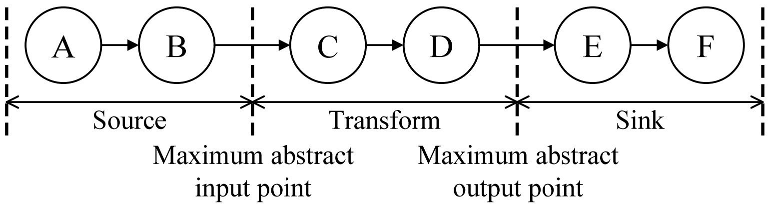
Task (i) described above is also called module design, because software component is partitioned into modules, which are the units of development (i.e., coding). In the module partitioning that is conducted during module design, structured design using the concept of structuring is used. For the module partitioning that is used in structured design, there are methods that focus on the flow of processing (or data). In general procedures, higher-level module partitioning is first performed by using STS partitioning, after which lower-level modules are partitioned by using transaction partitioning. After this, the modules are verified, and common functional partitioning is performed.

[Module partitioning techniques focused on the flow of processing (or data)]

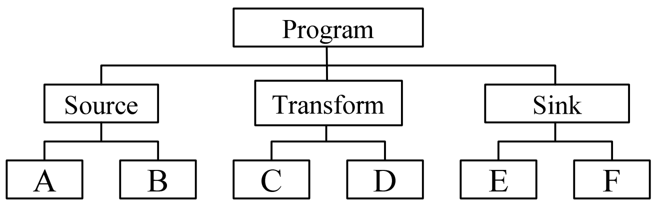
- STS partitioning

  This is a technique that partitions program flow into three parts: input (i.e., Source), processing (i.e., Transform), and output (i.e., Sink). Each part becomes a module. Partitioning in this case is carried out at the maximum abstract input point where input data has been abstracted, and the maximum abstract output point where the models for output data have been collected.

  [Program flow (bubble chart)]

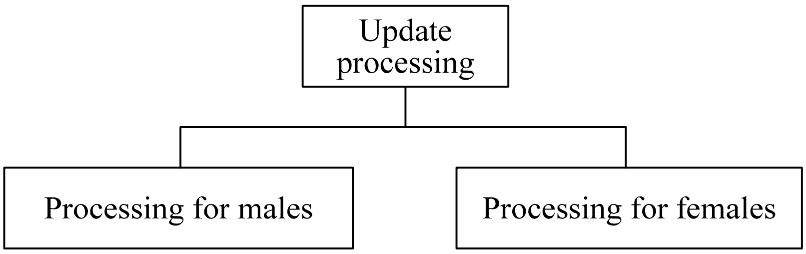


  [Module structural diagram] (functional hierarchy diagram)



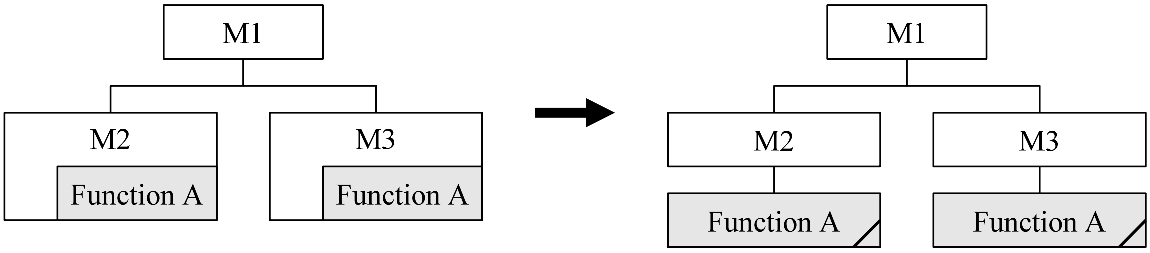
- TR partitioning (Transaction partitioning)

  This is a technique that partitions each process as a module when processing differs according to type of data. As an example, when processing procedures differ for males and females in file updating, partitioning can be performed as follows:



• Common functional partitioning

When there are functions that are common to multiple partitioned modules, this technique partitions these functions into a single independent module.



In addition to methods focused on the flow of processing (or data), there are also methods of module partitioning that focus on data structure.

[Module partitioning techniques focused on data structure]

• Jackson method

This is a technique that analyzes input data and output data, and partitions modules according to the output data structure. In the Jackson method, both data structures and program structure are represented as three basic structures (sequence, selection, and iteration).

• Warnier method

This is a technique that uses the set theory to analyze input data structures from the perspective of when and how many times to perform processing.

Modules partitioned in this way must be evaluated for independence. Module strength and module coupling are used as metrics for evaluation.

- Module strength

This metric represents the associations of functions within the module. A better module has a higher strength. When modules are arranged in order of higher module strength, the result is as follows:

Functional strength	A collection of only functions that execute one certain process
Informational strength	A collection of multiple independent functions that process specific data
Communicational strength	A collection of multiple sequential functions, with internal passing of data
Procedural strength	A collection of multiple sequential functions, without internal passing of data
Temporal strength	A collection of multiple functions executed at a specific timing
Logical strength	A collection of multiple functions selected by parameters
Coincidental strength	A collection of meaningless functions partitioned by size and others

- Module coupling

This metric represents associations with other modules. A better module has a weaker coupling. When modules are arranged in order of weaker module coupling, the result is as follows:

Data coupling	Passes only parameters that do not affect control
Stamp coupling	Passes the data structure itself
Control coupling	Passes parameters that affect control
External coupling	Externally declares and shares only necessary data
Common coupling	Externally declares and shares data including unnecessary data
Content coupling	Directly looks up data in other modules

Partitioned modules are to be evaluated according to evaluation criteria, such as scope of control and scope of effect of the module, amount of partitioning of the module (the number of steps), partitioning into components, and reuse. After that, they are to be repartitioned as necessary.

[Guidelines for amount of module partitioning]

- Partition a single component into about 10-200 modules.
- Partition a component so that partitioned modules have a hierarchical depth of up to 4 levels.
- Partition a component so that the number of modules at the same depth (i.e., level) is 10 or less.

Module specification design (or program design) is to be performed to clarify the functions of the partitioned modules. At this time, methods for representing module specifications include flowcharts, decision tables, and NS (Nassi-Shneiderman) charts. (Details are described in "2-2-1 Structured Design.")

In "(ii) Detailed design of software interfaces" (interface design), physical design is to be performed, which includes responsiveness, hardware functions, and others along with what have been considered in architectural design. In input/output detailed design, as input media, input design to determine input data checking methods (e.g., numeric checks, limit checks, format checks, duplication checks, matching checks, balance checks, logical checks (validity checks)), output objectives, and others are considered, output media (e.g., display screens, printer forms) is determined. In addition, output design is performed to design layouts based on the limitations of paper (specialized paper, general paper), displays, printers, and others. In physical data design for files and others, data property analysis, file organization methods (e.g., sequential organization, relative organization, indexed sequential organization, partitioned organization, direct organization), recording media, the layout of records (generally with key items positioned to the front, and reserved items added with expansion taken into account), and others are determined. This way of thinking is that same as that in "(iii) Detailed design for the databases," and a physical data model is created with an awareness of the DBMS product to be implemented.

With regard to interfaces between software components and interfaces between software units, appropriate interfaces (e.g., parameters and return values) are to be defined on the basis of the relationships between modules (i.e., main routines) that perform calls and modules (i.e., subroutines) that are called. At this time, call by value and call by reference are to be used appropriately as methods for calling subroutines (i.e., methods for passing parameters).

In "(v) Definition of test requirements for software units," in the same manner as test requirements for software integration, checklists, and others are to be used. In addition, criteria are to be created for test requirements for not only black box tests but also white box tests that verify whether the internal structure (i.e., algorithm) of the software is correct. (Details of black box tests and white box tests are described in "1-2-4 Software Construction Process.")

(2) Evaluation and review of software detailed design

The following tasks are to be executed in evaluation and review of software detailed design.

(i) Evaluation of software detailed design

Software detailed design is to be evaluated, with consideration given to the criteria of traceability to the requirements of the software configuration item, external consistency with architectural design for the software configuration item, internal consistency between the software components and software units, appropriateness of design methods and standards used, feasibility of testing, and feasibility of operation and maintenance.

(ii) Implementation of joint review in software detailed design

A joint review is to be conducted, with agreement obtained concerning software architectural design.

1-2-4 Software Construction Process

The software construction process produces executable software units that properly reflect the software design. (In general, this is called programming.)

[Activities of software construction process]

(i) Software construction

(ii) Evaluation of software code and test results

(1) Software construction

Five tasks are executed in software construction.

(i) Development of software units and databases

Each software unit and database are to be developed and documented.

(ii) Development of test procedures and test data

Test procedures and test data for testing each software unit and database are to be developed and documented.

(iii) Implementation of software unit and database testing

Each software unit and database is to be tested to confirm that it satisfies software requirements, and the results are to be documented in a software unit test report document.

(iv) Updating user documentation

User documentation is to be updated as necessary.

(v) Updating of test requirements for software integration

The test requirements and the schedule for software integration are to be updated.

In "(i) Development of software units and databases," programming is performed according to the specifications for coding conventions and programming languages, on the basis of the software detailed design. (The work of creating (or writing) a program on the basis of algorithms (i.e., procedures) defined in the software detailed design and others is also called coding.)

Coding conventions are rules for performing coding. If notational conventions for coding are not set, programs will be inconsistent and will have poor readability, which will reduce maintainability. For that reason, coding conventions (i.e., programming style) should be set, notational conventions should be unified, and program intelligibility (i.e., ease of understanding), efficiency (i.e., ease of creation), maintainability (i.e., ease of change), functionality, usability, and such other factor should be improved. In general coding conventions, indentation, depth of nesting, naming conventions (e.g., how variables are named), prohibited instructions, and others are to be set, in consideration of the standards (i.e., paradigm) of the programming languages used.

In programming, it is also necessary to determine the structure of the data (data structure) to be processed. Since appropriate data structures differ by programming language, the used data structures must be decided on the basis of the data processing to be achieved, the ease of implementation, and so on.

Basic data structure		
	Simple-type	Integer type, real type, character type, Boolean type, enumerated type, pointer type
	Structure type	Array, record type
	Abstract data type	Object
Problem-oriented data structure		List, stack, queue, tree, hash

One concept (i.e., technique) for creating easy-to-understand programs with high maintainability is structured programming. In structured programming, programs are created with processing procedures considered according to structure theorem, which can represent a program with one entrance and one exit as a combination of three basic structural units (i.e., sequence, selection, and iteration).

Furthermore, in order to perform coding efficiently, coding support tools described below should also be considered.

- Code auditor
  This is a tool to verify whether a program follows coding conventions.
- Source code editor
  This is dedicated software for creating programs (i.e., the source code). It offers functions, such as code completion which displays a menu when a portion of a command or a variable name is entered, so that an input item can be selected from the input candidates in the menu, and syntax highlighting which displays an instruction in a code in color according to the type or classification of the instruction.

In "(ii) Development of test procedures and test data," the test system (e.g., the scope and schedule of the test, the test implementer), the test tools to be used, and others are considered by using appropriate test methodology according to the software unit test specifications document, and test plans are drafted. After this, creation of test data, preparation of a test environment, and other test readiness are performed in order to execute test plans.

The objective of all testing, including the software unit test performed in (iii), is the discovery of errors (i.e., bugs). Errors (i.e., bugs) are faults or defects in software, or portions of a program that do not fulfill specifications or requirements defined in design documents and specifications documents. The following is a list of testing objectives to be implemented in the software implementation process.

Type of test	Objective of test
Software unit test	This verifies whether software unit functions and others fulfill the specifications of the software detailed design document.
Software integration test	This verifies whether the software unit's combined portion (e.g., interface) fulfills the specifications of the software architectural design document (and the software detailed design document).
Software qualification test	This verifies whether the software fulfills the requirements of the software requirements definition document.

In order to achieve such objectives, appropriate and efficient testing methods (i.e., techniques) must be used in order to reliably find errors ((i.e., bugs).

Testing methods include white box tests and black box tests.

- White box test
  This is a test implemented with a focus on the internal specifications (e.g., algorithms, logic paths) of software units (i.e., modules). It is generally used only in the software unit test that is performed by developers.

- Statement coverage

  This designs test cases that execute every statement in a unit (i.e., module) at least once.

- Decision condition coverage (branch coverage)

  This designs test cases that execute TRUE/FALSE at least once for every "decision condition" (i.e., branch) in a unit (i.e., module).

- Condition coverage

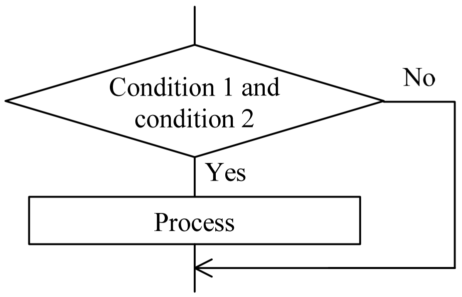
  This designs test cases that execute TRUE/FALSE at least once for every "condition" used as a decision condition.

- Decision condition / condition coverage

  This designs test cases that fulfill both decision condition coverage (i.e., branch coverage) and condition coverage.

- Multiple-condition coverage

  This designs test cases that include every combination of TRUE/FALSE for every condition.



(Truth value chart)

	Condition 1	Condition 2	Decision condition
I	TRUE	TRUE	TRUE
II	TRUE	FALSE	FALSE
III	FALSE	TRUE	FALSE
IV	FALSE	FALSE	FALSE

Coverage criteria	Test cases that fulfill coverage criteria
Statement coverage	(I)
Decision condition coverage (branch coverage)	(I and II) or (I and III) or (I and IV)
Condition coverage	(I and IV) or (II and III)
Decision condition /condition coverage	(I and II and III) Note: Avoid (I and IV).
Multiple-condition coverage	(I and II and III and IV)

Note: Verification of all test cases may be difficult when processing is complex. In such a case, coverage rate (i.e., test coverage), a metric that represents coverage rate of test cases (or of paths), is used. The idea is to set a test coverage target in consideration of the balance between productivity and reliability from perspectives of cost, delivery, and others; in other words, the test is completed when this target is cleared.

- Black box test

  This is a test performed with a focus on the external specifications (i.e., functional specifications and input/output (interface) specifications) of software units (i.e., modules). It is used in all software testing, including software unit test.

  - Equivalence partitioning / boundary value analysis

    This is a method that partitions input data into several groups (i.e., classes), and test data is selected from each group. In general, input data is partitioned into a valid equivalence class (i.e., the group processed normally) and an invalid equivalence class (i.e., the group handled as an error), and then the valid equivalence class is further staged if necessary. From among these partitioned groups, representative values are used as test cases in the case of equivalence partitioning, and values at both ends of each class are used in the case of boundary value analysis.

    Example: For a unit processed normally when input data is between 10 and 30

. . . 7 8 9	10 11 . . . 29 30	31 32 33 . . .
Invalid equivalence class	Valid equivalence class	Invalid equivalence class

    Equivalence partitioning: {7, 21, 39} ... One representative value from each class

    Boundary value analysis: {9, 10, 30, 31} ... All boundary values from each class

  - Cause-effect graph method

    This method represents the cause-effect relationship of input (i.e., cause) and output (i.e., effect) as a graph (i.e., cause-effect graph) when class sorting of input data is difficult. It is a method that then creates a decision table based on the graph to sort out test data.

In addition to white box tests and black box tests, testing methods and test implementation methods include the following.

- Error embedding method

  This is a method that embeds the known errors in software, and the number of inherent potential errors is estimated from the ratio of the number of discovered known errors to the number of inherent errors (i.e., number of errors not already known).

- Experimental design

  This is a method that selects test data efficiently through statistical analysis, when tests that use large volumes of data are required.

- Metrics measurement

This is a method that collects and analyzes metrics for the size, complexity, and others of software on the basis of development information and others. Then, the possibility that errors or defects are present is investigated.

When test data is created under these methods, tools such as test data generators are used. The implementation of tests is performed according to drafted test plans. At this time, when a module (i.e., software unit) that is the target of testing is called by a higher-level module, a dummy module called a driver is used in place of the calling module (i.e., main routine). Conversely, when a module that is the target of testing calls a lower-level module, a dummy module called a stub is used in place of the called module ((i.e., subroutine).

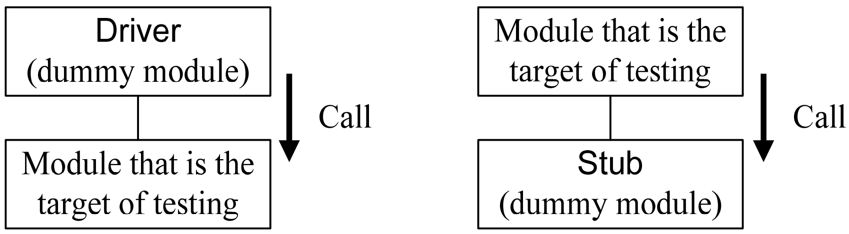


Fig. 4-3 Drivers and stubs

Any errors (i.e., bugs) detected by testing are to be eliminated or corrected. This series of tasks, from detection of such errors (i.e., bugs) to their elimination or correction, is called debugging. For efficiency, a debugging environment that offers tools (i.e., debuggers) to support debugging and tools (i.e., test support tools) to support testing is used.

[Examples of test support tools]

- Program static analysis tools

  These are tools that support the analysis of static testing (i.e., testing that does not execute the program), such as desktop debugging for confirming on the desktop that values have not been substituted in variables that are no longer used.

- Program dynamic analysis tools

  These are tools that support analysis using dynamic tests (i.e., tests that execute the program), such as assertion checking, which embed a logical expression that describes the conditions or the relationships among variables at a specific point in time and verify the validity of the program.

(2) Evaluation of software code and test results

The following tasks are to be executed in evaluation of software code and test results.

(i) Evaluation of software code and test results

Software code and test results are to be evaluated, with consideration given to the criteria of traceability to the requirements and design of the software configuration item, external consistency with the requirements and design of the software configuration item, internal consistency between requirements for software units, test coverage of software units, appropriateness of coding methods and standards used, feasibility of software integration and testing, and feasibility of operation and maintenance.

In "evaluation of software code," code review is performed. In code review, whether coding conventions are maintained and are based upon the software detailed design document, whether the efficiency and maintainability of code are appropriate, and others are verified along with the results of metrics measurement.

[Types of code review]

- Peer code review

  This is a review performed by members of the development team, colleagues, and other people primarily for the purpose of eliminating defects in deliverables (i.e., code).
- Code inspection

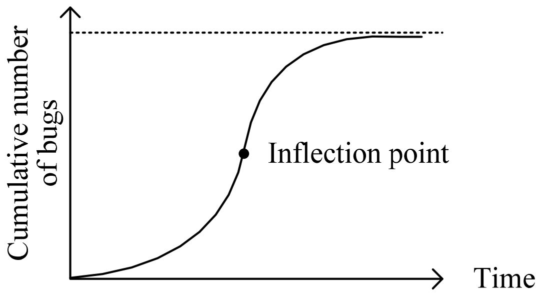
  This is a formal review performed by determining a moderator (i.e., the person responsible for implementation), primarily for the purpose of improving the quality of deliverables (i.e., code).

In "evaluation of test result," test results are to be comprehensively evaluated by using methods as described below. Through the evaluation, errors (i.e., bugs) in the program are to be corrected as necessary.

- Bug curve (reliability growth curve)

  This is a graph that plots test results with the cumulative number of bugs or errors on the vertical axis and the elapsed time on the horizontal axis. It is used to quantitatively predict reliability. It can also be used for test progress management by additionally entering the number of finished test items (or the number of unfinished test items), the number of unresolved bugs, and others.

  When the bug curve has an inflection point and eventually converges to a logistic curve, the program can be assessed as having high reliability (i.e., high quality).



For using in progress management, the progress status and quality of the program are to be comprehensively assessed, including not only the cumulative number of bugs but also the number of finished test items, number of unresolved bugs, and others. As an example, even if the cumulative number of bugs exceeds expectations, the progress of testing can be considered fast if the number of finished test items also exceeds expectations. However, if the number of finished test items is below expectations, then the quality of the program should be assessed as low.

- Bug control chart

This is used to understand test status, product quality, and others on the basis of bug curves. The actual bug curve is recorded onto a graph that already depicts the lower control limit line and the upper control limit line, which are predicted from past performance and such other factor, and is compared with these lines.

1-2-5 Software Integration Process

In the software integration process, software units and configuration components are integrated to create software configuration items that have consistency with the software design and that fulfill the software requirements (i.e., functional requirements and non-functional requirements) within the operating environment (i.e., the production environment or equivalent environment).

[Activities of software integration process]

(i) Software integration

(ii) Evaluation and review of test readiness and software integration

(1) Software integration

Three tasks are executed in software integration.

(i) Development of a software integration plan

An integration plan to integrate the software units and the software components into the software configuration item is to be developed. In the integration plan, test requirements, procedures, data, responsibilities, schedules, and others are to be documented.

(ii) Implementation of software integration test

Software units and software components are to be integrated in accordance with the integration plan. At this time, performing testing for each created collective will ensure that each aggregation satisfies the software requirements and that the software item is integrated at the conclusion of the integration activity. The results of integration and testing are to be documented as a software integration test report.

– A test environment and test data are to be prepared and implemented under test plans in accordance with a software integration test specifications document defined in software architectural design and updated in later processes.

(iii) Updating user documentation

User documentation is updated as necessary, with the inclusion of corrections of operation manuals.

In software integration, the software units developed in the software construction process, the software components (i.e., programs) and software units to be reused, and other configuration components are assembled, and software configuration items are created.

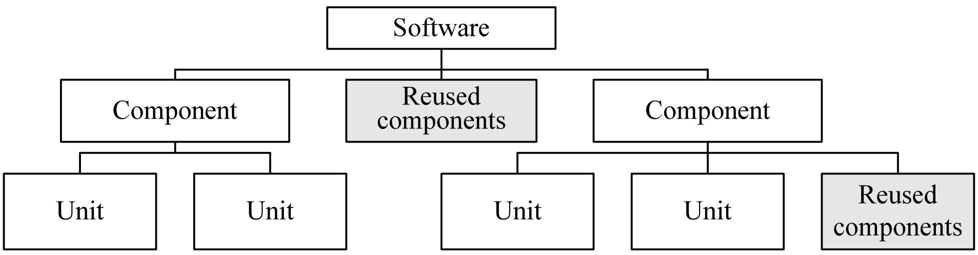


Fig. 4-4 Depiction of software integration

The software integration test is a test that assembles partitioned and developed deliverables to verify correct operation (i.e., correct interfaces).

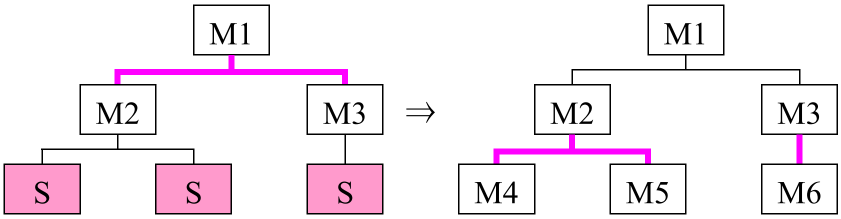
Typical methods of an integration test include incremental testing and non-incremental testing.

• Incremental testing

This is a test in which tested module groups are incrementally integrated with new modules. It is a test suited to large-scale systems, and requires dummy modules for integration testing.

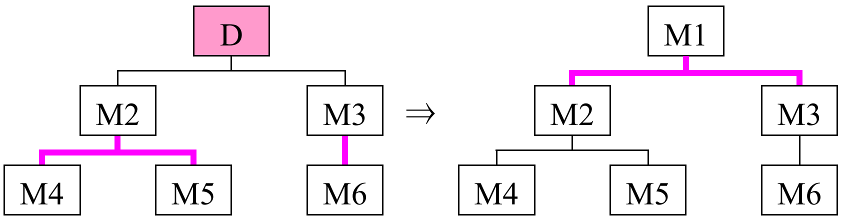
- Top-down testing

  This is a test that performs integration from top-level module to lower-level modules. It requires stubs that work as lower-level modules.



- Bottom-up testing

  This is a test in which integration is performed from bottom-level modules to higher-level modules. It requires drivers that work as higher-level modules.



- Sandwich testing

  In sandwich testing, a sandwich line is determined, after which top-down testing is performed on modules above the line and bottom-up testing is conducted on modules below the line. At the end, these are integrated at the sandwich line. This allows testing in a short period of time, but both stubs and drivers are necessary for use as dummy modules.

- Non-incremental testing (Big bang testing)

  In this test, all modules are integrated and tested all together after each unit test is completed. It is suited to small-scale systems, and does not require dummy modules for integration testing. However, it has demerits, such as disallowing implementation in parallel with development activities, and difficulty in identifying the locations (i.e., interfaces) of the causes of detected errors.

In "(i) Development of a software integration plan," the integration sequence of units and components, and others, are created in the form of an integration plan, in consideration of the software integration test methods. The integration plan is to also include test planning, covering the testing system (scope of testing, schedule, and test implementer), the test tools to be used, and others, in accordance with the software integration test specifications document. In (ii), test preparation (e.g., preparation of test data and test environment) is performed in order to execute the integration plan.

(2) Evaluation and review of test readiness and software integration

Three tasks are executed in evaluation and review of test readiness and software integration.

(i) Preparation for software qualification testing
A set of tests, test cases (e.g., inputs, outputs, test criteria), and test procedures are developed and documented for conducting the software qualification testing.

(ii) Evaluation of software integration
The results of software integration are to be evaluated, in consideration of standards including traceability to the system requirements (i.e., software requirements), external consistency with system requirements (i.e., software requirements), internal consistency, test coverage of the requirements of the software items, appropriateness of the test methods and test standards used, conformance to expected results, feasibility of the software qualification testing, and feasibility of operation and maintenance. The software is then to be modified and documentation updated as required.

(iii) Implementation of joint review of software integration
A joint review is conducted, and agreement is obtained concerning software integration.

1-2-6 Software Qualification Testing Process

In the software qualification testing process, whether the integrated software configuration items (i.e., software products) fulfill the defined requirements is to be confirmed.

[Activities of software qualification testing process]
(i) Software qualification testing

(1) Software qualification testing

Six tasks are performed in the software qualification testing.

(i) Implementation of software qualification testing
Software qualification testing is conducted in accordance with the qualification

requirements specified for the software in the software requirements definition. It is ensured that the implementation of each software requirement is tested for compliance. The qualification testing results are documented in a software qualification testing report.

– Whether the software products have been implemented in line with the software requirements is to be confirmed through functional testing, non-functional testing, performance testing, load testing, security testing, exception testing, regression testing, and other testing.

(ii) Updating user documentation

User documentation is to be updated as necessary.

(iii) Evaluation of software qualification testing

The results of the software qualification testing are to be evaluated, in consideration of test coverage of software requirements, conformance to expected results, feasibility of system integration and testing, and feasibility of operation and maintenance.

(iv) Implementation of joint review of software qualification testing

A joint review is to be conducted, with agreement obtained concerning qualification test.

(v) Support for audits

Audits are to be supported, and the audit results are documented.

(vi) Preparation of deliverable software products

The deliverable software product is to be updated and prepared for system integration, system qualification testing, software installation, and software acceptance support.

1-2-7 Software Installation / Acceptance Support Process

The software installation process and software acceptance support process are processes used when the acquirer directly installs the software developed in the software implementation process, in the form of a software product. Thus, these processes are not necessary when software configuration items are developed as system elements. The activities and tasks of the software installation process and software acceptance support process are composed of nearly the same concepts as in the system installation process and the system acceptance support process.

In the software installation process, software products fulfilling the agreed-upon software requirements are installed in the production environment (i.e., the actual operational environment).

[Activities/tasks of software installation process]

(i) Software installation

- Development of the software installation plan
- Implementation of software installation

In the software acceptance support process, the acquirer is supported in being certain that the software product fulfills software requirements.

[Activities/tasks of software acceptance support process]

(i) Software acceptance support

- Support for the acquirer's acceptance review and acceptance testing
- Delivery of software products
- Education/training and support for the acquirer

1 - 3 Maintenance and Disposal Process

1-3-1 Maintenance Process

The maintenance process provides high-cost-performance support for delivered systems and software products. In maintenance, modifications and improvements are carried out while the safety of systems (or software products) is maintained, in response to the occurrence of problems, requests for functional expansion, improvements, and others.

In implementing maintenance, maintenance requirements and maintenance frameworks are to be defined, and maintenance agreements are to be concluded, in consideration of both the requests on the part of the party receiving maintenance and the costs and feasibility on the part of the party providing the maintenance.

[Activities of maintenance process]

(i) Preparations for initiating the maintenance process
(ii) Assessment of issues, and analysis of changes
(iii) Implementation of changes
(iv) Maintenance review and/or acceptance
(v) Support for operational testing and migration

(1) Preparations for initiating the maintenance process

Five tasks are executed in preparations for initiating the maintenance process.

(i) Transfer of deliverables necessary for maintenance

Deliverables necessary for maintenance are to be transferred, including code and databases, design documents, qualification test plans / test results, the acquirer's acceptance confirmation document, documents concerning current business operations and system operations, and the system migration procedures / migration framework for the new operational environment.

(ii) Development of a plan and procedures

A maintenance plan and procedures are to be developed, documented, and executed.

(iii) Establishment of problem management procedures

Procedures are to be established for receiving, recording, and tracking problem reports and modification requests from users, and for providing feedback to users.

(iv) Management of change activities

Configuration management (i.e., defining configuration items and managing information) is to be implemented for managing modifications to the systems (or software products).

(v) Development of documents for maintenance

Transferred deliverables are to be identified, and documents for maintenance are to be created as necessary.

In "(ii) Development of a plan and procedures," a maintenance plan is established in consideration of how maintenance is to be implemented, the type and form of maintenance, implementation methods, points for caution, and other factors.
Typical types and forms of maintenance include the following.

- Preventive maintenance

  This is implemented with a maintenance plan prepared in advance, to prevent the occurrence of faults and others. Since it allows planned securing of maintenance staff members, it enables efficient maintenance.

  - Daily maintenance

    This is maintenance in which the equipment that composes systems is monitored on a daily basis.

  - Scheduled maintenance

    This is performed periodically.

- Corrective maintenance

  This is implemented when faults or abnormal situations occur. Unlike preventive maintenance, it is not scheduled in advance. Because of this, it is difficult to secure maintenance staff, and therefore, it is recommended to put emergency maintenance staff in regular posts.

- Non-scheduled maintenance

  This is performed when conditions appear that differ from normal operation.

- Emergency maintenance

  This is performed for the purpose of restoration after the occurrence of a fault.

- Software maintenance

  This is maintenance for the purpose of improving the software configuration items that compose software products or systems (e.g., changes and improvements in programs, changes in documents). By contrast, maintenance of the whole system, including software maintenance and hardware maintenance for the purpose of improving the hardware configuration item (e.g., increasing the hard disk information storage capacity), is called system maintenance.

  - Corrective maintenance

    This is maintenance (e.g., changes in programs) that is implemented to resolve problems (i.e., items that do not fulfill system requirements) that are discovered after system delivery.

  - Adaptive maintenance

    This is maintenance (e.g., improvement of programs) that is implemented to resolve issues that occur because of the changes in the environment after system delivery.

  - Perfective maintenance

    This is maintenance (e.g., improvement of programs) that is performed after system delivery to improve performance and others of the delivered systems (or software products).

- On-site maintenance

  This is implemented through on-site visits by maintenance staff members. On the other hand, remote maintenance is performed from a remote location without on-site visits by using WOL (Wake On LAN) and others to boot computers over a LAN.

Since continually securing dedicated maintenance staff members is costly, external contracting (i.e., outsourcing) of maintenance work and others are also to be considered.

(2) Assessment of issues and analysis of modifications

Five tasks are executed in assessment of issues and analysis of modifications.

(i) Analysis of problem reports and modification requests

The effects of problems reports and modification requests on the system and on related systems are analyzed, in terms of type (e.g., correction, improvements, prevention), scope (e.g., size of modification, cost involved, period to modify), and severity (e.g., performance, safety).

(ii) Reproduction or verification of problems

Problems are to be confirmed through reproduction or verification.

(iii) Preparation of options for implementation of modifications

On the basis of the analysis, options are to be developed for the implementation of modification.

(iv) Documentation

Problems, modification requests, analysis results, and options for implementation are to be documented.

(v) Approval of modification proposals

Approval is to be obtained for the selected modification options, as specified in the contract.

(3) Implementation of modifications

Two tasks are executed in implementation of modifications.

(i) Analysis and determination of modification portions

Analysis of modifications is performed, and the system (or software) and related documents to be modified, and the content of modifications (e.g., functional additions, performance improvements, correction of problems), are determined and documented.

(ii) Implementation of modifications

Modifications are implemented. Modification tasks are implemented according to the system development process and the software implementation process. Depending on the object and content of modifications, the planning process and the requirements definition process may also be used.

- The requirements and evaluation criteria of maintenance testing to verify modifications are to be determined and documented. In addition to testing to confirm whether the modified portions accurately fulfill modification requirements, maintenance testing includes regression testing to verify that there are no effects on unmodified portions.
- Reverse engineering to analyze and derive the specifications of in-service systems (or software products) is to be performed as required.

When modifications consist of the correction of problems, implementation of preventive measures against recurrence of problems is also to be considered. In order to prevent recurrence of problems, the root causes of the problems are to be identified through specific cause analysis, and others, and the possibility of the occurrence of similar problems is to be considered. Depending on the results of consideration, improvement of the systems (or software products), revision of manuals, and others are to be implemented. When prevention of the recurrence of problems is deemed difficult, life cycle evaluation must be performed, with disposal also taken into consideration.

(4) Maintenance review and/or acceptance

Three tasks are executed in maintenance review and/or acceptance.

(i) Review of the modified system

A review is to be conducted in order to confirm the integrity of the modified system.

(ii) Approval of completion

Approval is to be obtained regarding the satisfactory completion of modifications.

(iii) Updating of documents for maintenance

Documentation for maintenance is to be updated as required.

(5) Support for operational testing and migration

Two tasks are executed in support for operational testing and migration.

(i) Support for implementation of operational testing

Prior to the release of a system (or software product), the operator is to take the lead in supporting the implementation of operational testing to verify whether there are any problems in the production environment.

(ii) Support for migration

The migration of a system (or software product) to the production environment is to be supported. The general migration procedures for the system (or software product) are as follows:

1) Documentation and verification of the migration plan
2) Notification of migration plans and others to all concerned parties
3) Parallel operation of the old and new environments, and disposal of the old system
4) Notification of migration to all concerned parties
5) Migration evaluation (i.e., verification and review of migration results)

6) Maintenance of old environment-related data, and assurance of security

1-3-2 Disposal Process

The disposal process ends the existence of system or software products.

[Disposal process tasks]

(i) Drafting of a disposal plan
(ii) Execution of the disposal plan
(iii) Notification of the disposal plan and others to users
(iv) Parallel operation of the new and old system, and education/training of users
(v) Notification of disposal to all concerned parties
(vi) Maintenance of old disposal-related data, and assurance of security / assurance of accessibility

2 Software Development Technology

The software implementation process defines the activities to be provided to the acquirer and provider, as a "shared yardstick" for software development. What is actually used to perform these activities is software development technology.

2 - 1 Software Development Method

2-1-1 Software Development Model

A software development model is a standard model that represents the procedures for developing software. This is also called a system development model for system development.

[Merits of software development models]

- Since development activities are routine, even developers with little experience can participate in work.
- Since deliverables are easily routinized, maintenance work can be mitigated.

(1) Waterfall model

The waterfall model is a technique in which large-scale and complex development processes are partitioned into multiple phases, and development is conducted for each phase. Development proceeds in the technique from upstream processes to downstream processes, without redoing the previous phases, as indicated by the name "waterfall."

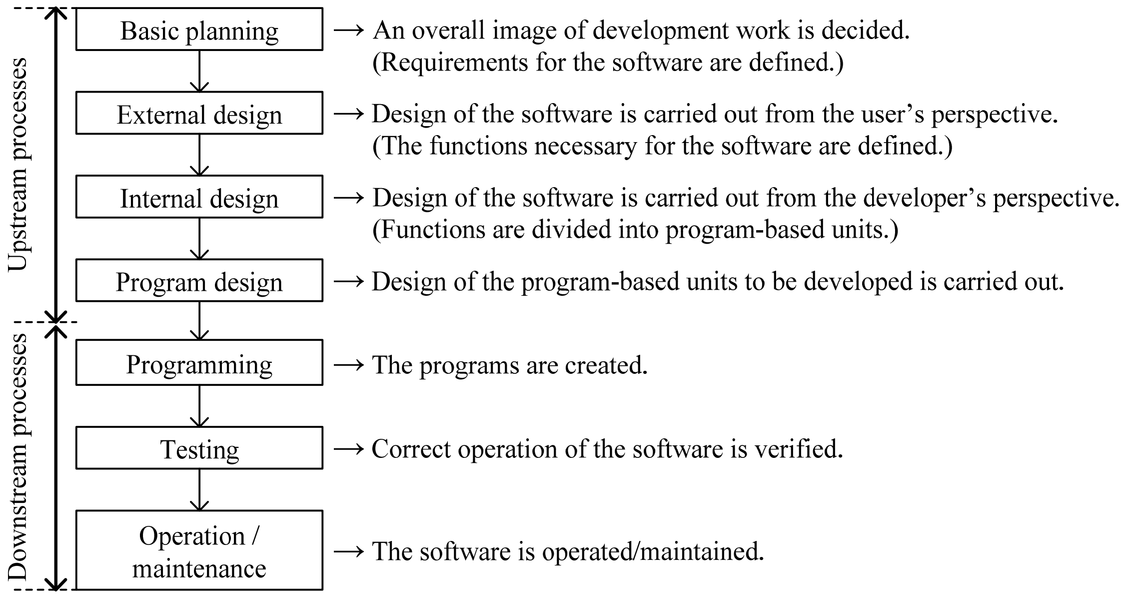


Fig. 4-5 Waterfall model

The main activities to be implemented in the waterfall model software process, and overall corresponding SLCP, are as follows:

Development process	Main activities	Corresponding SLCP
Basic planning	Computerization planning, requirements definition	Software requirements definition process
External design	Definition of subsystems, input/output outline design, code design, logical data design	Software architectural design process
Internal design	Functional partitioning /refinement, input/output detailed design, physical data design	Software detailed design process
Program design	Module partitioning	
Programming	Coding	Software construction process

In development under the waterfall model, a top-down approach is used so that development can proceed from the overall image of the software to increasingly detailed design. Conversely, in testing processes for developed software, a bottom-up approach is used so that development can proceed from the detailed level to the software overall. Thus, illustrating the relationship between design phases and tests reveals a V shape as shown below.

(This is known as a V-shaped model.)

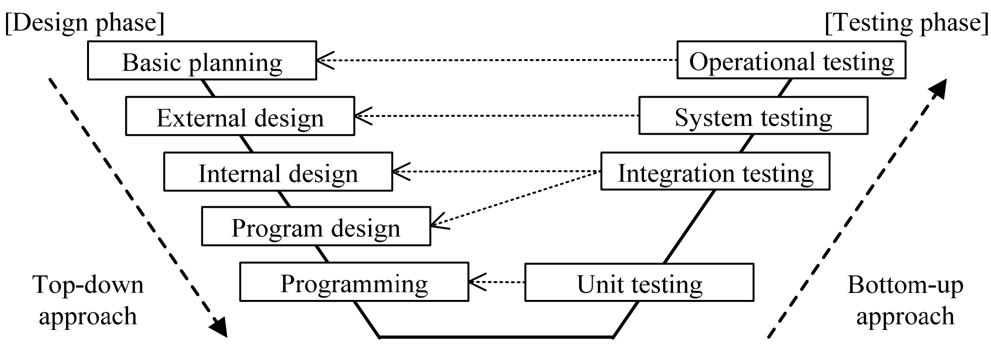


Fig. 4-6　Overall image of the waterfall model (V-shaped model)

Name of test	Content of testing	Corresponding SLCP
Unit test	Confirm that each individual module operates correctly.	Software unit test
Integration test	Modules are combined to confirm correct operation.	Software integration tests
System test	For the software overall, whether required functions are fulfilled and whether there are problems in operability or performance are to be confirmed.	Software qualification test
Operational test (Acceptance test, approval test)	The user department operates the software under conditions of actual operation, to confirm whether it fulfills requirements.	Acceptance test or operational test

(2)　Prototype model (prototyping)

The prototype model is a development technique that creates a provisional prototype in a short time and is tested and evaluated by users, with specifications finalized while changes are repeated.
Since it enables users to confirm at an early stage that user requirements are met, it is able to reduce reworking. However, as adjustments to the schedule are difficult and prototypes must be created even if incomplete, it is suited to development of small-scale systems.
In the end, it follows two methods: disposing the prototype after confirmation of specifications and then creating a new system, or improving the created prototype (through functional addition) to turn it into the production system.

(3) Spiral model

The spiral model is a development technique that divides a large-scale system into independent partial units, and processes including design/development/testing are repeated for each part to achieve a high degree of completion of a system. This technique combines the waterfall model and prototyping, and is suited to development of large-scale systems in which system development personnel are limited.

(4) RAD (Rapid Application Development)

RAD refers to rapid application development that is conducted by a small group of people through the use of development support tools. Users can be brought in to participate in the development work at an early phase. The technique was originally aimed at achieving development by a small number of people and facilitating communication.

(5) Software product line

Software product line is a method that analyzes the group of software to be developed and decomposes it into small parts that can and cannot be shared, which are then developed. By developing the sharable parts as core assets, software development can be performed efficiently.

(6) Iterative model

The iterative model is a technique in which software development processes (i.e., design/development/testing) are repeated many times. (The spiral model is a type of iterative model.)

- Incremental model
  This is a method that partitions software into multiple independent functions, which are developed and released incrementally in units of functions.
- Evolution model
  This is a technique that develops software of limited functional scope, and adds improvements repeatedly.

2-1-2 Agile

Agile is a general name for techniques that develops high-quality software with rapid and appropriate action. The Manifesto for Agile Software Development released in 2001 declares the values of agile software development to be as follows:

[The Values of Agile Software Development]

- Individuals and interactions are valued over processes and tools
- Working software is valued over comprehensive documentation
- Customer collaboration is valued over contract negotiation
- Responding to change is valued over following a plan

Note: With recognition of value in the compared items, the Manifesto declares the stated items to be of higher value.

Rather than spending time on design documents under the conventional idea that creating quality design documents equates to creating quality products, agile software development places importance on promoting smooth communication to develop software that actually works.

[Agile-related methods/technologies]

- XP (eXtreme Programming)

  This is a typical agile software development technique that simplifies the design phase and enhances programming and testing. It is a relatively new technique that emphasizes communication, and places importance on constant feedback, changes, and redesign rather than on setting up and proceeding processes in order. XP development practices include test driven development, pair programming, and refactoring.
- Test driven development

  This is a method that creates testing before programming (i.e., "test first"), and then creates programs which pass the testing. By performing the testing first, the required functions are made clear and simple design is possible.
- Pair programming

  This is a method in which programming is performed by a pair of persons. One person creates a program and the other person gives instruction while checking the program. The pair proceeds by switching each role, and thus it is always possible to perform code review. The technique is also expected to aid in maintaining concentration.
- Refactoring

  This is a technique that improves the finished code without changing its action (i.e., behavior) that is seen from the outside. It reworks code that is difficult to understand, because of bug fixes or adaption to requirements changes, into easily understood code with high maintainability.

2-1-3 Software Reuse

Software reuse is the concept of using developed software, commercially available software packages, and others to efficiently develop new software. In addition, the reuse of software packages may require customization.

- Partitioning into components
  This is the concept of developing modules (i.e., componentware) on the precondition of reuse. Development on the precondition of reuse requires standardization in the development phase, improvement of module independence, and management of module-based units, and therefore, man-hours and cost are increased in comparison with development of the same scale. However, modules created as components have high reliability and can be expected to improve development productivity (i.e., shortening of the development period) and quality. In general, using a large component has a greater effect on reducing development man-hours, but caution must be taken in that the component may be difficult to reuse.
- Re-engineering
  This is to acquire technology for the creation of new software from software that is already running, and to perform some customization. Within re-engineering, reverse engineering and forward engineering are performed.
  - Reverse engineering
    This is technology for analyzing existing programs and for creating call graphs (i.e., directed graphs indicating the relationships among procedures) and specifications.
  - Forward engineering
    This is technology for creating new programs by changing specifications taken from existing programs.
- Mashups
  This is technology for constructing new services by combining APIs from multiple providers. It is used as technology for Web2.0, a newer manner of using the Web.
- Architecture pattern
  This is a pattern of software construction that supports structures, such as packages, subsystems, and layers, and their connection and interaction. It uses existing architecture patterns and can improve software development efficiency.
  - MVC (Model-View-Controller) model
    This is a design model that implements software by combining “models” that form the core of processing, “views” for display or output, and “controllers” that control the views and models according to input content.

• Design pattern

This is a design pattern that is used in object-oriented design, and is composed of three types of patterns: creational pattern, structural pattern, and behavioral pattern.

2 - 2 Software Design Technique

2-2-1 Structured Design

Structured design is a technique (i.e., structured technique) that analyzes and designs the functions required for software and the data flows used by each function. The technique in which development is focused on functions (i.e., processing) as in structured design is called the POA (Process-Oriented Approach) or process-oriented design. Structured design offers merits that include improvement of processing efficiency, ease of maintenance, and partitioning of modules into components (for reuse).

In structured design, functions are incrementally refined according to the following procedures, and are placed into a hierarchical structure.

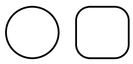
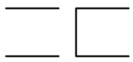
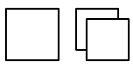
[Structured design procedures]

1) Identification of functions
2) Clarification of data flow
3) Grouping of functions
4) Hierarchical structuring
5) Determination of program functions
6) Documentation of functional specifications

"1) Identification of functions" and "2) Clarification of data flow" are processes that correspond to the software requirements definition process, and are also called structured analysis. In structured analysis, work processes, and others are analyzed by using diagramming methods as shown below, and the functions necessary for the software are clarified.

• DFD (Data Flow Diagram)

This is a diagramming method in which the targeted workflows are represented as data flows passed among processes. It is used in business operations modeling, which represents processing/functions and flows of data used in work.

Symbol	Name	Meaning
	Data flow	Represents flows of data.
	Process	Represents activities and processes including data processing/conversion.
	Data store	Represents stored data (e.g., ledgers, files, databases).
	Data source (External)	Represents the originating origin (i.e., source) or destination (i.e., sink) of data.

• State transition diagram

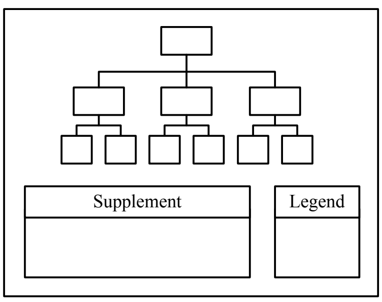
This is a diagramming method that represents the state that changes depending on the course of time, actions, and others. It is used when workflows (i.e., processing/functions) are visually analyzed or for screen transitions.

"3) Grouping of functions" through "6) Documentation of functional specifications" are processes that correspond to the software architectural design process and the software detailed design process. In these processes, functions required for software are organized (i.e., classified) and analyzed by using diagramming methods as shown below, and functional hierarchies are made clear through stepwise refinement.

• HIPO (Hierarchy plus Input Process Output)

This is a diagramming method that represents the functions and processing of software by using a hierarchical structure.

<Visual table of contents>



<IPO Diagram>

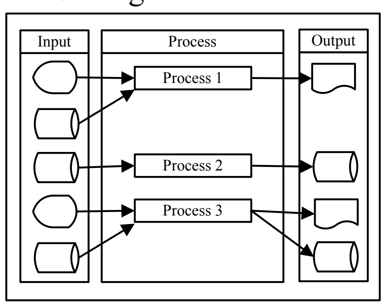
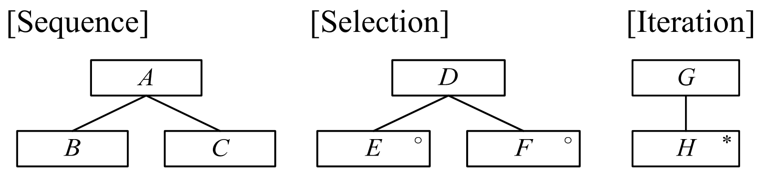


Diagram name	Role
Visual table of contents (hierarchical structure diagram)	A figure representing the functions of software (or a system) as a hierarchy
Summary diagram (IPO diagram)	A figure representing the input, process, and output of software (or a system)
Detailed diagram (IPO diagram)	A figure representing the input, process, and output of the components (or functions) composing the whole

- Jackson method / Warnier method

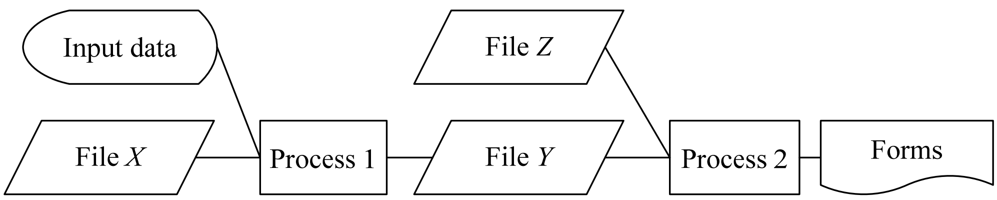
  This is a module partitioning technique that is focused on data structures. Each technique defines functional structure diagrams that correspond to data structures.

  [Diagram structure of Jackson method]



- Process flow

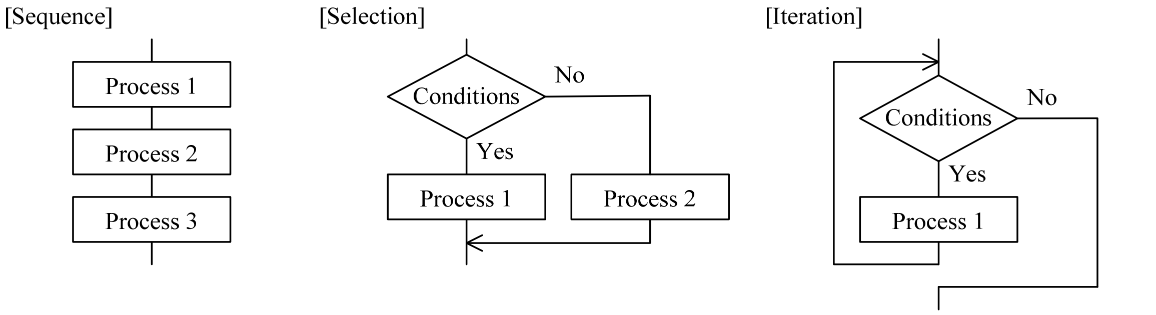
  This is a diagramming method that represents the execution order (i.e., flow) of processing (i.e., functions), along with interfaces (e.g., input/output).



Structured charts as shown below are used to represent the processing procedures of each function (i.e., program) in “6) Documentation of functional specifications.” A structured chart is a chart suited to structured programming, in which processing procedures are considered according to the structured theorem that states that a program with one entrance and one exit can be represented as a combination of three basic structural units (sequence, selection, and iteration).

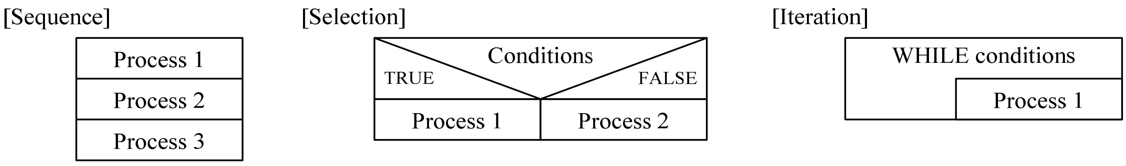
- Flowchart

  This is a commonly used method of algorithm notation. It represents processing procedures by using combinations of symbols, and has the merit of being easy to understand visually.



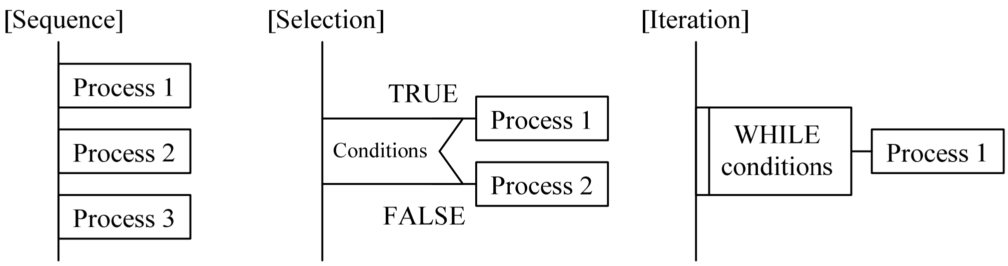
- NS (Nassi-Shneiderman) chart

  This represents the basic control structure (i.e., sequence, selection, iteration) by using quadrilaterals.



- PAD (Problem Analysis Diagram)

  This represents the logical structure of algorithms by using a tree structure.



By performing hierarchical structuring and stepwise refinement of functions through structured design, the software structure is refined in the following order: software configuration items → software components → software units (i.e., modules).
In stepwise refinement, the fulfillment of software requirements and software quality characteristics (i.e., functionality, reliability, usability, efficiency, maintainability, portability) must not be forgotten. In addition, in partitioning into software units (module partitioning), care should be taken to perform optimal module partitioning by evaluating module independence through module strength and module coupling.

2-2-2 Object-Oriented Design

Object-oriented design is an analysis/design technique based on the concepts of object orientation. Techniques for development with a focus on data, like object-oriented design, are called DOA (Data Oriented Approach) or data-oriented design. In object-oriented design, software is partitioned into components called objects, which are combined during development. This enables higher efficiency and quality in software development.

(1) Object orientation

In object orientation, objects with shared properties are collected as a class. (This process is called abstraction.) An embodiment of this class is called an instance.

Example: Class "Animals"

Name	Number of legs	Character	Cry

Instance

Cat	4	Self-centered	Meow

Dog	4	Obedient	Woof

Fig. 4-7 Class and instances

Classes are defined by data and also by the procedures (i.e., processes) for that data. This is called encapsulation, while the data is called attributes and the procedures (i.e., processes) are called methods. Encapsulation can be depicted graphically as follows:

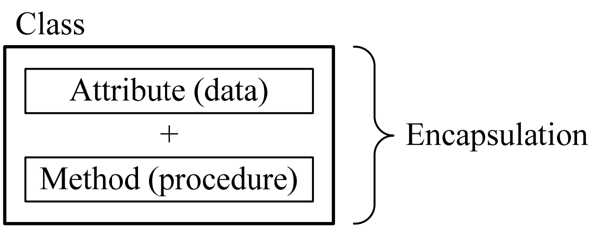


Fig. 4-8 Image of encapsulation

Through encapsulation, users need only send processing instructions (i.e., messages) to process data, without being concerned about the data. This is called information hiding.

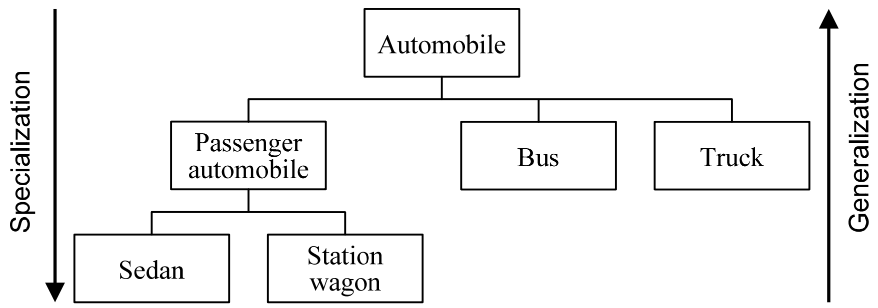
Classes can be reused in different software as components. At this time, classes can be grouped and managed as packages to facilitate reuse. Also, typical object-oriented languages, such as Java, offer APIs, which are packages that group reusable classes.

While classes can be used alone, associating multiple classes further enhances usability and others.

Class relationships (i.e., associations) in object orientation include the following:

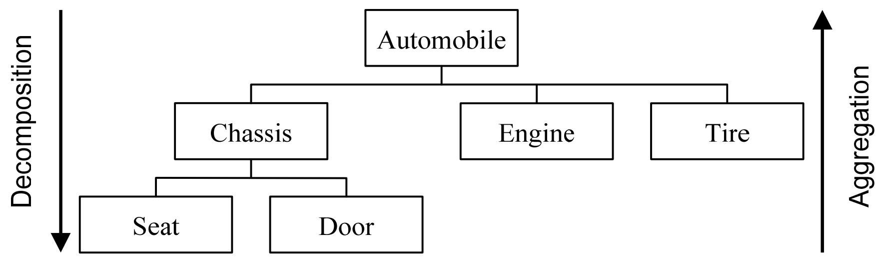
- "is-a" relationship (specialization/generalization relationship)

  This is a relationship in which sections common to several classes are extracted to define a higher-level class. The higher-level class is called a superclass and the lower-level classes are called subclasses. Extracting the common sections from multiple subclasses is called generalization; conversely, refining a superclass is called specialization.



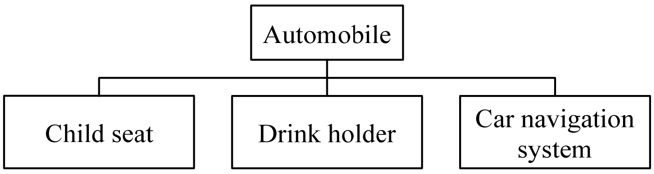
- "part-of" relationship (aggregation/decomposition relationship)

  This is a relationship in which multiple lower-level classes are aggregated to compose a single higher-level class. The development of higher-level classes into lower-level classes is called decomposition, and the grouping of lower-level classes into higher-level classes is called aggregation.



- "has-a" relationship

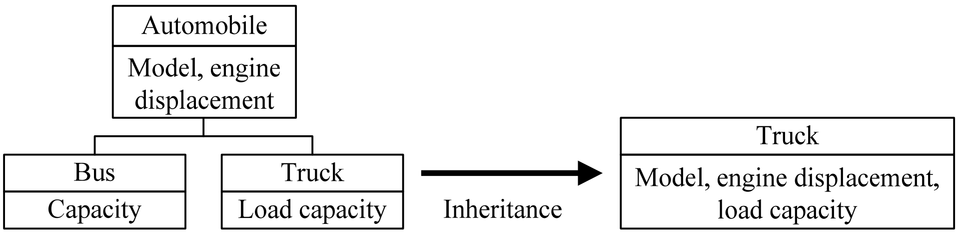
  This relationship means that a higher-level class holds a lower-level class. This relationship has almost the same meaning as the "part-of" relationship. However, they differ in that whereas the higher-level class is not possible in the "part-of" relationship if even one lower-level class is missing, it is possible in the "has-a" relationship even if multiple lower-level classes are missing.



Characteristics of object orientation include the following:

- Inheritance

  Attributes defined in an upper-level class can be passed (or inherited) to lower-level classes. Inheritance includes single inheritance from one superclass, and multiple inheritance from multiple superclasses. Inheritance does not exist in "part-of" relationships. The rewriting, by an inheriting lower-level class, of methods that are defined in a superclass is called override (redefinition).

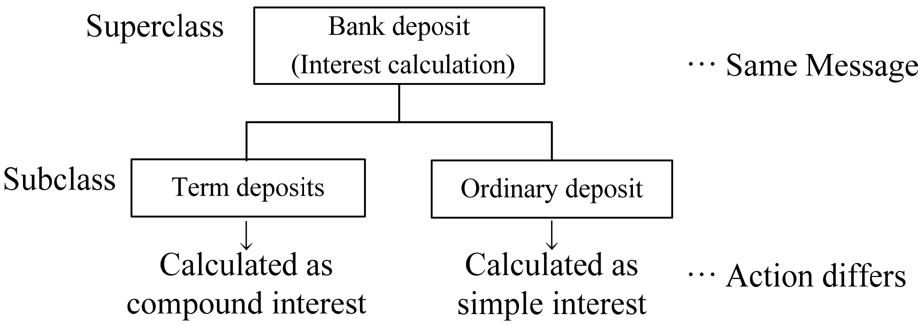


  - Differential programming

    This is a programming technique in which a superclass is inherited, and only the portions differing from the superclass are defined in the subclasses.

- Polymorphism

  This is the ability of actions (or behaviors) for a given message to differ according to the class (i.e., object). Polymorphism is implemented by override (redefinition) etc.



- Delegation

  This is the ability to delegate processing to other classes (i.e., objects).

- Propagation
  This is the ability, when operations are applied to a given class (i.e., object), to automatically apply the operations to other related classes (i.e., objects).
- Role
  It is possible to group multiple instances and define roles. Actions will change when roles differ, even for instances of the same class.

Class relationships are extremely important in object orientation. Since many attributes in object orientation are also determined by class relationships, classes and the relationships among classes are summarized as a class diagram. Class diagrams are diagrams included in the UML (Unified Modeling Language) described later.

(2) Object-oriented development model

Object-oriented development model is a spiral model-type development technique that begins with analysis/design/development of important classes, and proceeds in stages to analysis/design/development of detailed classes.

[Development phases in the object-orientated development model]

Object-oriented analysis	Object-oriented design		Object-oriented programming
	Architectural design	Class design	

(i) OOA (Object-Oriented Analysis)

This models the real world that is the target of development through object orientation (i.e., the integration of data and procedures). E-R diagrams and state transition diagrams are used in the modeling.

- E-R diagram / ER model
  These are data models that represents the targeted work as entities and relationships among entities. They are used in data modeling, and others which represents the data structures used in work.

- One fact in one place
  This is a concept in data analysis that manages one fact (i.e., information) in one place. It checks whether the same data, used in multiple tasks, is managed

under different names. In a database, one fact in one place is achieved by performing normalization.

(ii) OOD (Object-Oriented Design)

The architectural design (i.e., global design) that equates to external design in the waterfall model and the class design (i.e., local design) that equates to internal design are carried out.

(iii) OOP (Object Oriented Programming)

Object orientation is more the concept of clearly defining methods of using classes than the concept of creating programs. In this phase, class libraries (i.e., libraries for preserving created classes) and packages are referenced in order to reuse existing classes. Programming languages used include Java and C++.

- CORBA (COmmon Request Broker Architecture)

  This is a standard specification that enables message exchange among objects developed by using different programming languages in a distributed environment.

- IDL (Interface Definition Language)

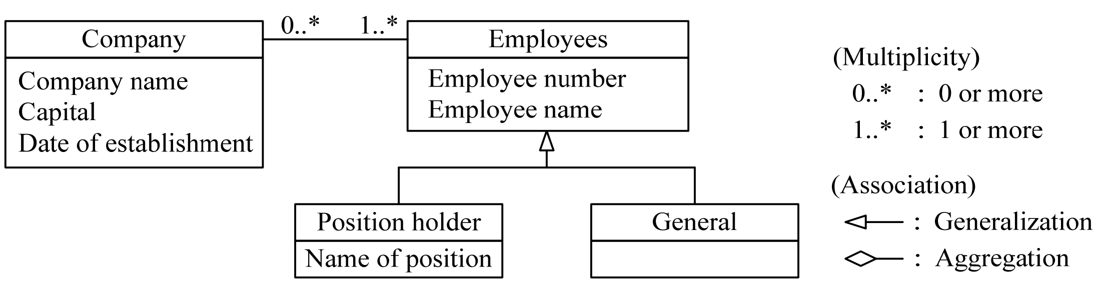
  This is a set of rules concerning interfaces for reusing created objects from other programming languages.

(3) UML (Unified Modeling Language)

UML is a standard unified modeling language approved by the OMG (Object Management Group) (a standardization body for object-oriented technologies). It is used in the notation of deliverables (e.g., specification documents) in object-oriented development, from analysis to design, implementation, and testing.

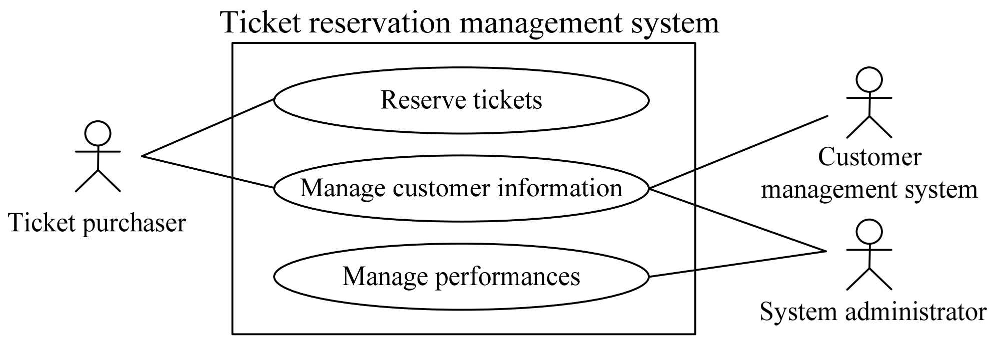
(i) Class diagram

This is a diagram that represents the relationships among classes. It describes class names, operations, attributes, multiplicity, role names, and others. It is also used as data models.



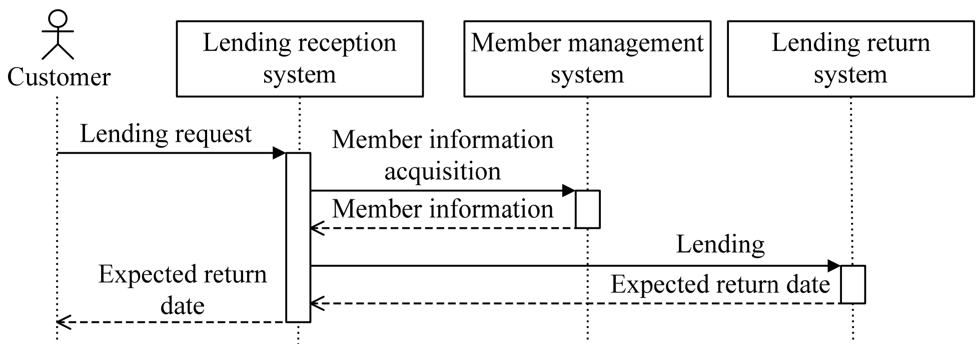
(ii) Use case diagram

This is a diagram that represents scenarios for what the system will do, from the point of view of the actors (i.e., external users or machines that will boot or exchange information with the system).



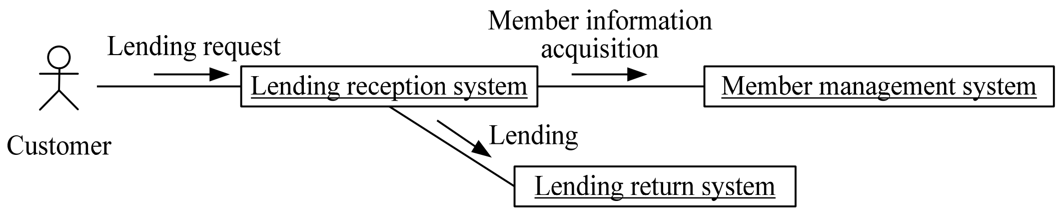
(iii) Sequence diagram

This is a type of interaction diagram (i.e., a diagram that depicts exchange of messages among objects), and represents message transmission and object lifelines in a time series.



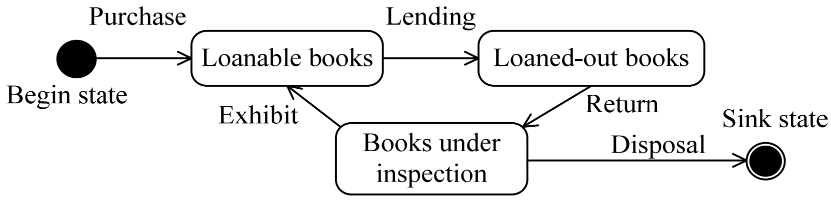
(iv) Communication diagram (collaboration diagram)

This is a type of interaction diagram that represents exchange (i.e., message flow) of messages, with a focus on objects and such others.



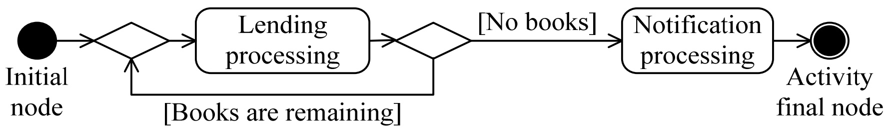
(v) State machine diagram (statechart diagram)

This is a diagram that represents the state transitions which occurs during object life cycles.



(vi) Activity diagram

This is a diagram that represents the flow of systems and work.



(vii) Component diagram

This is a diagram that represents the configuration of systems and software. In general this is a diagram that depicts software component configuration, and on the other hand, a diagram that depicts system hardware configuration is called a deployment diagram.

(viii) Object diagram

This is a diagram that represents the relationships among objects (i.e., instances).

(ix) Package diagram

This is a diagram that represents the associations among packages of grouped classes.

(x) Timing diagram

This is a diagram that represents message exchanges and the status of object lifelines that change over time.

[Other languages]

- ADL (Architecture Description Language)

  This is a language that describes the architecture (i.e., structure) of systems (i.e., software). UML can be considered a type of ADL.

- DDL (Data Definition Language)

  This is a language that defines the logical structure and names of databases.

2 - 3 Development Process

(1) SLCP-JCF (Software Life Cycle Process-Japan Common Frame)

SLCP-JCF is the Japanese version of SLCP, which is standardized by ISO/IEC as a common frame that clarifies the life cycle (e.g., development, operation, maintenance), with the aim of optimization of software development and its transactions. At present, Common Frame 2013 (SLCP-JCF2013), jointly drawn up by users, vendors, academic experts, and others in Japan, is in use.

The content of Common Frame 2013 contains ISO/IEC 12207 (JIS X 0160), which was standardized as a "common yardstick" for development work overall, in order to clarify dealings between software acquirers and providers. JIS X 0160 is a JIS standard that provides collection of defined processes necessary for smooth communication among the acquirer, provider, and other concerned parties in the life cycle of a software product. It also defines the responsibilities of the acquiring party, such as the clarification of acceptance criteria and procedures.

(2) CMMI (Capability Maturity Model-Integrated)

CMMI (Capability Maturity Model-Integrated) is a process improvement model developed at the SEI (Software Engineering Institute) at U.S. Carnegie Mellon University. It evaluates the maturity level of development processes through quality management standards that objectively indicate software development capabilities.

It evaluates capabilities as a software development organization on a scale of 1 to 5 as shown in the table below, on the basis of the results of project management practice.

Maturity level	Overview
Level 5 Optimizing	This is the level at which all persons participate in process improvements, and improvement activities become routine. Continuous improvements in processes are implemented through feedback and an innovative technology orientation.
Level 4 Quantitatively managed	This is the level at which quantitative management of processes and products is performed. Detailed quality data on processes/products is collected, and understanding and control of processes and products can be performed on the basis of data.
Level 3 Defined	This is the level at which process management is conducted organizationally. Definition and integration of management processes and development processes are conducted, and all

	projects observe documented processes.
Level 2 Managed	This is the level at which basic project management is performed. Processes for rudimentary management of schedules, expenses, and functionality are established, and process discipline exists which can repeat success experiences in the same area.
Level 1 Initial	This is the level of an organization that has not achieved Level 2. Work is performed on an ad hoc basis and is chaotic at times, with almost all processes undefined.

3 System Development Environment

A system development environment is an environment used to develop systems (or software). An appropriate system environment is necessary to perform development efficiently.

3 - 1 Intellectual Property Application Management

Intellectual property application management is the management of intellectual property rights related to system development. Intellectual property application management aims to protect a company's own intellectual property rights, and to avoid infringing on the intellectual property rights of other parties.

(1) Copyright management

In copyright management, the rights (copyrights) of the authors of works are managed. In system development, software (i.e., program) copyrights are mainly the target of management. In the case of employee works in particular, copyrights are managed so that the corporation or such other organization becomes the author as far as there are no agreements or work rules. (Refer to p.96 for more about copyrights.)
In order to protect its own copyrights, a company uses technologies that may include copy guards to prevent the duplication of works, DRM (Digital Rights Management) to protect digital data works, or activation to require license registration before use.

(2) Patent management

In patent management, applications (to the Patent Office) for patent rights to inventions newly conceived in the development process, and licensing of the use of patents held by others, are managed. Forms of licensing, such as cross-licensing and patent pools, should be considered in addition to fee-based license agreements. Furthermore, patent rights include non-exclusive licenses and exclusive licenses, and it is impossible to use a patent when an exclusive license is registered for the patent. (Refer to p.97 for more about patent rights.)

(3) License management

In license management, a company manages license agreements when it uses software for which it does not own copyright. The company must also perform management so that the number of users of the software does not violate licensing agreements. (Refer to p.113 for more about licensing agreements.) The party conferring a license is known as the licenser, and the party receiving the license is the licensee.

3 - 2 Development Environment Management

In development environment management, the hardware, software, network, development tools, and such others to be used in development are prepared (or constructed) in line with development requirements, and are appropriately managed.

(1) Development environment operating status management

In development environment operating status management, the operating status of the development environment (e.g., computer resources, development tools) is observed, and is appropriately managed for conducting efficient development.

- Resource management
  Computer resources, development tools, and other configuration management items are managed, and are prepared so that necessary resources are available when needed.
- Operations management
  The development environment is managed so as to be operated appropriately, and operating status is observed.
- Maintenance management
  The development environment is always maintained in an appropriate state. Maintenance of appropriate status does not always update the environment to the latest state, but rather periodic confirmation of operation to assure the ability to use the environment appropriately in line with objectives.

(2) Design data management

In design data management, version management, sharing management, safety management, and such others are performed for the various kinds of data (e.g., specifications documents) involved in design.

- Change history control
  The update history (i.e., versions) of the objects to be controlled is managed. In the version management system (i.e., database) for unified management of important information, various types of definition information, design information, program

information, test information, and such others are managed in a repository. In order to use the repository effectively, the format and such other of documents to be recorded is important. Recently, there is increased emphasis on design (i.e., document design) of physical/logical structure of design documents, reports, and other documents coupled with process automation and management methods. For example, there is a method of designing all documents in XML format and managing these in an XML-compatible repository by effectively using text information, diagrams, images, and such others.

- Access rights control

  Appropriate access rights are to be set and managed as required to prevent unauthorized search/removal/falsification of a company's confidential information, such as trade secrets and personal information.

(3) Tool management

In tool management, the types and versions of development tools to be used are managed for the effective development of software. Developed software carries the risk of compatibility problems, because of differences in types and versions of development tools. Moreover, the occurrence of problems, such as bugs or security holes originating in development tools, may have adverse effects on the developed software. For those reasons, it is necessary to manage the development tools used.

[Typical development tools]

- IDE (Integrated Development Environment)

  This is a general name for tools that provide integrated support for the overall development process. Typical IDEs include the OSS Eclipse and such other tool.

- Design tools (design support tools)

  These are tools to support design processes, and include support tools for various designs (e.g., screen design), database design support tools, and library management tools.

- Building tools (programming support tools)

  These are tools to support programming, and include language processors (e.g., compilers, interpreters), editors, and such others. In the way that programs created with editors are translated by a compiler, the linking of development tools (in which the output of one tool is entered into the next tool) is called a tool chain.

- Program test support tools

  Program inspection test tools (i.e., test support tools) include program static analysis tools to support static testing and program dynamic analysis tools to support dynamic testing.

- Test execution support tools

  These are test tools (i.e., test support tools) to support test implementation.

  - Stub / driver tool

    This automatically generates stubs or drivers.
  - Test data generator

    This automatically generates test data.
  - Dump

    The content of main memory and registers is written to a dump file. This type of tools includes memory dump that writes the status of main memory, and snapshot dumps that writes the status at a given time.
  - Tracer

    This traces the running state of a program. This is often used together with an inspector that writes the values of the variables used in a running program.
  - Assertion checker

    This tests the validity of programs. (This test is called assertion check.)
- Emulator

  This is a tool (i.e., a microprogram-based tool) that creates a virtual environment including a different OS or such other software, in which programs made for other computer types can be executed.

  - ICE (In-Circuit Emulator)

    In microprogram development, this emulates microprocessor functions through hardware.
- Simulator

  This is a tool that simulates the actions of programs.
- CASE (Computer Aided Software Engineering) Tools

  CASE refers to a group of software to aid the processes of system development.

Upstream CASE tool	This primarily supports design.
Downstream CASE tool	This primarily supports implementation (building) and testing.
Maintenance CASE tool	This primarily supports operation/maintenance.
Integrated CASE tool	This provides integrated support for all development processes.

- VDM (Virtual DOS Machine) Tool

  This is a development support tool for VDM, one of the formal methods (i.e., methods that rigidly describe according to formal specification language to enhance software quality).

Use of these development tools can promote EUC (End User Computing), by which users actively engage in system development, and EUD (End User Development), by which users themselves perform system development. For example, integrated CASE tools or such others are used in RAD (Rapid Application Development), by which users participate in development work from an early stage. EUC is a general name for the use of spreadsheet software, database software, and such other application software to execute work, and the technologies or methods to achieve this.

(4) License management

In license management, the number of target software installations and licenses held are regularly checked and verified with understanding of the content of the licenses, and management is performed to avoid violation of licensing conditions (e.g., unauthorized copying of software and other unauthorized usage).

[Points of caution for license management]

- Software installation information, hardware configuration information, network configuration information, and such others are collected from clients and are recorded in databases by using inventory collection functions and such other functions to accurately assess usage status.
- The number of licenses is accurately assessed by performing inventory taking and such other control.
- Since using different versions of software can violate licensing conditions, software version management is also to be conducted.

3 - 3 Configuration Management and Change Control

3-3-1 Configuration Management

The purpose of the configuration management process is to establish and maintain the integrity of all identified outputs of a project or process and make them available to concerned parties.

[Activities/tasks of configuration management process (Common Frame 2013)]

(i) Configuration management planning

- Define a configuration management strategy
- Identify items that are subject to configuration control

(ii) Configuration management execution
- Maintain information on configurations
- Secure configuration baselines

SCM (Software Configuration Management) is specialized as a software configuration management process. In this process, configuration identification system, or what combination of SCI (Software Configuration Items) composes the software as a whole, is established, and management methods for the configuration identification system are set.

3-3-2 Change Management

Change management refers to the software configuration management process activities/tasks, in which changes to software configuration items are centrally managed and reflected in configuration management.

[Activities and tasks related to change control]

(i) Configuration control

Identification and recording of change requests, analysis and evaluation of changes, approval or rejection of change requests, and implementation, verification, and release of modified software items are performed.

(ii) Recording of configuration status

The number of times changes are made in a project, the latest version, migration (or release) status, and such others are documented as management records and status reports.

(iii) Evaluation and assessment of integrity of configuration items

The functional completeness (e.g., consistency, accuracy) and the physical completeness (e.g., whether the latest technical descriptions are reflected) of software items are determined and guaranteed.

(iv) Release management and delivery (or shipment)

The release and delivery of software products and documentation are formally controlled. Master copies of the delivered items are maintained, with version management, for a period of retention equal to the lifespan of the software product, which is based on SLCP (Software Life Cycle Process).

4 Web Application Development

Web application development is the development of web applications used in the web services on the Internet. Since these presume use of the Internet, they may require technology differing from that of general software development.

4 - 1 Web Applications

Web application is a general name for software used in web services. In general, this often means software that runs on the web servers that compose web systems and provide services to web clients.

Web systems are client/server systems in which web clients make a processing request to web servers that provide web services. However, in the case of web systems that use databases, 3-tier client/server systems are often used. The system configuration of 3-tier client/server systems uses web browsers at the presentation layer, application servers (web servers) at the function layer, and database servers at the database access layer. Using an application server as the web server facilitates adaption to system changes or enhancements.

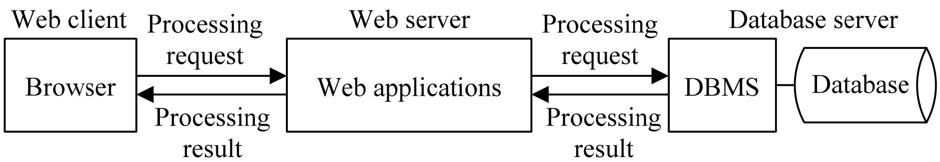


Fig. 4-9 Web system configuration

A web server launches and executes web applications in response to processing requests from web clients (i.e., browsers). This mechanism is known as CGI (Common Gateway Interface), and the web applications that run on web servers are sometimes called CGI programs.

Web applications receiving processing requests use database servers as required. At this time, a processing request from a web application is passed as SQL statements to a database server, which in turn returns the execution result of the SQL statements to the web application. Then, the web application returns HTML document, dynamically generated from the received result of executing the SQL statements, to the browser, which displays the HTML document.

Web applications executed on the web server side, as in this example, are called servlets. Conversely, web applications downloaded to and executed by the web client are called applets, and the feature by which such applets are downloaded to and executed by web clients as necessary is called rich clients.

4 - 2 Web Application Development

In web application development, depending on usage conditions, web design and security technologies may be necessary in addition to general software development technologies.

(1) Server-side programming

Server-side programming is the development (i.e., programming) of web applications that run on web servers. Programming languages, such as Java, PHP, and Perl, are often used in server-side programming.

In addition to general programming points of caution, security measures are emphasized in server-side programming. In particular, in the case of a website or other use by a large number of anonymous users, secure programming is required to create programs that implement various security measures and have no security holes (i.e., software vulnerabilities).

(2) Web design

Web design is the logical design of a website overall. Web design strives for not only technical design but also "user-friendly" design, in consideration of "ease of use (web usability)" and "ease of access (web accessibility)."

The validity, efficiency, and satisfaction demanded by web usability is evaluated by experts through heuristic evaluation, by test subjects (i.e., users) through usability testing, and other means.

(3) Other related technologies

- SOAP (Simple Object Access Protocol)
  This is a protocol in which web applications cooperate by exchanging messages described in XML. Web applications that can be used from outside via SOAP may be called web services.
- Ajax (Asynchronous JavaScript + XML)
  This is a mechanism by which browsers and web servers transmit and receive XML-format data without synchronizing, to dynamically redraw screens. This mechanism enables redrawing of only necessary portions of a web page, without screen transitions.
- RSS (RDF Site Summary)
  This is an XML-based document format that enables structuring and writing of metadata, such as page headlines, summaries, and update time. It enables efficient information collection and communication on web sites.

Chapter 4 Exercises

Q1

In system development, which of the following is the process that clarifies configuration items at the top level of a system?

a) System integration process
b) System installation process
c) System architectural design process
d) System requirements definition process

Q2

Among the software quality characteristics defined by ISO/IEC 9126 (JIS X 0129-1), which of the following is an explanation of reliability?

a) The capability of the software product to maintain a specified level of performance when used under specified conditions
b) The capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions
c) The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions
d) The capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions

Q3

Which of the following is the deliverable that can be obtained as the result of software architectural design?

a) A specification document for system architectural design
b) A specification document for software integration test
c) A specification document for software qualification test
d) A document for software requirements definition

Q4

Among module partitioning techniques, which of the following is a technique that partitions input functions, conversion functions, and output functions according to data flow, and makes each into a module?

a) STS partitioning
b) Common functional partitioning
c) Jackson method
d) Transaction partitioning

Q5

As a measure of module independence, it can be said that the weaker the module coupling, the higher the level of module independence becomes. Which of the following is the coupling with the highest module independence?

a) Common coupling
b) Stamp coupling
c) Data coupling
d) Content coupling

Q6

Which of the following is an appropriate explanation of a code auditor?

a) It verifies whether the created source code fulfills the criteria that are set in advance.
b) It displays a menu of candidate names for a variable when the name of the variable is being entered.
c) It creates programs by using a combination of three basic structures.
d) It displays the input command in color according to the type of the command.

Q7

A program has the complex conditions below.

Condition 1 OR (Condition 2 AND Condition 3)

When testing is performed on the basis of the decision condition coverage (i.e., branch coverage), test coverage is not fulfilled by executing only (1) and (2) of [Completed test items] shown below. Which of the following is the most appropriate test item to be added?

[Completed test items]

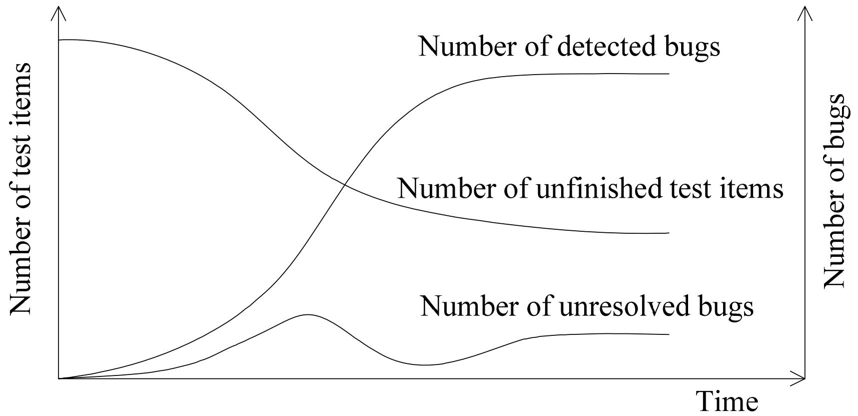
(1) Condition 1 is TRUE, Condition 2 is FALSE, and Condition 3 is FALSE

(2) Condition 1 is FALSE, Condition 2 is TRUE, and Condition 3 is TRUE

	Condition 1	Condition 2	Condition 3
a)	FALSE	FALSE	TRUE
b)	TRUE	FALSE	TRUE
c)	TRUE	TRUE	FALSE
d)	TRUE	TRUE	TRUE

Q8

In program testing, all lines become flat, as shown in the graph below. Which of the following is the testing status that can be surmised from this graph?



a) The project faces bugs that are difficult to resolve, and subsequent testing is not progressing.

b) The number of finished test items is increasing, and bugs no longer occur.

c) There are many bugs, and the number of finished test items is no longer increasing.

d) The rate of occurrence of bugs matches the rate of the finished test items, and there are no more unresolved bugs.

Q9

Which of the following is an appropriate description of top-down testing?

a) It is required to create drivers that function as lower-level modules.
b) Since higher-level modules are used repeatedly in testing, the reliability of higher-level modules is enhanced.
c) Since testing is conducted from both higher-level modules and lower-level modules, programming and testing can be conducted in parallel from the initial stage of development.
d) When a problem occurs in the interface among modules, it is difficult to identify the locations of the causes of the problem.

Q10

Since the sales tax was changed after the delivery of an invoice issuing system, maintenance was implemented to revise the sections concerned with invoice amount calculation. What is this sort of maintenance called?

a) Remote maintenance
b) Corrective maintenance
c) Adaptive maintenance
d) Daily maintenance

Q11

Which of the following is an appropriate explanation of the software development model known as the waterfall model?

a) Design, development, and testing of applications are carried out and repeated on a part-by-part basis.
b) Since software development progresses in order of phases, software development efficiency considerably declines at the occurrence of rework.
c) An executable trial model is created, and requirements specifications are confirmed and evaluated at an early development stage.
d) Software is developed in a short period of time by a small group of people through the active participation of users and the use of development tools.

Q12

Which of the following is a method that improves software quality by starting programming at an early stage to enhance programming and testing, instead of spending time to create a high-quality design document?

a) XP (eXtreme Programming)
b) Test-driven development
c) Pair programming
d) Refactoring

Q13

Which of the following is an appropriate combination of the components of the diagramming method known as HIPO?

a) Model, View, Controller
b) Sequence, Selection, Iteration
c) Visual table of contents, summary diagram, detailed diagram
d) Data flow, process, data store

Q14

In object orientation, which of the following is the characteristic by which attributes defined in a superclass are passed to subclasses?

a) Inheritance
b) Override
c) Delegation
d) Polymorphism

Q15

Which of the following is an appropriate explanation of a UML sequence diagram?

a) This is a diagram that represents the relationships among objects and is used for the purpose of organizing message interactions in a time series.
b) This is a diagram that represents state transitions in objects and is used for the purpose of organizing object life cycles.
c) This is a diagram that represents system functions as viewed externally and is used for the purpose of organizing functional requirements through requirements definition,

and so on.

d) This is a diagram that represents the relationships among classes and is used for the purpose of organizing data relationships.

Q16

Which of the following is a development tool that writes the values of the variables used in a running program, for the purpose of tracing program execution?

a) Assertion checker
b) Inspector
c) Emulator
d) Memory dump

Q17

In software development, which of the following is a problem that originates in configuration management?

a) Multiple versions of the same program exist, and the latest version that should be modified cannot be identified.
b) Test data (i.e., data that is used in the real working environment) that is used in development is discovered through search by a party that is not meant to see the data, and is leaked to the outside.
c) There is a request for improvement of a program delivered several years earlier, but the development environment from that time is not maintained, and the request cannot be responded.
d) In software qualification testing, there are many bugs at the software unit testing level, and development is not proceeding on schedule.

Chapter 5

Project Management

1 Project Management Overview

A project refers to fixed-term activities that are initiated irregularly in order to produce or provide a unique product or service. Project management refers to the management (i.e., control and administration) carried out in order to lead a project to its success.

1 - 1 Objective and Concept of Project Management

The purpose of project management is to meet the requirements of the project and lead it to its success. For this, in addition to knowledge, skills, and tools, techniques that make use of these are employed, and management is performed through a PDCA cycle that involves planning (Plan), proceeding (Do) with activities according to the plan, verifying the differences between the plan and actual result, and taking action (Act) against the cause of differences.
A project has the following constraints, and its characteristics are summarized as shown in the table below.
[Project constraints]

Quality	Quality standards that the project and the deliverables are required to meet
Cost	Budget that can be used in the project
Delivery	Date of delivering the deliverables

[Project characteristics]

Uniqueness	Unique deliverables are created.
Temporariness	The period from the initiation until the termination is decided.
Resource finiteness	The usable resources and the cost are decided.
Stepwise refinement	Uncertain elements are clearly identified by refining in a stepwise manner.

There are various types of projects including system development projects for developing a system, new product development projects for planning and producing a new product, and new business projects for planning and developing a new business. In all projects, in order to obtain the final deliverable (i.e., product), a shipment process for creating the product and a support process for supporting the creation of the product are implemented in addition to the project management process.

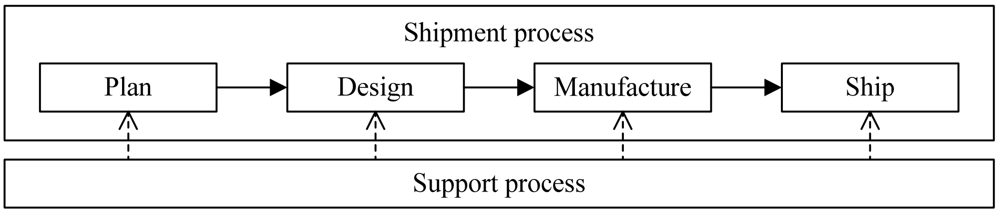


Figure 5-1 Shipment process and support process

(1) Project influence elements

The following elements influence the execution of a project. The project constraints are decided on the basis of these influence elements.

- Project environment

  This is the internal environment factors and external environment factors encompassing the project that may impact the success of the project. The project environment corresponds to such factors as the organization culture or system, national standards or industry standards, human resources or personnel management, and market situation or political situation.
- Stakeholder

  This is an organization or individual having interests in the activities of the project. The stakeholder corresponds to the organization/enterprise, employees, shareholders, creditors, customers, suppliers (or vendors), local community, and governmental agencies that form the main constituents of a project.
- Project life cycle

  This is the life cycle from the initiation of a project until its end, which includes the predictive type, iterative type, incremental type, and adaptive type.

  [Characteristics of a general project life cycle]

Starting the project	The cost is low and staff members are few.
Organizing and preparing	The cost and the staff members increase gradually.
Carrying out the project work	The cost and the staff members reach the peak.
Closing the project	The cost and the staff members fall rapidly.

- Project governance

  This is the governance (i.e., rule) of a project that is consistent with the governance of the organization. It is implemented through the project life cycle.

(2) Project team

The project team (i.e., team executing the project) consists of a project manager and project members.

- Project manager
  This is the leader who leads a project to its success. A project manager is required to have competency (i.e., behavioral characteristics) in terms of knowledge, practical ability (i.e., execution capability), and human qualities (i.e., leadership, communication, negotiation, conflict management, motivation).
- Project members
  This is the staff members engaged in a project. In the organizational structure of a project, the project members are required to have the self-management capabilities to appropriately perform activity planning, progress management, quality management, cost management, risk management, change management, problem discovery/problem reporting, measures planning, documentation, and communication.

(3) Organizational structure of project

The organizational structure of a project refers to the project organization system and the project management support system as shown below.

- PBO (Project-Based Organization)
  This is the project organization system. PBO is one of the management organizations and is classified into the following three types:

Functional organization	An organization formed within the affiliated department. The authority of the project manager is the weakest.
Matrix organization	An organization formed by members belonging to several departments. It is classified into a weak matrix organization, a balanced matrix organization, and a strong matrix organization.
Projectized organization	An organization initiated as a dedicated department of the project. The authority of the project manager is the strongest.

- PMO (Project Management Office)
  This is a department or group that supports (or performs direct management of) project management by performing consolidated management or coordination of several projects. It may be thought of as a PMO (Program Management Office) specialized as

a project.

Supportive	Project support is performed. The extent of control is low.
Controlling	Compliance is required along with project support. The extent of control is mid-level.
Directive	Direct management and control of the project are performed. The extent of control is high.

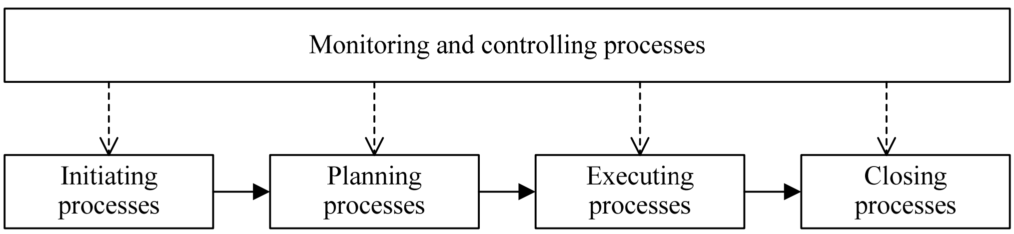
1 - 2 Project Management Implementation Method

In many cases, the following guidelines (i.e., international standards) are used as the standard for implementing project management. When these guidelines are applied, tailoring (i.e., corrections/adjustments) must be performed in response to the characteristics of the project.

- PMBOK (Project Management Body of Knowledge)
  This is a guide to the body of knowledge concerning project management that is issued by PMI (Project Management Institute).
- ISO 21500
  This is a comprehensive guideline on project management that is published by the ISO (International Organization for Standardization).

(1) Process groups

In PMBOK and ISO 21500, the project management processes (hereinafter, processes) that must be implemented in project management are classified into five process groups according to the flow of the project life cycle.



Process groups	Overview
Initiating process group	Definition of project outcome, deliverables, and range
Planning process group	Activity planning and scheduling for achieving the objectives

Implementing process group [Executing process group]	Implementation [or execution] of the projects or the processes
Controlling process group [Monitoring and controlling process group]	Progress management and monitoring, and evaluation/improvement
Closing process group	Arrangement of deliverables and closing of the project or contract

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(2) Subject groups (knowledge areas)

According to PMBOK and ISO 21500, a process is classified into the following 10 subject groups [knowledge areas] according to the applicable resources.

Subject group (Knowledge area)	Main objects to be managed
Project integration subject [Project integration management]	Overall project activities
Project scope subject [Project scope management]	Scope (e.g., deliverables)
Project time subject [Project time management]	Schedule
Project cost subject [Project cost management]	Budget/cost
Project quality subject [Project quality management]	Quality policies and quality objectives
Project risk subject [Project risk management]	Project risks
Project stakeholder subject [Project stakeholder management]	Interested parties
Project resource subject [Project human resource management]	Human resources/physical resources Note: PMBOK describes human resource only.
Project procurement subject [Project procurement management]	Procurement of external resources
Project communications subject [Project communications management]	Project information

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

In PMBOK and ISO 21500, processes are compiled together on the basis of a table (i.e., process map) configured by process groups and subject groups. (For example, in the initiating process, the "project charter development" process is implemented for the project integration subject.)

In this textbook, the typical processes are explained in order from the viewpoint of management implemented in each subject group on the basis of PMBOK and ISO 21500.

2 Subject Group Management

This section describes the purposes and typical processes of the subject groups (knowledge areas) related to quality, cost, and delivery, which are the project constraints, while focusing on the subject group management.

2 - 1 Project Integration Management

The purpose of project integration management is to identify, define, combine, unify, and coordinate the processes and the project management activities of each subject group.
In order to define, control, and manage the overall project management activities, the following processes are implemented.

Process groups	Process to implement
Initiating	Develop project charter
Planning	Develop project plans [Develop project management plan]
Implementing [Executing]	Direct project work [Direct and manage project work]
Controlling [Monitoring and controlling]	Control project work [Monitor and control project work]
	Control changes [Perform integrated change control]
Closing	Close project phase or project [Close project or phase] Collect lessons learned

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Development of a project charter

In this process, a project charter is developed on the basis of the project statement of work that describes the products expected from the project and the environmental factors or process assets of the organization body. The project charter is a document that declares the initiation of a project that is formally approved by the organization.

[Descriptions included in the project charter]
Purpose and validation of the project, objectives and success criteria of the project, needs and requirements (i.e., requirements concerning the outcome of the project) of

stakeholders, pre-requisites and constraints concerning the organization and related institutions, the overview and scope of the project, risks of the project, an overview of the overall schedule (i.e., summary milestone schedule), approximation of the overall budget (i.e., summary budget), responsibilities and authorities of the appointed project managers, a list of stakeholders, the approver and proponent (initiator) of the project charter, and so on.

In order to create the project charter, techniques such as feasibility study are used, in which investigation and verification are conducted to determine the execution possibility concerning the decision and facilitation of experts, and planning of a new business or a new project.

(2) Development of project management plan

From the project charter, subsidiary plans (i.e., basic rules such as planning, methods, and effective measurement methods) for management are developed, other than project integration management. The auxiliary plans are aggregated with the performance measurement baseline (i.e., scope baseline, schedule baseline, cost baseline) that are defined in the processes of other subject groups, and integrated into the project management plan.

[Descriptions included in the project management plan]
Project life cycle and applicable processes, tailoring items (e.g., clarification of processes, execution level of each process, techniques and tools to use), method of implementing change control (e.g., change management plan), method of communicating with stakeholders, method/content and scope/implementation period of problem resolution, and method of implementing activities for achievement of the objectives, and so on

(3) Integrated change control

This process performs centralized control of the change requests (corrective actions, preventive actions, and defect corrections) concerning the project and maintains the integrity of the project. The feasibility of a change request is decided on the basis of the decision of an expert or the reviews conducted in meetings, and it is approved by the project manager or CCB (Change Control Board). The approved change request is soon implemented, and the entire series of actions concerning the change request are described in a change directory. It must be noted that the project management plan and related project documents are also updated according to the change content.

(4) Closing of a project or a project phase

In order to close a project or a project phase (i.e., the project category controlled for acquiring important deliverables), all processes described in the project management plan is closed, and then the project or the project phase is formally completed.

The project that is completed because the objective of the project is accomplished, performs a transfer (e.g., a delivery) of the final deliverable (product) and project asset management (e.g., update of process assets). On the other hand, for a project that is closed (or aborted) because the objective of the project could not be accomplished, a material is developed in which the cause or reason of failure and the background details are described. In both cases, as the formal documents indicating the completion of the project, a project completion report and a closing report for the project or the project phase are developed.

Also, the lessons learned through the implemented project is compiled as a "Lessons learned document" for use in future projects and project phases, and is registered in the learning knowledge base.

2 - 2 Project Scope Management

The purpose of project scope management is to clarify of the activities necessary for the execution of the project without any deficiencies or excess, and to control them in order to make the project a success.

The following processes are implemented to define and control the items necessary to make the project a success.

Process groups	Process to implement
Initiating	–
Planning	Define activities [Plan scope management, Collect requirements]
	Define scope
	Create WBS (Work Breakdown Structure)
Implementing [Executing]	–
Controlling [Monitoring and controlling]	Control scope [Validate scope, Control scope]
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Development of scope management plan

This process develops a scope management plan which describes the methods for performing scope definition, validation check, and control on the basis of the requirements that is described in the project charter, and the project management plan and the subsidiary plans. (Scope refers to the deliverables and the scope of work for obtaining the deliverables.) At the same time, the process develops a requirements management plan which describes the methods for performing analysis and documentation of the requirements. The scope management plan is a guideline for scope management, and is expected to have effect of reducing the risks that arise from the scope creep (i.e., changes made without performing control).

(2) Definition of a scope

This process clearly identifies the deliverables and the activities necessary for achieving the deliverables as the deliverable scope and the project scope.
In order to achieve this, first of all, the requirements of the stakeholders are collected according to the requirements management plan, and then the collected requirements are documented as a requirements document. (There is also a concept to make this activity independent as a requirements collection process.) By using the scope definition methods specified in the requirements document and the scope management plan, the project scope is defined and a project scope statement is developed.

> [Descriptions included in the project scope statement]
> Deliverable scope description, project deliverables and acceptance criteria, items excluded from the project, and project pre-requisites and constraints.

(3) Creation of WBS (Work Breakdown Structure)

WBS (Work Breakdown Structure) is a hierarchical structure diagram in which the activities necessary for achieving the purpose of the project are divided in a stepwise fashion with the deliverables as the main constituent. On the basis of the project scope statement, the project deliverables are subdivided (or decomposed) into the work package, which is the lowest component. The work package is divided into more detailed activities and used when the cost and schedule are estimated.

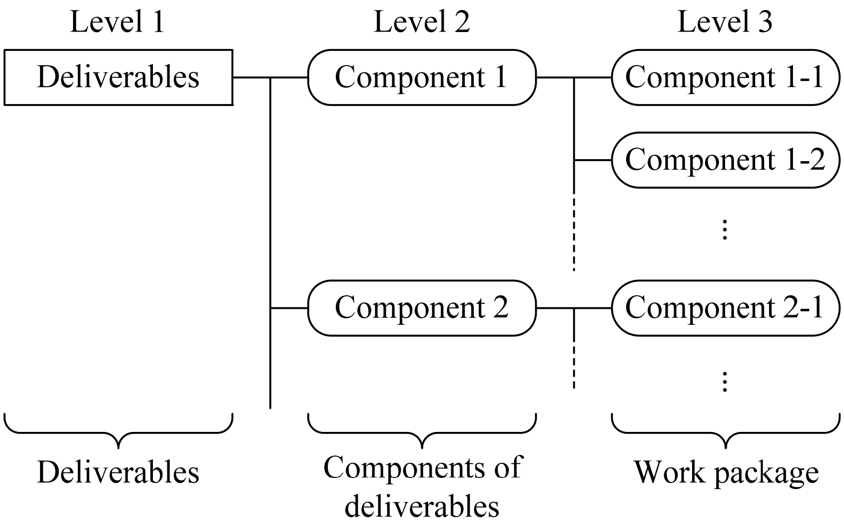


Figure 5-2 Example of WBS (WBS with three-level hierarchy)

The result of WBS creation is documented as the scope baseline. The scope defined as the baseline is used as the monitoring and controlling decision criteria in the project life cycle.

[Components of scope baseline]

- Project scope statement (output of scope definition)
- WBS
- WBS dictionary:

  A supplementary document describing the details of WBS components (e.g., the work package)

(4) Scope control

This process monitors the status of the deliverable scope and the project scope on the basis of the scope baseline that is integrated into the project management plan, and controls the changes made to the scope (or the scope baseline). During monitoring, variance analysis is performed for the progress information (i.e., performance) of project activities and the scope baseline, and the cause and extent of the difference are checked. On the other hand, concerning the change requests for the scope (or the scope baseline), the integrated change control decides and approves the requests, and applies the changes.

2 - 3 Project Time Management

The purpose of project time management is to clarify and control the schedule for completing the project within the defined period.

The following processes are implemented for setting up and controlling the schedule.

Process groups	Process to implement
Initiating	–
Planning	[Plan schedule management]
	[Define activities]
	Sequence activities
	[Estimate activity resources]
	Estimate activity durations
	Develop schedule
Implementing [Executing]	–
Controlling [Monitoring and controlling]	Control schedule
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Schedule management plan

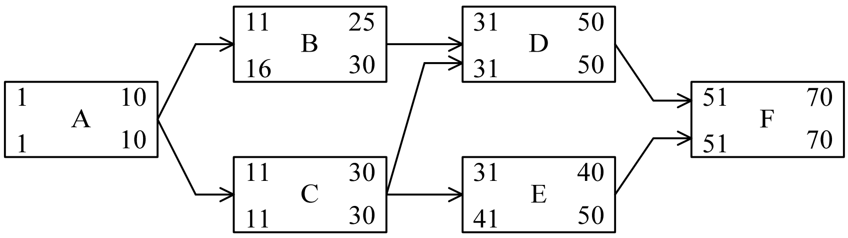
This process creates a schedule model (e.g., the scheduling method and the tools used) and a schedule management plan that describes the performance measurement method on the basis of the overview of the overall schedule (i.e., summary milestone schedule) described in the project charter and the project management plan and the auxiliary plan.

(2) Definition of activities / sequencing of activities

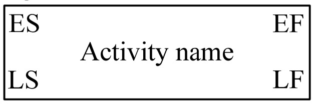
During activity definition, an activity, which is the unit obtained by further refinement of the work package that is the lowermost hierarchy of WBS, is clearly identified.
To achieve this, by using the activity definition level that is specified in the scope baseline (or WBS) and the schedule management plan, the work package is refined into activities, and an activity list is developed. At the same time, the milestones are identified, which act as important points of time in the work process (e.g., the start date/end date, or review date of the work process) that has an important meaning in the project, and then a milestone list is created.
The activities that are clearly identified through activity definition are arranged on the basis of a logical order relation with the help of an arrow diagram and PDM (Precedence Diagramming Method), and integrated into a project schedule network diagram. At this time, the following two dependencies are also decided: a lead during which a later activity can be started ahead of schedule without waiting for an earlier activity to complete, and a lag during which the start of a later activity is delayed even when an earlier activity is completed.

• PDM (Precedence Diagramming Method)

It is a technique used in CPM (Critical Path Method) according to which activities are represented through quadrangles and the logical order relation between activities is represented through arrows.



[Legend]:



ES : Earliest Start Date EF : Earliest Finish Date

LS : Latest Start Date LF : Latest Finish Date

Note: The duration and the lead time may also be specified.

(3) Estimate of activity resources

This process estimates the resources (e.g., staff members, devices, materials) that are required for executing each activity. On the basis of the resource calendar that is created through project human resource management and project procurement management or the activity cost estimate that is performed through project cost management, the type and quantity of the required resources are documented as an activity resource request list. Also, a RBS (Resource Breakdown Structure) is developed in which the resources to be used are classified hierarchically according to the category and the type.

(4) Estimate of activity durations

This process estimates the duration that is required for executing each activity when the expected resources are used. The basic concept of estimating the duration is "Duration = Man-hours ÷ Number of staff members," but in order to improve the accuracy, various estimation methods are combined together.

• Analogous estimate

This is a technique of relative estimate on the basis of the performance of a similar project in the past.

• Parametric estimate

This is a technique of estimate in which the past information is statistically analyzed and various coefficients are determined.

• Three-point estimate

This is a technique of estimate in which the optimistic value, the pessimistic value, and the mode (average) value are used.

- Reserve analysis

  This is a technique of estimate in which a reserve (i.e., buffer) is provided beforehand.

(5) Development of a schedule

This process creates a master schedule, an intermediate schedule (e.g., activity schedule by process), and a detailed schedule (e.g., weekly activity schedule) by using the scheduling method defined in the schedule management plan on the basis of the activity list, the activity resource requirements and resource calendar, and the estimate of activity durations.
During schedule development, schedule network analysis is performed by using the following techniques, and then various schedules are created.

- PERT (Program Evaluation and Review Technique)

  This is a technique that makes use of an arrow diagram. (Refer to p.59 for details.)
- CPM (Critical Path Method)

  This is a technique that makes use of an arrow diagram and PDM (Precedence Diagramming Method), and the basic concept is almost the same as PERT.
- Critical chain

  This is a technique by which schedule correction is enabled in order to meet the end date with limited resources by adding an activity (i.e., buffer) that does not involve actual work.
- Resource leveling

  This is a resource optimization technique by which the amount of usage of specific resources is maintained at a constant level.
- Schedule compression

  This includes techniques such as crashing in which the schedule is compressed by introducing resources such as staff members and cost, and fast-tracking in which the schedule is compressed through subdivision/parallel execution of specific activities and by proceeding with the succeeding process in parallel before the completion of the previous process.

The result of schedule development is documented as the schedule baseline. The schedule defined as the baseline is used as the decision criteria during monitoring and controlling. The schedule thus created is compiled in a Gantt chart that is used to manage the progress status by drawing horizontal bars representing the activity schedule (i.e., plan) and actual values on the upper and lower bars, and in a trend chart in which is used to perform the cost management and the progress management by representing and comparing the schedule and actual result of milestones through a line graph.

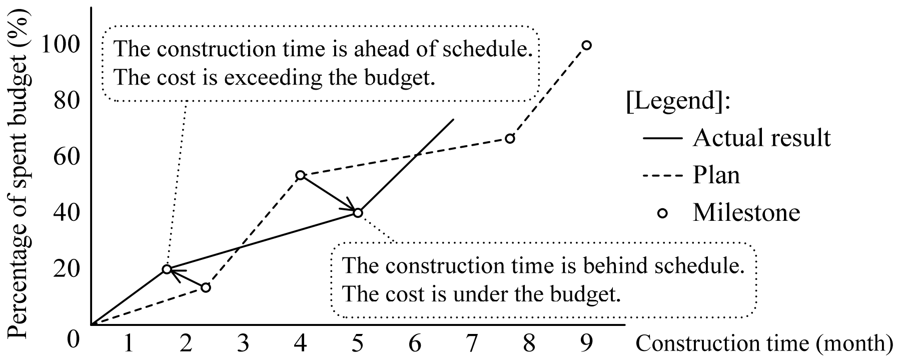


Figure 5-3 Example of a trend chart

(6) Control of the schedule

This process monitors and understands the progress status (i.e., schedule) of the project, and if there is a significant delay or an unexpected event has occurred, the changes are determined or approved through integrated change control, and the schedule is quickly readjusted (or the schedule baseline is changed).

The progress status of the schedule is understood by performing variance analysis of the activity performance data (e.g., the start status, work status, the completion status of an activity) created on the basis of the progress report that is submitted by the project members by using techniques such as EVM.

- EVM (Earned Value Management)

  This is a technique of quantifying and evaluating the progress of a project and the productivity (i.e., performance) of activities on the basis of the value of the amount of work completed (normally converted to the amount of money).

  [Basic indicators of EVM]

  - PV (Planned Value)

    This is the amount (i.e., cost) assigned to each activity during planning.
  - EV (Earned Value)

    This is the amount (i.e., cost) originally assigned to an activity completed at a recent point in time.
  - AC (Actual Cost)

    This is the cost that was actually required for an activity completed at a recent point in time.

  [Performance indicators of EVM]

  (1) Performance indicators of progress

- SV (Schedule Variance)

  This is an indicator of the difference as seen from the viewpoint of the schedule of each activity. If it is more than 0, the progress of the project is ahead of the schedule.

  $SV = EV - PV$

- SPI (Schedule Performance Index)

  This is an index of the efficiency as seen from the viewpoint of the schedule of each activity. If it is more than 1, the work efficiency is good; that is, the progress of the project is ahead of schedule.

  $SPI = EV \div PV$

(2) Performance indicators of productivity

- CV (Cost Variance)

  This is an indicator of the difference as seen from the viewpoint of the cost of each activity. If it is more than 0, the productivity is high.

  $CV = EV - AC$

- CPI (Cost Performance Index)

  This is an index of the efficiency as seen from the viewpoint of the cost of each activity. If it is more than 1, the cost efficiency is good; that is, the productivity is high.

  $CPI = EV \div AC$

2 - 4 Project Cost Management

The purpose of project cost management is to clarify and control the budget spending plan for completing the project within the defined budget.

The following processes are implemented for setting up and controlling the budget spending plan.

Process groups	Process to implement
Initiating	–
Planning	[Plan cost management]
	Estimate costs
	Develop budget [Determine budget]
Implementing [Executing]	–
Controlling [Monitoring and controlling]	Control costs
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Cost management plan

This process creates a cost data format (e.g., the effective number of digits, measurement unit, control threshold) and a cost management plan that describe the performance measurement method, on the basis of the overview of the overall budget that is described in the project charter (budget summary), and on the basis of the project management plan and the subsidiary plans.

(2) Cost estimate

The cost required for executing each activity is estimated. As compared with the approximation of the cost calculated initially, the accuracy of cost estimate improves with the progress of the project. (In PMBOK, the estimate accuracy during the initiating stage is between −25% and +75%, and the estimate accuracy during the stage when the detailed information is collected is between −5% and +10%.)

The main item of project cost management is the cost necessary for completing the project activities, but it is desirable to take into consideration the cost that arises after the project ends. For example, in the case of a system development project, not only the cost of development, but also the TCO (Total Cost of Ownership), including the cost of operations/maintenance after system installation and the cost of staff member training, must be taken into consideration.

Cost estimate involves the use of techniques, such as analogous estimate, parametric estimate, three-point estimate, and reserve analysis. In analogous estimate, the differences in the work package and activities that are refined stepwise are reflected on the basis of the performance of a similar project in the past. Therefore, it is also called top-down estimate. In contrast, there is bottom-up estimate, such as integration method in which the cost of the work package and activities keeps on adding up.

The other cost estimate techniques include the following. These techniques are also used in the activity duration estimate.

- COCOMO (COnstructive COst MOdel)
  It is a technique of estimating the development cost and the development man-hours by calculating the workload (i.e., development productivity) of the programmers through a statistical model on the basis of the software development size (e.g., the number of program steps). The statistical model includes elements such as the estimation target level (e.g., overview, regular, detailed) and the composition of work force (e.g., single experts group, common group, mixed group). Currently, there has been a shift to COCOMOII.
- FP (Function Point) method
  This is a technique of estimating the development cost and the development man-hours with the help of the software functions that are obtained from the number of screens

and the number of forms. The files or forms to be processed by the software that is to be developed are divided into the following five function types on the basis of the method of processing, then adjustments are made depending on the complexity and the characteristics, and the FPs (Function Points) are calculated. After that, the software size and the development man-hours are estimated.

Function type name	Overview
External input	Type and total amount of input data
External output	Type and total amount of output data
External inquiry	Type and total number of inquiries from outside
Internal logical file	Type and total number of files associated with access
External interface file	Type and total number of related interfaces

- LOC (Lines of Code) method

  This is a technique of estimating the development cost and the development man-hours on the basis of the number of lines of the source code of the software to be developed, the file size, and so on.

- Standard task method

  This is a technique of estimate in which the software development activities are broken down into standard activities, and the points (e.g., the man-hours and the cost) defined in each standard activity are integrated.

- Putnum model

  This is a model that takes into consideration the time series variation in the development man-hours, and is a technique of estimate in which the development cost and the development man-hours are estimated from the performance data of a past development project.

(3) Development of budget

This process creates a budget spending plan including the cost of resources as a cost baseline on the basis of the result of cost estimate. Since a cost baseline is represented as a graph in which the estimation cost is deployed in time series and built-up, the baseline generally results in an S-curve. During cost control, variance analysis is performed on the basis of EVM with the cost baseline as the reference, and the development productivity and the percentage of cost budget spent are managed. If the difference concerning the cost baseline is too great, it is necessary to consider changing the cost baseline to a realistic standard.

2 - 5 Project Quality Management

The purpose of project quality management is to clarify of the quality of the project and products, and to control the project in order to satisfy the quality. Use CMMI (Capability Maturity Model-Integrated) as the quality standard of the project and the software quality characteristics of ISO/IEC 9126 (JIS X 0129) as the quality standard of the products.
In order to achieve the purpose of the project and the quality desired by the stakeholders, the following processes are implemented in conformity to the ISO 9000 (JIS Q 9000) series (i.e., standard concerning the quality management system).

Process groups	Process to implement
Initiating	–
Planning	Plan quality [Plan quality management]
Implementing [Executing]	Perform quality assurance
Controlling [Monitoring and controlling]	Perform quality control [Control quality]
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Quality management plan

On the basis of the project management plan, the subsidiary plans, and the requirements document, the quality requirements or quality standards concerning the project and the products are specified. Then, a quality management plan is developed which describes the quality policies, quality objectives, and quality plan for securing the quality level. The quality management plan also includes activities towards continuous process improvements.
The following techniques and tools are used in quality management planning.

- QFD (Quality Function Deployment)
  This is a technique used to clarify the requirements concerning the products and services, and deploy them in specifications needed to develop the products and services meeting those requirements.
- COQ (Cost of Quality)
  This is the total cost of quality. The cost of quality is on the basis of the concept called "Prevention over Inspection" according to which "The cost of preventive action for a defect is much less as compared with the cost of corrective actions." Moreover, in the case of the waterfall model, the cost of correcting a defect that occurs at an early stage (e.g., design process) is more than the cost of correcting a defect that occurs at a later

stage (e.g., the programming process).

- Seven QC Tools

  These are the quality control techniques and include Pareto chart, histogram, scatter diagram, control chart, stratification, check sheet, and cause-and-effect diagram. (Refer to p.77 for details.)

- Benchmark (benchmarking)

  This is a technique of identifying the best practice of a project that is being executed (or under planning), or examining an improvement plan by comparing it with a similar plan.

(2) Quality assurance

In order to achieve the quality requirements and quality standards that are defined during quality management plan, the quality assurance activities are implemented according to the quality management plan.

The quality assurance activities are also implemented in an integrated manner by setting up a specialized department. Moreover, in order to perform continuous process improvement by repeatedly performing quality improvement of all processes, comprehensive support is necessary.

In quality assurance, in addition to the techniques and tools that are used during quality management planning, the following techniques and tools are used.

- New Seven QC Tools

  These are the quality control techniques and include affinity diagram, association diagram, matrix diagram, matrix data analysis, arrow diagram, tree diagram (logic tree), and PDPC (Process Decision Program Chart). (Refer to p.77 for details.)

- Quality audit

  In this technique, a third party investigates and evaluates systematically whether the project conforms to the quality policies, the processes, and the procedures. During quality audit, the implementation status of already-approved change requests is checked, which includes corrective actions, preventive actions, and defect correction.

- Process analysis

  The process analysis examines the problems and contradictions, and worthless activities that occur during the execution of processes, and identifies the improvement plans necessary in the process.

(3) Quality control

This process monitors, according to the quality management plan, if the quality requirements and quality standards that are defined during quality management planning are achieved. In addition, the monitoring results are recorded, and if there is a quality defect in a process or a product, the action plans are made and implemented in order to identify and remove the cause. In quality control, the same techniques and tools as during quality management planning and quality assurance are used. Also, the inspection is performed to see if the result of activities conforms to the quality standards. The inspection is performed onto the activity results and final deliverable (e.g., product) of each activity unit. The results of inspection and the records of detected failures are documented as a failure report, and the failures are dealt by either corrective actions or defect correction. At this time, the result of the corrective action or defect correction is confirmed by an inspection.
In a software (or system) development project, a review (e.g., walk-through, inspection) and a test (e.g., a unit test, join test, qualification test) are included in the inspection. The review execution time and the number of tested items (or coverage rate), which are included in the results, are part of the quality management indexes or indicators of software. Also, it must not be forgotten that during quality management, not only the system and software, but also various documents need to be managed.

2 - 6 Project Risk Management

The purpose of project risk management is to clarify and control the risks (i.e., uncertain events that exert either a positive or negative influence) hidden in the project.
The following processes are implemented in order to increase the number of risks that exert a positive influence and reduce the number of risks that exert a negative influence.

Process groups	Process to implement
Initiating	–
Planning	[Plan risk management]
	Identify risks
	Assess risks [Perform qualitative risk analysis] [Perform quantitative risk analysis]
	[Plan risk responses]
Implementing [Executing]	Treat risks
Controlling [Monitoring and controlling]	Control risks

Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Risk management plan

This process specifies the risk management methods (e.g., techniques and tools) and the risk category in a project, and prepares a risk management plan, on the basis of the project risks (i.e., high-level risks) that are described in the project charter, the project management plan, and the subsidiary plans. In the risk category, a RBS (Risk Breakdown Structure) is prepared in which stepwise refinement of risks is performed in order to classify and organize the risks.

(2) Risk identification

This process identifies the risks that affect the project on the basis of the management plan and the project documents (e.g., various estimates, baselines) that are created in each process, and creates a risk register describing the characteristics of each risk. If an executable risk treatment can also be identified during risk identification, it must also be listed in the risk register.
The following techniques are available for collecting information for risk identification.

- Brainstorming
  This is a technique to uncover and reveals the project risks by exchanging opinions freely and openly with the project team and external expert groups.
- Delphi method
  This is a technique to identify (or create an agreement on) the project risks by repeatedly collecting, summarizing, and redistributing the opinions of several experts through questionnaires.

The following risk identification techniques are available.

- Checklist analysis
  The risks are identified by cross-checking against a checklist prepared by compiling together the expected risks on the basis of the information and knowledge accumulated from similar projects in the past.
- Monte Carlo method
  The risks are identified by performing several simulations or numerical analyses that make use of probability distribution and random numbers.
- Assumptions analysis
  The risks that occur as a result of inaccurate, incomplete, and unstable assumptions are

identified by checking the validation of the assumptions of the project.

(3) Qualitative risk analysis / quantitative risk analysis

In these analyses, the identified risks are analyzed, and each risk assessment is performed. (For example, the priority for risk response and the risk acceptance/permission are assessed.)
In qualitative risk analysis, a priority order is given to the risk on the basis of the occurrence probability (or the occurrence frequency) of the risk and the extent of impact during the time of risk being actualized, and thereafter, the risk is listed in the risk register.
In quantitative risk analysis, the accuracy is improved by performing a detailed analysis starting from the risk with a high priority order, the effect of the risk is quantified into amount of money, hours, and number of persons, and this is described in the risk register.

(4) Risk response plan (risk treatment plan)

A risk response plan is created to increase the number of risks that exert a positive influence (i.e., opportunities) and reduce the number of risks that exert a negative influence (i.e., threats). The response to risks that exert a positive influence includes "utilization, sharing, and enhancement" and the response to risks that exert a negative influence includes "avoidance, transfer, and mitigation." However, a response called "risk acceptance" is applicable for both types of risks.
A contingency plan (emergency response plan) is also set up as a measure in cases where a threat with a particularly large impact has manifested itself.

(5) Control of risks

Risk response is implemented according to risk response planning. At this time, a follow-up check of the identified risks is performed, and the residual risks are monitored. If there is a possibility of intervention of new risks along with the progress of the project, the risks are identified and appropriate measures are taken. The series of activities are controlled and the effectiveness of risk management is evaluated.
Since the risk environment changes with time and situation, it is desirable to repeatedly perform risk management according to the PDCA cycle.

2 - 7 Management of Other Subject Groups

2-7-1 Project Stakeholder Management

The purpose of project stakeholder management is to clearly identify the stakeholders (i.e., interested parties: individuals, groups, and organizations affected by, or affecting the project) and to perform control so as to build and maintain a favorable relationship with the stakeholders. The following processes are implemented in order to proceed smoothly with the project while a favorable relationship is built and maintained with the stakeholders.

Process groups	Process to implement
Initiating	Identify stakeholders
Planning	[Plan stakeholder management]
Implementing [Executing]	Manage stakeholders [Manage stakeholder engagement]
Controlling [Monitoring and controlling]	[Control stakeholder engagement]
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Identification of stakeholders

This process identifies the stakeholders and the impact that the stakeholders bring about on the basis of the project charter, and creates a stakeholder register. The identified stakeholders are classified on the basis of the authority and the interest level, the authority and the participation level, the participation level and influence, and the salience model (which classifies stakeholders by using three factors: power, urgency, and legitimacy).

(2) Stakeholder management plan

A plan is drafted for encouraging the identified stakeholders to effectively participate in the project, and a stakeholder management plan is developed. At this time, a stakeholder engagement (active participation in the project) is analyzed, which forms an important element for leading the project to its success, on the basis of five stages namely Unaware, Resistant, Neutral, Supportive, and Leading.

(3) Stakeholder engagement management

A favorable relationship with the stakeholders is built and maintained under the responsibility of the project manager according to the stakeholder management plan. At this time, the content of the information transmitted to the stakeholders and the transmission means conform to the communications management plan that is created in project communication management. By improving stakeholder engagement, it is expected that the project will be supported and the risks caused by the stakeholders will be reduced.

2-7-2 Project Resource Management

The purpose of project resource management is to clarify of the resources necessary for achieving the purpose of the project, and to control the resources. In addition to human resources such as staff members like the project manager and the project members, the project management team (team that performs management activities within the project), and organization systems such as PBO (Project-Based Organization) and PMO (Project Management Office), resources include physical resources such as devices, equipment, material, software, and hardware. In project resource management, these resources are estimated and arranged appropriately without any excess or deficiency.

In PMBOK, the following processes are implemented as project human resources management in order to perform control concerning human resources.

Process groups	Process to implement
Initiating	Establish project team
Planning	Estimate resources Define project organization [Plan human resource management]
Implementing [Executing]	[Acquire project team]
	Develop project team
	[Manage project team]
Controlling [Monitoring and controlling]	Control resources Manage project team
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Human resource management plan

This process creates a human resource management plan (i.e., a subsidiary plan) that is composed of "roles and responsibilities," "project organization chart," and "staff members management plan" on the basis of the content that is described in the project management plan.

(2) Establishment of a project team / development of a project team

The members who are necessary for completing the project are collected according to the human resource management plan, and a project team is started. In order to enable the project team to exhibit sufficient performance, the ability of the project team is developed and enhanced.

[Project team organization]

- Chief programmer team

  Staff members such as programmers, backup programmers, and a librarian are assigned under the chief programmer, and the development work progresses under the guidance of the chief programmer.
- Specialist team

  Several technical specialists from specialized fields assist one chief programmer who creates all programs.

2-7-3 Project Procurement Management

The purpose of project procurement management is to acquire or purchase the resources necessary from outside of the project team for executing the project. In addition to outsourcing and system integrator, the methods of utilization of external resources include co-sourcing, which is a form of outsourcing in which the outsourcee and the outsourcer perform their work at equal positions and distribute the profits, and IDC (Internet Data Center), which is a data center specializing in Internet connections.

The following processes are implemented in project procurement management. As for the actual procurement procedures, the acquisition processes of Common Framework 2013 are commonly applied. (Refer to p.222 for details on the procurement procedures.)

Process groups	Process to implement
Initiating	–
Planning	Plan procurements [Plan procurement management]
Implementing [Executing]	Select suppliers

	[Conduct procurements]
Controlling [Monitoring and controlling]	Administer procurements [Control procurements]
Closing	[Close procurements]

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Procurement management plan

This process specifies the procurement standard (i.e., supplier selection criteria) and procurement contract type, and create a procurement management plan. Also, it is necessary to prepare various procurement documents: the procurement statement of work that defines the scope of activities for procurement; RFI (Request For Information), RFP (Request For Proposal), and RFQ (Request For Quotation) that are used during procurement; and such other documents.

[Procurement contract type]

- Fixed price contract (lump-sum contract)
  The supplier provides products and services at a fixed remuneration up to the specified deadline. Since the amount is fixed, there is less risk to the acquirer.
- Cost-reimbursable contract
  The supplier adds a profit to the cost and charges the acquirer. Since the total cost is not clear at the time of the contract, the risk to the acquirer is high.
  - Cost plus fixed fee contract
    In this type of contract, a fixed profit (i.e., fixed fee) is added to the cost.
  - Cost plus incentive fee contract
    In this type of contract, an incentive that is in response to the objectives accomplishment level is added to the cost.
- T&M contract (Time and material contract)
  The supplier charges the acquirer an amount obtained by multiplying the actual work time and the amount of resources used with the unit value set for the time and the material. Since the total cost is not clear at the time of the contract, the risk to the acquirer is high.

2-7-4 Project Communications Management

The purpose of project communications management is to control the communication with the stakeholders and the communication within the project team by appropriately performing the tasks from generation of information up to its disposal in the project.

The following processes are implemented in project communications management.

Process groups	Process to implement
Initiating	–
Planning	Plan communications [Plan communications management]
Implementing [Executing]	Distribute information [Manage communications]
Controlling [Monitoring and controlling]	Manage communications [Control communications]
Closing	–

Note: The terms enclosed in brackets [ ] are used only in PMBOK.

(1) Communications management plan

This is the process of creating a communications management plan and setting the stakeholders' requirements, along with the information/language/format/content/detailing to be conveyed, and the communication methods.

[Communication methods]

- Interactive communication (bidirectional communication)
  This is a method in which information is exchanged mutually between two or more parties, such as meetings, conversations, and video conferences. Since this results in a feedback loop in which opinions are mutually exchanged, it is also called feedback communication.
- Push communication
  This is a method of distributing information to specific recipients who need to receive the information. Push communications include letters, e-mails, voice mails, reports, faxes, and such others.
- Pull communication
  This is a method of obtaining information at recipients' discretion from websites on the Internet or the Intranet and from printed materials such as newspapers and magazines. It is used when there are many unspecified recipients or a large amount of information.

(2) Communications management

Generation, collection, distribution, storage, and search of information is performed effectively in a project according to the communications management plan. In particular, when information such as project performance and deliverables is distributed to stakeholders, it is necessary to make efforts to convert the scope, schedule, cost, and quality into an easy-to-understand format. The feedback of the stakeholders concerning information distribution is utilized in performance correction and process improvement of the project.

Chapter 5 Exercises

Q1

Which of the following is a characteristic that is common to many project life cycles and is the highest during the implementation of the activities of the project?

a) Extent of influence of stakeholders
b) Uncertainty of the project
c) Required number of staff members for the project
d) Risk of not being able to achieve the objectives

Q2

Which of the following is an appropriate item that is described in the project charter?

a) Performance measurement baseline
b) Causes and background of project discontinuation
c) Change requests concerning the project
d) Purpose and validation of the project

Q3

Which of the following is an appropriate purpose of using WBS (Work Breakdown Structure) in a project of software development?

a) To estimate the development cost and manage it intensively
b) To discover the critical path at an early stage and manage it intensively
c) To divide the activity into smaller segments by using the top-down method, and simplify the management of activities
d) To create an activity schedule in consideration of usable resources

Q4

In a project, an activity that an experienced employee can complete in one day, can be completed in two days by a general employee. When a new employee who is not yet familiar with the work performs the same activity, it takes six days to be completed. Which of the following is a technique to estimate the period that is required for the activity as three days by the expression that is described below?

Estimate of the duration that is required for the activity = $(1 + 2 + 6) \div 3 = 3$ days

a) Parametric estimate
b) Three-point estimate
c) Reserve analysis
d) Analogous estimate

Q5

In a project, the performance management is conducted through EVM. Which of the following is the expression of the condition where the progress of the project is behind schedule?

a) $EV - AC > 0$
b) $EV - AC < 0$
c) $EV - PV > 0$
d) $EV - PV < 0$

Q6

The following table shows the number of measurements and the weighting coefficient of each function type on the basis of the FP (Function Point) method of an application program. What is the number of function points of this application program? Here, the correction coefficient of complexity is 0.75.

Function type name	Number of measurements	Weighting coefficient
External input	1	4
External output	2	5
Internal logical file	1	10
External interface file	0	7
External inquiry	0	4

a) 18
b) 24
c) 30
d) 32

Q7

When the activities of project quality management are classified into quality plan, quality assurance, and quality control, which of the following is an appropriate activity of quality assurance?

a) Deciding on the method for removing the cause of occurrence of unsatisfactory results for the quality standards that is defined in the project
b) Performing planned and systematic activities to ensure the fulfillment of the quality standards that is defined in the project
c) Inspecting whether or not the performance results of the project conform to the defined quality standards
d) Setting appropriate quality standards for the performance results of the project, and defining the procedures to satisfy the standards

Q8

Which of the following is a technique to identify project risks by repeatedly collecting, summarizing, and redistributing opinions from several experts?

a) Qualitative risk analysis
b) Delphi method
c) Brainstorming
d) Monte Carlo method

Q9

The table below shows the relationship between preparation activities *A* through *E* for an event, the standard number of persons in charge for each activity, and the number of days required for each activity. On the basis of this table, preparation activities were started 35 days ago, but because of other activities only one staff member was assigned for the first 20 days. In order to perform the remaining preparation activities in time for the event, what is the minimum number of staff members that must be assigned per day? Here, each preparation activity has a manual, therefore, anyone can perform any activity and the activities can be performed in parallel.

Preparation activity	Standard number of staff members	Required number of days
A	2	5
B	2	5
C	3	10
D	2	5
E	5	10

a) 4 b) 5 c) 6 d) 7

Q10

In a project, the project manager sends a report that contains the project performance to specific stakeholders through e-mail. Which of the following is the communication method that is implemented by the project manager?

a) Interactive communication
b) Feedback communication
c) Push communication
d) Pull communication

Chapter 6
Service Management

1 Overview of Service Management

Services are offered to fulfill the requirements of the customers. Service management refers to management for efficiently and continuously offering the service.

1-1 Purpose and Concept of Service Management

Service management is a set of capabilities and processes to direct and control the service provider's activities and resources for the design, transition, delivery, and improvement of services to fulfill the requirements of the customers.

Service refers to the means that are used by the service provider for delivering value for the customer by facilitating results that the customer wants to achieve. Service is generally intangible and can also be delivered to the service provider by a supplier, an internal group, or a customer acting as a supplier. An IT-based service is especially called IT service, and management of IT service is called IT service management.

For fulfilling the service requirements of the customer and for increasing customer satisfaction, it is necessary to clearly define the service value that is required by the customer. For that, the service provider prepares an SLA (Service Level Agreement) that contains an SLR (Service Level Requirement), such as the type of service provided, service quality (e.g., availability, reliability), service time, response time of service, performance of service process, and security. Service level agreement is a documented agreement between the service provider and the customer. (It is sometimes included in contracts.) It identifies the service and the service targets and describes the following.

Item Number	Item	Contents
1	Establishment	Provider and user of the service
2	Scope	Name of the service to be delivered
3	Review and change	Arrangement regarding review or change of service level
4	Service to be delivered	Explanation of the service to be delivered
5	Delivery time	Time period of delivering the service
6	Organization	Explanation concerning various notifications such as communication or inquiry/maintenance Policy of priority scheduling in service delivery
7	Contact details	Emergency contact method or contact details in the event of occurrence of fault, etc.

8	Security	Explanation of security and scope of responsibility of security
9	Targets and evaluation	Definition of targets and evaluation of service level, and explanation of evaluation procedure
10	Charging	Definition and explanation of billing at the time of using the service
11	Exclusion of liability (scope of responsibility)	Explanation of matters that are excluded from the scope of responsibility in the agreement

1 - 2 Establishment and Improvement of Service Management System

Service management system refers to the management system that the service provider uses for directing and controlling the service management activities. Related standards include the ISO/IEC 20000 (JIS Q 20000) family as follows:

Standard name	Overview
ISO/IEC 20000-1 (JIS Q 20000-1)	Service management system requirements
ISO/IEC 20000-2 (JIS Q 20000-2)	Guidance on the application of service management systems

In service management systems, as a conformity assessment system of the IT service management system, there is the ITSMS (Information Technology Service Management System) certification system that uses the requirements of the ISO/IEC 20000 (JIS Q 20000) family as the certification criteria. In this system, process approach (i.e., policy of comprehensive operations management of the system by understanding mutual relationship by using all activities as processes) based on a PDCA methodology is applied for the service management system and improvement process.

Cycle	Process	Overview
Plan	Plans of service management	Plan for implementation and execution.
Do	Implementation of service management	Implement objectives and plans.
Check	Monitoring, measurement, and reviewing	Evaluate the achievement of objectives and plans.
Act	Continual improvement	Improve effectiveness and efficiency.

The ITSMS certification system recommends the establishment of ITSMS with the following four steps.

[Step 1: Gap analysis]
The service provider uses BIP0005/PD0015 (i.e., checklist for the operations manager describing the overview of service management) to investigate the current status of service management and identifies gaps between the current status and the requirements. The service provider defines requirements for correcting these gaps and prepares an establishment plan for the service management system.
[Step 2: Establishment of service management system]
The service provider forms the service management organization including the management team and clarifies responsibilities regarding service quality. Furthermore, in order to be able to perform the operational management of a service appropriately, the service provider plans the documentation of operation methods/manuals and the training of the operations manager.
[Step 3: Implementation of service management plan]
The service provider prepares and implements a service management plan including targets of service management, processes and roles/responsibilities of members, methods of monitoring, evaluation and improvement of service quality, and process improvement cycle of service management.
[Step 4: Implementation of service management processes]
The design and transition of new or changed services and the service management processes are implemented on the basis of the service management plan.

1 - 3 ITIL

ITIL (Information Technology Infrastructure Library) is a guidebook that systematically summarizes the best practices for efficiently delivering and managing IT services. Its contents have become the de facto standard of IT service management.

(1) ITIL v2

ITIL v2 is composed of two books of service support and service delivery that were released in the beginning of 2000, which contains the collection of books of ITIL published since 1998.

[Structure of ITIL v2]

- Service support

It refers to day-to-day operations management that is performed for the entire IT service. Service support is composed of one function and five processes.

Function/process	Overview
Service desk	Point of contact and support for users of IT service
Incident management	Quick recovery from fault and minimizing the impact
Problem management	Countermeasures for incident and preventive action
Configuration management	Maintenance and management of information related to configuration of IT service
Change management	Change management related to configuration of IT service
Release management	Application of changes related to configuration

- Service delivery

It refers to medium- and long-term operations management of overall IT service between the IT service provider and the customer, in which the business strategy is considered. Service delivery is composed of five processes.

Process	Overview
Service level management	Management of IT service level
IT service financial management	Management of cost and profit of IT service assets
Capacity management	Resource performance management of IT service
Availability management	Availability management of IT service environment
IT service continuity management	Continuity plan and management of IT service business

(2) ITIL v3

ITIL v3 is service management that is systematically organized from the standpoint of service life cycle in 2007. (It was updated to ITIL 2011 edition in 2011.)

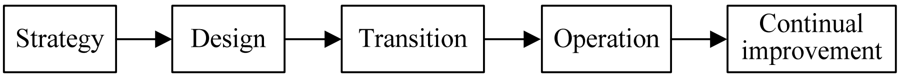


Figure 6-1 Service life cycle

[Structure of ITIL v3]

- Service strategy (strategy)
  The service provider decides the policy of the organization and the goals to be achieved related to the service.
- Service design (design)
  The service provider prepares the contents, operation method, and transition plan of the service.
- Service transition (transition)
  The service provider implements a new service or modifies the existing service.
- Service operation (operation)
  The service provider operates the service and delivers value to the customer.
- Continual service improvement (continual improvement)
  The service provider applies the PDCA cycle and improves the service.

Correspondence between ITIL v2 and ITIL v3 is as shown below. Roles of the processes, which have identical (or almost identical) names in ITILD and ISO/IEC 20000 (JIS Q 20000), can be considered to be almost the same.

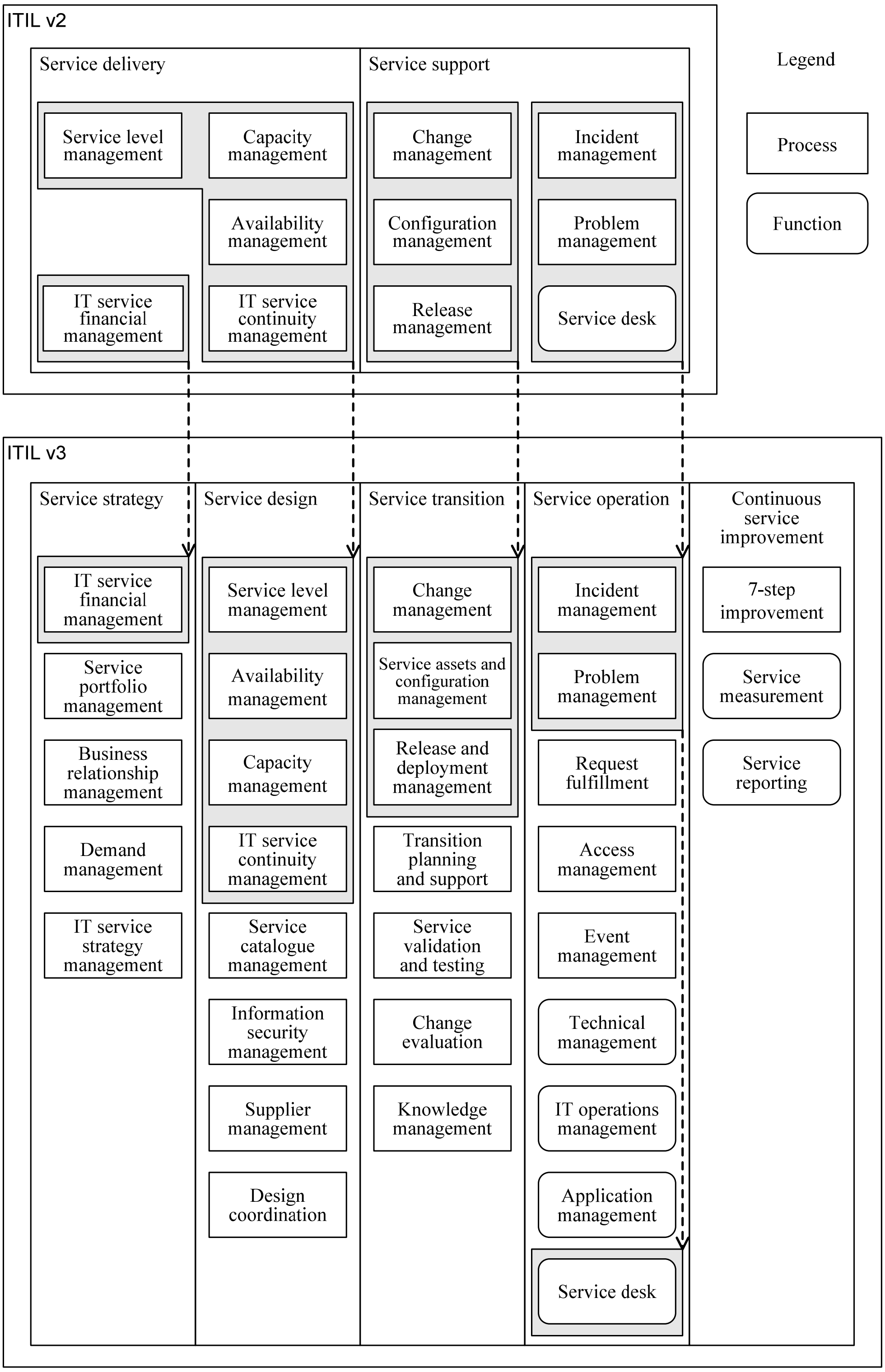


Figure 6-2　Correspondence between ITIL v2 and ITIL v3

2 Method of Service Management

In service management, management is performed that focuses on the service and the operation of information system that is used in service delivery. This chapter explains the method of service management considering ITIL on the basis of service management using ISO/IEC 20000 (JIS Q 20000).

2 - 1 Service Design and Transition

Service design and transition refers to preparing a plan for a new service or changing the existing service, designing and developing the service (or information system that delivers the service) according to the plan, and transiting it to the live environment (i.e., operational environment).
ISO/IEC 20000 (JIS Q 20000) defines the following procedure as "design and transition of new or changed service" regarding service design and transition.

[Design and transition of new or changed services (excerpted from ISO/IEC 20000 (JIS Q 20000)]

1) Plan of new or changed services
2) Design and development of new or changed services
3) Transition of new or changed services

2-1-1 Plan of New or Changed Services

In the plan of a new service or a changed service, the service provider identifies the service requirements of the customer and prepares a plan that fulfills the requirements. The planning must be agreed on with the customer and the interested parties (i.e., stakeholders).

[Matters that are included or referred to in the planning of a new or changed service]

- Authorities and responsibilities for design, development, and transition activities
- Activities to be performed by the service provider and other related parties
- Communication with interested parties
- Human, technical, information, and financial resources
- Timescales for planned activities
- Identification, assessment, and management of risks
- Testing required for new or changed services

- Service acceptance criteria
- Expected outcomes from delivering the new or changed services, etc.

2-1-2 Design and Development of New or Changed Services

In design and development of new or changed services, requirements of the identified services are defined as functional requirements or non-functional requirements, and services (or system that offers the services) that fulfill the requirements are designed, and they are documented in a service design document. After that, services (or system that offers the services) are developed according to the service design document.

[Matters that are included in design and development of new or changed services]

- Authorities and responsibilities for delivery of the new or changed services
- Activities to be performed by the service provider, the customer, and other related parties
- New or changed requirements concerning human resources and financial resources
- New or changed technology
- New or changed plans and policies
- New or changed contracts and other documented agreements (e.g., SLA)
- Updates to the catalogue of services
- Procedures, measures to be used for the delivery of the new or changed services

2-1-3 Transition of New or Changed Services

In transition of new or changed services, an acceptance test is conducted against the service acceptance criteria to verify whether the service requirements are fulfilled or not. When the services are approved in verification, an operational test is conducted in the live environment (or simulated operating environment), and a transition decision is made in terms of whether to deploy or not. As a result, when the operation and system transition are decided, a transition plan is prepared and deployed in the operating environment. Here, before transition, the service provider conducts a transition rehearsal (i.e., transition test), and checks the transition procedure and problems following transition from security and efficiency standpoints. When transition is completed, the service provider notifies the concerned parties about the transition and conducts the handover of operations and transition evaluation including operational service level agreement, and so on.

The following types of transition methods are available.

- Parallel transition

  In this method, for a certain period, the new system runs in parallel with the existing system. This is useful for systems where high reliability and availability are required, and systems that are likely to be severely affected at the occurrence of a fault. It costs more because two systems run in parallel.
- Phased transition (transition by office / transition by business operation / sequential transition)

  In this method, an old system is partially replaced with a new system, and both the old and the new systems are operated in the unit of an office, business operation, and so on. While it costs less than parallel transition, new and old system components co-exist temporarily, and when a problem occurs, it may be difficult to identify the problem.
- Big bang transition

  In this method, the entire system is replaced all at once. While it costs less than parallel transition, there is a risk that when a problem occurs, it may have a widespread impact.

2 - 2 Service Management Processes

In ISO/IEC 20000 (JIS Q 20000), service management processes are classified into four processes.

[Classification of service management processes]

1) Service delivery processes
2) Relationship processes
3) Resolution processes
4) Control processes

2-2-1 Service Delivery Processes

Service delivery processes are a group of processes for the service provider to deliver services that fulfill the customer requirements in a safe and continuous manner.

[Group of processes of service delivery processes]

1) Service level management
2) Service reporting
3) Service continuity and availability management
4) Budgeting and accounting for services
5) Capacity management

6) Information security management

(1) SLM (Service level management)

In SLM (Service Level Management), a PDCA cycle is used to maintain and manage the service level requirements (SLR) mentioned in the service level agreement (SLA).

In service level management, the service provider monitors trends and performances against service targets at planned intervals. Monitoring results are recorded and reviewed to identify the causes of nonconformities and the opportunities for improvement. As a result of the review, if nonconformity of service level is identified, it is required to review SLA or processes and promptly make improvements by preparing the service improvement plan. (Changes made for making improvements are managed with the change management process.)

In addition, in service level management, a service catalogue is also managed. The service catalogue include a "business service catalogue" that conveys types and functions of services to the customer and a "technology service catalogue" that tells the service provider staff members how the services are delivered. Another important role of service level management is to agree on the service catalogue with the customer and maintain consistency with services and SLA. In ITIL, management of service catalogue is made independent as "service catalogue management."

(2) Service reporting

In service reporting, the service provider produces a service report by using the information from the delivery of services and the service management processes, and then agrees with the interested parties about the report description. The service provider makes decisions and takes actions to improve services and deal with the problems on the basis of the findings in the service report.

[Description of service report]

- Performance against service targets
- Relevant information about significant events including major incidents (i.e., events that inhibit the service) and deployment of new or changed services
- Workload characteristics including volumes and periodic changes in workload
- Detected nonconformities against the service requirements and their identified causes
- Trend information
- Customer satisfaction measurements, service complaints, and results of the analysis of satisfaction measurements and complaints.

(3) Service continuity and availability management

In service continuity and availability management, under normal conditions and conditions after service interruption, the service provider implements the requirements regarding service continuity and availability as agreed with the customer.
For continuing the service, the service provider prepares, implements, and maintains a service continuity plan. Service continuity planning includes recovery procedures to be implemented in the event of a major loss of service, availability targets when the plan is implemented, recovery requirements, and an approach for the return to normal working conditions. In addition, as part of BCM (Business Continuity Management), the service provider prepares the service continuation plan by maintaining consistency with the business continuity plan, and so on.

- BCP (Business Continuity Plan)
  For continuing important business operations in the event of a disaster, a policy and an action plan are prepared so that disaster can be avoided beforehand or operations can be quickly recovered from the damage. System recovery methods include cold standby, which puts the system on standby without operating the spare system, warm standby, which puts the system on standby with the state of only starting the OS, and hot standby, which puts the system on standby in the same state as the production system. The recovery method is selected on the basis of the business operations to be continued and the cost.
- Business impact analysis (reduction of the impact of disaster)
  In this analysis, the disaster scenario is anticipated, the permissible service stoppage time is decided, and the following countermeasures are prepared: constructing a backup center and preparing service recovery procedures.

On the other hand, in service availability management, the service provider prepares availability requirements and targets as an availability plan and monitors and evaluates availability, which is the indicator of availability, MTBF (Mean Time Between Failure), which is the indicator of reliability, and MTTR (Mean Time To Repair), which is the indicator of maintainability.

(4) Budgeting and accounting for services

In budgeting and accounting for services, the following services are implemented: a budgeting service that plans and manages the budget for service delivery cost; and an accounting service for handling accounting processes. In this manner, financial management

(i.e., managing the financial condition) is efficiently conducted.
In these services, costs are budgeted to enable effective financial management and decision-making for services to be delivered. In addition, a decision is made and the document is created concerning the apportionment of indirect costs and the allocation of direct costs to services for providing the overall cost of the service. This corresponds to "IT service financial management" in ITIL.

(5) Capacity management

In capacity management, the service provider identifies capacity and performance requirements, and maintains and manages the required capacity for fulfilling the requirements. The service provider prepares, implements, and maintains a capacity plan taking into consideration human, technical, information, and financial resources.

[Contents of capacity plan]
- Current and forecast demand for services
- Expected impact of agreed requirements for availability, service continuity, and service levels
- Time-scales, thresholds, and costs for upgrades to service capacity
- Potential impact of statutory, regulatory, contractual, or organizational changes
- Potential impact of new technologies and new techniques
- Procedures to enable predictive analysis, etc.

The service provider monitors the usage status of capacity, analyzes data, and performs tuning to provide sufficient capacity to fulfill requirements agreed on with the customer. In this case, the following are used as the capacity management indexes, such as CPU utilization, memory utilization, file utilization, network utilization. This data is centrally managed in CMDB (Capacity Management Database).
Capacity management includes the following three subprocesses.

- BCM (Business Capacity Management)
  It is a subprocess that corresponds to capacity requirements of future business deployments.
- SCM (Service Capacity Management)
  It is a subprocess that monitors and evaluates the usage status of an IT service in order to fulfill the capacity requirements stated in SLA.
- CCM (Component Capacity Management)
  It is a subprocess that monitors and evaluates the usage status of IT resources (i.e.,

components), such as hardware, and handles the problems related to IT resources.

(6) Information security management

In information security management, the service provider implements and operates the information security controls for preserving confidentiality, integrity, and availability (or accessibility) of information assets.

Confidentiality	The property of making information unusable by, or undisclosed to, unauthorized parties
Integrity	The property of protecting the accuracy and completeness of assets
Availability	The property of enabling access and use when requested

Management with appropriate authority approves an information security policy (i.e., document that identifies information assets to be protected by the organization, reasons to be protected, and approaches to information security) by taking into consideration the service requirements, statutory and regulatory requirements, and contractual obligations. Furthermore, management communicates the approved information security policy to the service provider, the customer, and the internal staff members and ensures that everyone complies with it.

On the other hand, while fulfilling the requirements of the information security policy, the service provider implements and operates physical, administrative, and technical information security controls in order to preserve confidentiality, integrity, and availability (or accessibility) of information assets.

[Example of information security controls]

- Physical entrance and exit control
- Network security solution

  Service and business operator that offers the mechanism of network security (e.g., tapping measures, spoofing measures, falsification measures)
- User access management
- User authentication
- User password management
- Privilege management

  Technique of managing "privilege," the most powerful authority related to information system in order to protect unauthorized use by a third party
- Access control
- Protection of log information
- Measures against malware

With regard to requests for change of the information security, the following are evaluated and identified: new or changed information security risks, and potential impact on the existing information security policy and controls.
Information security incidents (i.e., events that inhibit the service and are attributable to information security) are managed according to the incident management procedures and priority appropriate to the information security risks. In this case, the service provider analyzes the type, frequency of occurrence, and impact of an information security incident, and then reviews it after reporting and recording in order to identify opportunities for improvement.

2-2-2 Relationship Process

Relationship process is a group of processes for the service provider to maintain a good relationship with the customer and the interested parties.

[Group of processes of relationship process]

1) Business relationship management
2) Supplier management

(1) Business relationship management

In business relationship management, the service provider identifies customer, users, and interested parties of the services and establishes the communication mechanism for building a good relationship. Besides, the service provider reviews the performance of the services at planned intervals with the customer. In addition, the service provider receives, records, analyzes/investigates, acts upon, and reports the complaints from the customer; and records, analyzes, and reviews the results of customer satisfaction conducted at planned intervals; and uses them for improving the service.

(2) Supplier management

In supplier management, the service provider manages contracts with suppliers in order to implement and operate the service management process.

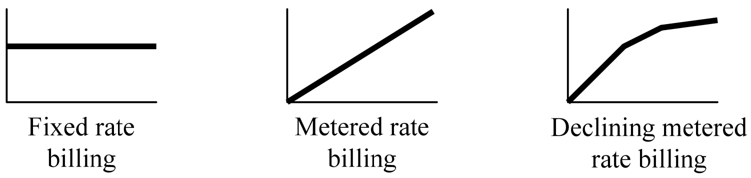
[Contents of contract documentation with the suppliers]

- Scope of the services to be delivered by the supplier
- Requirements to be fulfilled by the supplier, and service targets
- Authorities and responsibilities of the service provider and the supplier

• Basis for charging, etc.

Moreover, when the supplier is part of an internal group of the service provider, an OLA (Operation Level Agreement) is prepared. The OLA summarizes requirements that are related to operations.
The following types of billing methods are used as the basis for charging.

• Fixed rate
  In this method, a fixed usage fee, such as a fixed monthly fee, is set in the beginning.
• Metered rate
  In this method, billing is done in proportion to the amount of use of service.
• Declining metered rate
  It is a metered rate where unit price becomes cheaper as the amount of use increases.



2-2-3 Resolution Process

Resolution process is a group of processes for the service recovery through quick response and the prevention of recurrence when events occur that hinder the delivery of service.

[Group of processes of resolution process]
1) Incident and service request management
2) Problem management

(1) Incident and service request management

In incident and service request management, incident handling or service requests handling is performed in order to recover the services as quickly as possible that are agreed on with the customer.
The incident is an event or episode that adversely affects the service. Apart from a fault in the system (e.g., hardware, software) that delivers the service, a human error and violation of operation rules are also incidents. For example, when the operations department enters sales slips that are prepared by the sales department, if the data entry operator corrects errors in sales slips on the basis of his/her own judgment, it amounts to a man-made incident. (In this case,

sales slips should be returned to the sales department for verification and correction.) Other than this, loss of sales slips and operator's input error are also incidents. For preventing such incidents, it is effective to define the rules for handling information and the scope of management responsibility by which original slips are managed by the sales department, while data is managed by the operation department.

In addition, service requests, such as requests for refilling ink/toner in the printer and requests for reissuing when a user ID or password is forgotten, are also treated as incidents.

In incident and service request management, the following procedure is used for managing the flow from occurrence and detection of an incident up to temporary resolution (i.e., service recovery). Besides, a fundamental solution for preventing recurrence of an incident is carried over to the problem management process.

1) Recording

   Recording (i.e., documenting) information of an incident (and service request).

2) Allocation of priority

   Prioritizing response taking into consideration the impact and urgency of incident.

3) Classification

   Categorizing the incident (There are cases where it is conducted immediately after recording.)

4) Escalation

   Checking whether or not it is a known incident, and implementing a known resolution if one exists. If there is no known incident, implementing resolution (or workaround) as per escalation procedure, such as hierarchical escalation of requesting the problem resolution to the higher position and functional escalation of requesting the problem resolution to professional experts.

(2) Problem management

In problem management, the service provider identifies the root cause of the problem that leads to an incident and proposes fundamental resolution for preventing recurrence of the incident.

For the problems that are not permanently resolved (i.e., problems that may appear again), the service provider must identify the root cause and identify actions to reduce or eliminate the impact of the problem on the service. Problem management is conducted for this.

In problem management, the following procedure is used for defining the permanent resolution method or workaround (i.e., emergency measures) to minimize or avoid the impact of incidents and problems.

1) Identification and recording

In order to identify a root cause and potential preventive action, the cause of occurrence (e.g., unresolved risk, vulnerability) of an incident is identified and recorded.

2) Allocation of priority

Prioritizing of response is taken into consideration, and the impact and urgency of the problem are set.

3) Classification

The problems are categorized. (There are cases where it is conducted immediately after identification and recording.)

4) Escalation

The fundamental resolution of a problem is identified according to an appropriate escalation procedure. When the resolution requires changes, a request for change is submitted. (The actual changes are carried over in change management and release and deployment management.)

Records are made concerning the problems and their resolutions that are identified with a series of processes as known errors in KEDB (Known Error Database). The known error database must be managed in the accessible state for checking whether or not an incident is a known incident in the incident and service request management process. In this manner, the latest information concerning known errors and problem resolutions that have come to light with problem management is continuously provided to the incident and service request management process.

Also, after implementation of resolutions, it is necessary to monitor and evaluate effectiveness of problem resolution and also review and report it. In this case, if it is determined that the resolution is not effective as a means of problem resolution, a new resolution must be considered.

There is also a concept that problem management is composed of "problem control" that controls the overall situation and "error control" that identifies the resolution of an error.

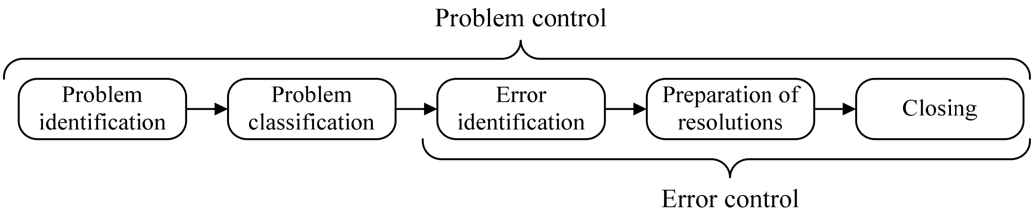


Figure 6-3 Problem control and error control

2-2-4 Control Process

Control process is a group of processes for managing the configuration elements of the services delivered and ensuring to implement changes to the configuration elements.

[Group of processes of control process]

1) Configuration management
2) Change management
3) Release and deployment management

(1) Configuration management

In configuration management, the definition is made for CI (Configuration Items), such as hardware, software, and documents that constitute a service, and accurate configuration information is managed and maintained.
In configuration management, configuration items are identified, and the records are made concerning information of configuration items and related incident information and/or change information in the CMDB (Configuration Management Database). The following is an example of information to be recorded in the configuration management database.

Item Number	Item	Contents
1	Configuration item number	Code that uniquely identifies a configuration item
2	Configuration item name	Name of configuration item
3	Classification	Classification such as hardware and software
4	Classification details	Detailed explanation of classification (e.g., hardware → printer)
5	Supplier	Supplier or vendor of configuration item
6	Model number	Model number of supplier (i.e., manufacturer)
7	Warranty period	Warranty period of supplier
8	Management representative	Management representative of configuration item
9	License number	License number of configuration item
10	Delivery date	Delivery date of configuration item
11	Current status	Current operation status
12	Planned status	Planned operation status
13	Installation location	Installation location of configuration item
14	Incident information	Information on incident related to configuration item

15	Problem information	Information on problem related to configuration item
16	Error information	Information on error related to configuration item
17	Change information	Information on change management

Configuration management is the asset management process that manages service assets, such as software assets and hardware assets. A special attention should be paid to manage the model number and installation location of the hardware, and the license and version information (i.e., edition) of the software. (For software management, it is recommended to refer to Software Management Guidelines provided by Japan's Ministry of Economy, Trade and Industry.)

(2) Change management

In change management, a decision is made whether or not to accept the RFC (Request For Change), and the approved changes are deployed according to the change schedule. After the implementation of the change, a review is performed with certainty to avoid risks arising from change.

In change management, a change management policy is established that defines the following.

- Configuration items (CIs) which are under the control of change management
- Criteria to determine changes with potential to have a major impact on services or the customer.

  [Change with potential to have a major impact]

  - Removal of a service
  - Transfer of a service from the service provider to the customer or a different party, etc.

In change management, the request for change is approved according to the following procedure in order to control the changes. Release and deployment management process takes over implementation and testing of changes.

1) Record of request for change and assessment of appropriateness

   All requests for change are recorded, and their appropriateness is assessed.

2) Prioritization of changes

   An appropriate priority ranking (e.g., urgent to postpone) is decided according to the contents of request for change. After the definition of emergency changes is documented, it must be agreed on with the customer.

3) Classification on the basis of the extent of impact of change

Requests for change are classified according to the extent of impact (e.g., severe to minor). Requests for change classified as having the potential to have a major impact must be managed by using the design and development/transition of new or changed services process.

4) Approval of changes

The service provider and interested parties must make decisions on the acceptance of requests for change. This decision-making must take into consideration the risks, the potential impacts on services and the customer, service requirements, operating profit, technical feasibility, and financial impact. For example, there may be situations, such as “some bugs come to the surface by adding functions to the system” and “system or application can no longer be used because of version upgrade of OS.” Therefore, the situations must be checked in advance as much as possible.

5) Preparing schedule of change

A schedule of change containing details of the approved changes and their proposed deployment dates must be prepared and communicated to interested parties.

6) Implementation and testing of changes

7) Evaluation of changes

The changes by review are evaluated, and if the changes are unsuccessful, the unsuccessful changes are reversed or remedied. If the changes are successful, information is updated in the configuration management database.

(3) Release and deployment management

In release and deployment management, the changes approved in the change management process are deployed in the live environment as a release. (Release means the approved changes themselves, and deployment means actually applying the approved changes.)
In release and deployment management, the service provider establishes a release policy and agree on it with the customer.

[Description of release policy]

- Frequency and types of releases
- Naming convention and acceptance criteria of release, etc.

In release and deployment management, the release is deployed in the live environment according to the following procedure.

1) Release and deployment planning

The service provider must plan with the customer and the interested parties the deployment of the new or changed service and service component (i.e., one of the units constituting a service) on the basis of the schedule of change. Similar to emergency change, the service provider must agree with the customer on the definition of an emergency release.

2) Designing and building of release

The releases are designed and built according to release policy and release and deployment plan. (This task can be outsourced to the development department or an external company.)

3) Release acceptance

The release is verified and approved before deployment on the basis of the agreed acceptance criteria. An approved release is stored in DSL (Definitive Software Library) if it is software or in DHS (Definitive Hardware Store) if it is hardware.

4) Release deployment

The release is deployed into the live environment so that the integrity of hardware, software, and other service components is maintained. In this case, if it is required, training is conducted for staff members and the customer.

5) Evaluation of release deployment

In order to evaluate success or failure of release deployment, the release is monitored and analyzed. If the deployment of the release is unsuccessful, it must be reversed or remedied. If the deployment of the release has succeeded, the evaluation of change or the updated information to configuration management database is provided to the change management process.

Incidents and problems detected in the incident and service request management process are carried over to the problem management process and the change management process. They are resolved fundamentally in the release and deployment management process.

2 - 3 Operation of Service

Operation of service refers to day-to-day activities that are conducted for delivering the service to the customer. Service is operated with system operations management for maintenance and improvement of system operations to deliver service, service operation for conducting stable operation of the system, and service desk, which is a point of contact for the customer.

2-3-1 System Operations Management

In system operations management, the following are managed according to various plans: resources and facilities that are required for operating the system, fault, security, or cost of the system.

[Plans used in system operations management]

- Daily operation plan
- Plan for conducting appropriate operation at the occurrence of a fault
- Improvement plan for reducing operation load, etc.

Daily operation plan is a plan that an operations management representative issues after checking and approving the contents of the plan, and it corresponds to the design document for system operation. The operation plan contains a detailed description of operations management rules, operational procedure, responsible personnel, annual operation plan, maintenance procedure, and so on.
The following operations management activities are conducted on the basis of the operation plan.

- Resource management of operations

  The resources that are required for system operation are maintained and managed so that it conforms to the targets of the organization.

Managed resources	Specific examples
Hardware resources	Computer, peripheral devices, etc.
Software resources	OS, application, etc.
Data resources	Files, databases, etc.
Network resources	Network related devices, infrastructure, etc.
Documents	Various documents, various manuals, etc.
Human resources	Operations staff members, users, etc.

- Job management

  The jobs are launched in an appropriate order (or monitor that they are automatically executed in an appropriate order) and managed so that each job operates normally.

Virtual environment operations management that uses cloud computing or SOA (Service Oriented Architecture) needs to be planned and managed in a similar manner.
In addition, operations management includes activities that are undertaken on the basis of the policies of capacity management, information security management, and service continuity and availability management of the service management processes.

2-3-2 Operation

In an operation, a system is operated according to the operation procedure that is defined in the operations manual or such other document, and the operation status of system is monitored and then reported periodically.

(1) System operations

System operations must be basically conducted according to the work instructions that are described in operations manual or such other document. Therefore, for preparing an operation plan, schedule design becomes important in terms of what kind of activity should be performed when and how. In particular, with regard to jobs such as backup after completion time of service delivery, it is necessary to prepare job scheduling for completing before the starting time of service delivery.

[Types of backups]

- Full backup
  This copies all data.
- Differential backup
  This copies all data that is updated after the previous full backup.
- Incremental backup
  This copies only data that is updated after the previous backups (i.e., full backup and incremental backups).

In addition, plans for appropriate operation at the occurrence of a fault are also important, such as recovery and rerun methods in the event of unsuccessful job execution and a restore procedure (i.e., data recovery procedure) using backup files in the event of loss of data because of a fault or such other error.

(2) System monitoring

System monitoring is conducted for early detection of system defects and for proposing improvements in system quality and solutions to problems. For that, it is required to utilize output management, such as managing the forms and the log information that are generated from the system and operations support tools (monitoring tools, diagnostic tools). In addition, it is also required to use the client monitoring tool, which is one of the operations support tools, and monitor the status of a client. For example, the inventory collection function is used to inspect that any non-business related software is not installed, and the software distribution function is used to update the antivirus software (or virus definition file) to the latest state.
In this manner, it is also important to maintain the system in the appropriate state by also monitoring the client. While it is good to identify the reasons for decline in performance to propose improvements by monitoring the system, the operations department should not change the system or configuration devices on the basis of its own decision.

2-3-3 Service Desk

Service desk is a SPOC (Single Point Of Contact) for inquiries (e.g., communication of fault, service request, complaint) from the service user (i.e., customer). The service desk offers convenience of service by responding to the inquiries from the users.

[Classification of service desk on the basis of the functions offered]

- Service desk
  It acts as the reception for the overall service and is provided with primary response functions.
- Help desk
  It acts as the reception for specific fields (or service) and is provided with primary response functions.
- Call center
  It is only provided with the reception function for the overall service. CTI (Computer Telephony Integration) with telephone integrated in the system is also used.

[Classification of service desk on the basis of structured form]

- Central service desk
  In this form, the service desk is consolidated in one place.
- Local service desk
  In this form, a service desk is established in each user location.

• Virtual service desk

In this form, multiple service desks work in collaboration and act as one service desk. There is another form called follow the sun that supports the user all over the world with regional service desks in different standard time zones.

The following is the general response procedure of service desks. The basic response procedure is documented as response manual.

1) Reception and recording

The following are recorded here: the contents of inquiry, date and time, and name and contact details of the inquiring person.

2) Problem discrimination

The content of an inquiry is analyzed after the content is compared with the past cases that are recorded in knowledge base and so on. As a result of analysis, if it can be handled, the service desk deals with it. If it cannot be handled, it is taken over by the department that can deal with it. (A formal escalation process must be in place.)

3) Recording of the results of handling

The process of how the inquiry was addressed is recorded. Even for an inquiry that could not be handled by the service desk, if possible, after a report is received from the department that dealt with the inquiry, handling process is recorded. On the basis of these records of handling, by preparing, publishing, and distributing FAQ (Frequently Asked Questions) containing common questions and their answers, the number of similar inquiries can be reduced.

2 - 4 Facility Management

Facility management is management for maintaining the facilities (i.e. computers and peripheral devices, and peripheral environment, such as facilities/equipment where computers are installed and network infrastructure) in the appropriate state. Here, facility management related to facilities and equipment is explained.

For safe operation of the system, it is necessary to manage facilities to be maintained at a certain level. Guidelines and standards for maintaining system environment include “Standards for Information System Safety Measure” and “System Management Standards” published by Japan’s Ministry of Economy, Trade and Industry. In the operation (or design) of facility and equipment, it is necessary to consider from three aspects: reliability, expandability, and cost. In particular, with regard to expandability, it is desired to design and manage with a margin taking into consideration the progress of technology and the external changes. Also, environmentally friendly concepts, such as Green of IT, are also important for promoting energy saving in the whole society by energy saving of the entire computer system and the effective use of resources to protect the global environment.

2-4-1 Facility Management

Facility management is management for maintaining the facility where computers and other peripheral devices are installed in a safe and ideal state.
For minimizing the damage because of natural disasters (e.g., earthquakes, floods), fire, or other accidents, the facility is installed in the environment where risk can be avoided and prevented. In addition to disasters, risks to the facility include unauthorized intrusions in the building or facility and the abnormal operation or failure of the disaster prevention facility.
In facility management, the following types of management are undertaken as measures against risks to the facility. In addition to these management activities, it is necessary to utilize equipment related to fire and crime prevention, knowledge related to safety management, and other useful resource.

- Disaster prevention management
  In preparation for natural disasters and fire, the building is reinforced with quake-resistant devices and quake-proof devices, fire extinguishing equipment is installed, and flood prevention measures is taken.
- Crime prevention management
  In order to guard against theft, security cable (i.e., wire for connecting the computer or such other device) is used.
- Access management
  An ID card or such other method is used to authenticate the people who enter and leave the facility. In principle, according to position or responsibility, minimum access permission is set so that the business operations are not affected.
- Confirmation of the status of management
  A management representative is assigned for each facility and define management procedures (or rules). In the case of outsourcing the management to an external building management company or a security company, the following are included in the contract: compliance with management procedures, scope of responsibility, periodic audit, and so on.

2-4-2 Management of Power Supply Related Equipment

As power supply related equipment, the following devices are used for stable power supply to computers (or computer system).

- Main power supply
  Generally, commercial power supply is used as the main power supply of the system. In order to guard against decline in quality (e.g., disaster, construction work) of commercial power supply, an AVR (Automatic Voltage Regulator) is used for supplying electric power in a continuous and stable manner.
- Private power generator
  While it is mainly used as backup of the main power supply, it is also used as the main power supply in an environment where commercial power supply cannot be used. In the event of power outage, until the power supply is switched to a private power generator, power is temporarily supplied by using CVCF (Constant Voltage Constant Frequency).
- UPS (Uninterruptible Power Supply)
  This device handles instantaneous outage of a commercial power supply (i.e., instantaneous interruption of power supply) and supplies power only until the system shuts down normally at the time of the power outage.
- Battery
  It is charged with commercial power supply and used for supplying power in the environment without any power supply.
- Power distribution equipment
  It includes a distribution board, breaker, and surge protection unit. Periodic inspection is important for such equipment.
- SPD (Surge Protective Device)
  It protects power supply circuits, communication devices, or other equipment from the overvoltage (i.e., surge voltage) and the overcurrent (i.e., surge current) that is generated from overvoltage. This type of protection is called surge protection. In order to protect from overvoltage such as lighting, it is necessary to connect a communication cable and computer through the surge protection device.

2-4-3 Management of Air Conditioning Facility

An air conditioning facility is used for maintaining temperature and humidity that are suitable for operation of devices inside the facility so that the configuration devices of the system can be operated in a stable manner.

An air conditioning facility can be either centralized air conditioning, where a large air-conditioner is installed to manage temperature of the entire room, or distributed air conditioning, where an air conditioning facility is installed for each device. For devices that emit a large amount of heat, a water cooling type cooling device may also be used. There is a concept of improving indoor cooling efficiency by clearly separating hot aisle, which is a space where only exhaust (i.e., hot air) of the device is collected, and cold aisle, which is a space where only cold air blowing from an air conditioner is collected. This concept can reduce power consumption and the cost of air conditioners.

Chapter 6　Exercises

Q1

An SLA (Service Level Agreement) is sometimes used in relation to operation of the in-house information systems. Which of the following is an appropriate description of SLA?

a) It is a form of contract for new operation services with external vendors, and it protects a company's secrets by incorporating provisions concerning leakage of confidential information in the agreement.
b) It is a performance indicator of the information systems department from the standpoint of the management team, and it contains numerical values of goal achievement of the information systems department in the annual plan. For example, it includes the development budget, development productivity, number of issues.
c) It is an agreement document that information systems staff members exchange with the company, and it sets forth a wage system, working hours, and steps to be taken in the event of an emergency, such as trouble, for information systems staff members who work in a complex working environment.
d) It is an agreement document that is entered into between the user department and the information systems department, and it includes items, such as billing, inquiry reception hours, and recovery time in the event of a fault in the online system. It may also include penal provisions when the agreement is not fulfilled.

Q2

When the construction of an ITSMS (IT Service Management System) is performed in four steps of Step 1 through Step 4, which of the following is the step that defines the requirements for management's responsibility and documentation?

a) Step 1 (Gap analysis)
b) Step 2 (Establishment of service management system)
c) Step 3 (Implementation of service management plan)
d) Step 4 (Implementation of service management processes)

Q3

Which of the following is the concept that treats service management as a flow of strategy, design, transition, operation, and continual improvement?

a) Service support
b) Service strategy
c) Service transition
d) Service life cycle

Q4

Among the descriptions of the system transition (or migration), which of the following is an appropriate characteristic of the big bang transition approach?

a) Since the operation method is notified in a phased manner after the system operation has started, this approach can avoid confusion in users.
b) This approach is used when system scale is large, and it can make the extent of impact be limited if the transition is unsuccessful.
c) Since the double burden of work can be avoided by a parallel operation with both the new system and the old system, this approach offers large economic effects.
d) The system can be operated in comparison of processing results of both the new system and the old system, and if there are no issues, it is possible to stop the comparison work and make a transition to the new system.

Q5

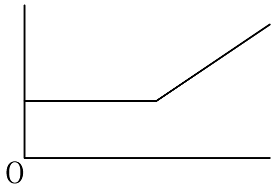
Which of the following is used as a KPI (Key Performance Indicator) of "service continuity and availability management," which is one of the service delivery processes?

a) Number of service interruptions
b) Number of information security incidents
c) Number of incidents that arise from insufficient performance
d) Number of service level requirements that could not achieve the targets

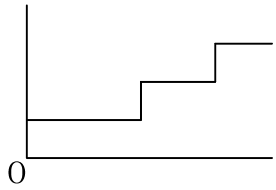
Q6

Which of the following is the graph that indicates the declining metered rate method where the fee for using the computer system is shown on the vertical axis and the amount of resources that are used is on the horizontal axis?

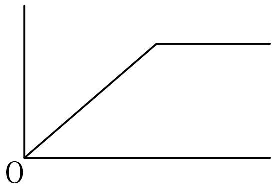
a)



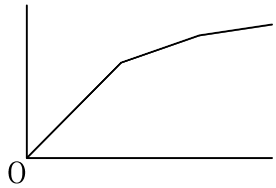
b)



c)



d)



Q7

In the resolution process of service management, which of the following is the main activity of “incident and service request management”?

a) Registration of incidents and their resolution in the database of known errors
b) Investigation of the root cause of an incident
c) Service recovery with temporary resolution of incident
d) Evaluation of resolution of the problem that leads to the incident

Q8

Mr. *M* is asked to create configuration management database related to hardware configuration items. He proposes a management method using the management table as shown below.

[Management table]

Management_number	Product_name	Serial_number	Purchase_date	Purchase_price

[Management method]

- At the time of purchasing PCs, Management_number is assigned for each set including peripheral devices as a unit, and each set is registered in the management table.
- When a peripheral device is purchased separately, Management_number is assigned for each peripheral device and each peripheral device is registered in the management table.
- On the devices to be managed, the label that contains Management_number is placed.

In this management method, there is a risk that it may not be possible to match all devices including peripheral devices with the management table. Which of the following is appropriate advice for Mr. *M*?

a) If the devices of the same type are purchased on the same day, it may not be possible to identify each device. Therefore, it is better to add purchase time as a management item.

b) It may not be possible to distinguish an unauthorized act, such as an act that the label placed on a device is replaced with another device label. Therefore, it is better to write all items on the labels in addition to Management_number.

c) If an additional device that has the same product name is purchased, it may not be possible to identify the device. Therefore, it is better to add an item which shows installation place in order to identify each device.

d) If a PC and a peripheral device are purchased as a set, it may not be possible to confirm whether the peripheral device exists or not. Therefore, it is better to assign Management_number to each peripheral device even when the peripheral device is purchased at the same time of purchasing a PC.

Q9

In the change management process of service management, which of the following is an appropriate description of the request for change?

a) For handling an emergency request for change, the change is implemented without assessment of the extent of impact of changes.
b) Since it is a request for change from the customer, it is unconditionally approved as the highest priority.
c) In order to manage the request for change without any omission, an unapproved request for change is also recorded.
d) Since the request for change is for handling legal amendments, it is approved without an estimate of the cost that is required for making the changes.

Q10

A help desk was setup as a contact for an end user for fault handling. When the root cause of the fault is unknown but an emergency measure for the fault is needed, which of the following is the most appropriate sequence for the help desk to handle the fault?

a) Reception and recording → Problem determination → Emergency measures → Prioritization for investigation of cause → Investigation of cause and problem resolution
b) Reception and recording → Problem determination → Prioritization for investigation of cause → Emergency measures → Investigation of cause and problem resolution
c) Problem determination → Reception and recording → Emergency measures → Prioritization for investigation of cause → Investigation of cause and problem resolution
d) Problem determination → Emergency measures → Prioritization for investigation of cause → Reception and recording → Investigation of cause and problem resolution

Q11

Which of the following is the device that is used for handling instantaneous outage of power supply and supplying electric power only for the time that is required for shutting down the system in the case of a power outage?

a) AVR b) CVCF c) SPD d) UPS

Chapter 7
System Audit and Internal Control

1 System Audit

A system audit is a way to objectively certify whether or not the measures against risks concerning the information system are developed and operated appropriately from an independent standpoint. In addition, accountability to the stakeholders is fulfilled by sharing the audit results.

1 - 1 Purpose and Concept of Audit

An audit refers to supervising/verifying an event or a subject. Apart from system audits, audits related to companies and information systems include the following.

- Accounting audit
  This is an audit that verifies the reliability of financial statements.
- Business operations audit
  This is an audit that verifies effectiveness, security, reliability, and such other aspect of business activities.
- Information security audit
  This is an audit that verifies whether or not risk management pertaining to information security measures is effectively conducted. It is conducted in accordance with the Information Security Audit Standards, from the viewpoint of whether or not the audit target is compliant with the Information Security Management Standards.
- Personal information protection audit
  This is an audit that verifies whether or not the personal information protection system satisfies JIS Q 15001 (Personal information protection management system — Requirements) or a privacy mark system compliant with JIS Q 15001.
- Compliance audit
  This is an audit that verifies whether or not any law (e.g., the Copyright Act, the Industrial Property Law, the Unfair Competition Prevention Act, laws and regulations on labor such as the Labor Standards Act, business-related laws and regulations) is violated.

While audits have the following sections, these are not exclusive. For example, an accounting audit, which is one of the statutory audits, is conducted as an external audit by a certified public accountant.

Audit classification	Overview
Statutory audit	This refers to an audit that is stipulated as mandatory by laws such as the Companies Act.
Voluntary audit	This refers to an audit that is conducted by the organizations at their own discretion for a specific purpose.
External audit	This refers to an audit that is conducted by a certified public accountant, an external association (i.e., auditing organizations), etc.
Internal audit	This refers to an audit that is conducted by the audit department of the organization that has a department to be audited.

In addition, for the purpose of popularizing audits, the "list of companies providing system auditing services" and the "list of companies providing information security auditing services" are published, which are the summarized list of parties (including individual business operators) that conduct audits according to the audit standards and management standards defined by the Ministry of Economy, Trade and Industry. Users can access these lists.

1 - 2 Purpose and Implementation Procedure of System Audits

System audit verifies whether or not risk management pertaining to an information system is effectively implemented. A system audit is conducted in accordance with the System Audit Standards, from the viewpoint of whether or not the information system to be audited is compliant with the System Management Standards.

1-2-1 Purpose of System Audits

In the "System Audit Standards," the purpose of system audits is described as shown below. Here, some supplementary explanation is provided for making it a little easier to understand.

> [Excerpt from System Audit Standards "II. Purpose of system audits"]
> From an independent and professional standpoint, the system auditor verifies and evaluates whether risk control related to the information systems of the organization is appropriately developed and operated on the basis of risk assessment (i.e., identification, analysis, and evaluation of risk), and the auditor gives assurance (assurance-based audit) or gives advice (consulting-based audit), and thereby contributes to achieving IT governance (i.e., organizational capability to control the formation and execution of IT strategy, and lead in the desired direction for the purpose of building competitive superiority).

The purpose and scope (or business operations) to be audited in the system audit, and the authority and responsibility of the system auditor are clearly defined in documented regulations (e.g., system audit regulations, internal audit regulations), or in a contract, and then approval of the management is obtained.

The business operations to be audited in the system audit encompass the entire life cycle (i.e., planning, development, operation, maintenance) of information systems, and information resources involved in information systems are also covered in the system audit. For smoothly conducting the system audit, it is desired that information systems should be developed and maintained with being aware of auditability. Information system auditability means it should be possible to effectively audit or review the validity of a process, and it includes mechanisms such as collecting and tracing logs.

The system auditor must verify and evaluate the information systems to be audited from an objective standpoint. Therefore, in the "System Audit Standards," the following items are set forth as qualifications for the system auditor.

- Apparent independence: For objectively conducting the system audit, the system auditor should be independent from the audit target. (Depending on the purpose, there should not be any conflict of interest owing to his/her position.)
- Psychological independence: The system auditor should overcome bias and always make a fair and objective audit judgment.
- Professional ethics and honesty: The system auditor should honestly conduct the work in accordance with the principle of professional ethics.
- Professional skills: Through appropriate education and work experience, the system auditor should maintain knowledge (e.g., audit, information system, information security, related laws and standards) and specialized skills as a professional.
- Practical obligations: The system auditor should adhere to the duty of care, the duty of nondisclosure, and so on.
- Quality management: The system auditor should conduct appropriate quality management for ensuring the correctness of audit results.

1-2-2 Implementation Procedure of System Audits

The following is the implementation procedure of system audits based on the "System Audit Standards." In order to effectively and efficiently conduct a system audit, it is necessary to make implementation preparation for obtaining support and active cooperation of the subject to be audited before the audit is conducted.

[Implementation procedure of system audits]

1) Preparation of system audit plans
2) System audit implementation (i.e., preliminary audit, main audit, evaluation, and conclusion)
3) System audit reporting
4) System audit evaluation

(1) Preparation of system audit plans

In the preparation of system audit plans, in order to effectively and efficiently achieve the purpose of system audits to be conducted, the system auditor prepares appropriate system audit plans concerning contents, timing, and scope of audit procedure, and documents them as the system audit plans.

The following three plans are prepared as system audit plans.

- Medium- and long-term plan
  It is a medium-to-long-term (3 to 5 years) audit plan with consistency between medium-to-long-term management plan and information systems plan of the subject (i.e., organization) to be audited.
- Basic plan
  It is an annual audit plan with consistency between the annual management plan and information system plan of the subject (i.e., organization) to be audited.
- Individual plan
  It is an audit plan for each audit target (i.e., business operations to be audited).

It is ideal to prepare the system audit plans in the sequence of a medium- and long-term plan, a basic plan, and an individual plan. However, for practical purposes, most of the time the basic plan is prepared first, and then the medium- and long-term plan is prepared by consolidating the basic plans of several years. After that, the individual plan is prepared by defining the basic plan in detail for each audit target.

In the preparation of system audit plans, on the basis of the results (e.g., frequency of risk occurrence, extent of impact) of risk assessment related to information systems, audit targets and important audit topics are selected. After that, audit scope and audit procedures are defined, and the corresponding audit implementation framework and audit schedule are decided.

The system audit plans that are prepared in this manner are released after the approval is obtained from the head of the organization of the department to be audited. However, in the event that the fulfillment of audit purpose possibly may be blocked (e.g., “New facts are found during the audit process," "Environment of the subject to be audited has changed"), flexible operation is required so that the plans can be modified on a case-by-case basis such as by changing the audit procedure.

(2) System audit implementation (preliminary audit, main audit, evaluation, and conclusion)

System audit implementation is done in the sequence of preliminary audit, main audit, and evaluation and conclusion on the basis of individual plans. Here, the system auditor appropriately conducts the audit procedures, collects adequate audit evidence required for supporting the audit results in terms of given assurance or advice, and evaluates them.

Audit evidence refers to the facts that are required for substantiating the audit opinion of the system auditor. Audit evidence is broadly classified into the following four types.

- Physical evidence

  This refers to physical objects (e.g., configuration devices of the information system) that are verified personally by the system auditor.
- Documentary evidence

  This refers to documents and electromagnetic records (e.g., design documents, specifications, minutes of meetings, review sheets, system operation records, logs, output forms) that are personally verified by the system auditor.
- Verbal evidence

  This refers to documented evidence, such as testimonies, explanations, verbal statements, and responses to interview or questions, which the system auditor has found as potential audit evidence.
- Situational evidence

  This refers to situations (e.g., actions and behavior of employees outside regulations) that are personally observed by the system auditor.

The system auditor uses an appropriate audit procedure for obtaining audit evidence. Audit procedures are procedures of selecting and operating appropriate system audit techniques for collecting adequate audit evidence required for rational evaluation and conclusion of the audit items.

[Main system audit techniques]

- View or collection of materials or documents
- Use of lists of questions or questionnaires
- Field investigation
- Interview-based investigation (interview/hearing)

• Use of audit tools

The system auditor consolidates the results of audit procedures and related documents as an audit working paper. An audit working paper is a record of a system audit that is conducted by the system auditor, and it forms the basis of the audit opinion. Therefore, audit evidence and related documents must be recorded in a very orderly manner and appropriately stored so that the background for arriving at the audit opinion (i.e., conclusion of audit) is clear. In related documents, apart from the items collected and organized by the system auditor, documents submitted by the audited department are also included. In addition, it is necessary to preserve the audit working paper for a reasonable period even after the completion of the system audit. Furthermore, careful attention is required in specifying the storage place and the person responsible for storage, because the audit working paper contains confidential matters of the audited department. Here, in the case of an external audit, please keep in mind that the audit working paper may also remain with the external system auditor.
Preliminary audit, main audit, and evaluation and conclusion are conducted in the following manner.

1) Preliminary audit

   It is conducted for clearly understanding the actual state of the audit target. In a preliminary audit, the auditor collects and views questionnaires and material, and conducts interview-based investigation (i.e., interviews/hearings) with the concerned persons. In this way, the auditor understands things such as whether or not risks of the information system to be audited have been appropriately identified, and whether or not controls based risk assessment have been appropriately maintained.

2) Main audit

   The main audit actually investigates, analyzes, and verifies the audit target according to the purpose of the audit, and it verifies whether or not risk control is done appropriately. It uses field investigations, interviews, and other system audit techniques, and checks the actual state of the audit target and possible problems identified in the preliminary audit. It also collects documents and records for supporting the information.
   When audits using information systems (i.e. computers) are conducted, Computer Assisted Audit Techniques (CAATs) are used.

[Main Computer Assisted Audit Techniques]

- Utility software method

  It uses the utility software supplied by the manufacturer.
- Test data method

It runs the program to be audited by using test data that is created with a generator or such other tool, and checks whether or not the expected results are obtained.

- Audit software method

  It uses software with the functions, such as search and extraction of the files to be audited, which are very frequently used in system audits.

- Audit module method

  It embeds a module in the system, where this module extracts and exports the data that satisfies the specified conditions, from the file to be audited into the audit file.

- ITF (Integrated Test Facility) method / integrated test method

  It creates a record for the system auditor in the files to be audited, and checks the accuracy of the process by performing various operations on this record.

- Parallel simulation method

  The system auditor prepares a program for verifying a specific audit purpose, enters the same data in both this program and the program to be audited, and compares the processing results of both programs.

- Code comparison method

  This method compares the program verified beforehand by the system auditor and the program to be audited, on a line by line basis at the source code level.

3) Evaluation and conclusion

From the results of the preliminary audit and main audit, compatibility (whether appropriate or not) is evaluated by matching the actual state of the audit target with the purpose of the audit. Concerning evaluation and conclusion, the system auditor confirms accuracy by exchanging opinions with the audited department.

(3) System audit reporting

In system audit reporting, the auditor prepares a system audit report in the appropriate format according to the purpose of the performed system audit, and presents it to the audit requester (i.e., head of organization, or the person to whom the head of organization delegated the authority) without delay. In addition, if the system audit report is required to be disclosed, the system auditor should decide the disclosure method by discussing with the audit requester.

A system audit report is a report that contains the documents that are collected by the system auditor by implementing the audit procedures and the audit opinion of the system auditor on the basis of these documents. The system audit report describes the audit target, the outline of the audit, assurance opinion or advisory opinion, constraints or matters excluded, findings, recommendations, and relation of other matters that should be noted with audit evidence, and it contains matters that are deemed necessary by the system auditor according to the purpose of the audit. The system auditor is responsible for the matters that are described in the system audit report.

In addition, the system auditor gives an appropriate improvement suggestion (or a follow-up) to the audited department so that the required measures on the basis of the audit results are taken.

(4) System audit evaluation

In the system audit evaluation, the auditor evaluates the validity of the results of the system audit. For example, concerning the findings, the auditor clearly defines what exactly the problems are and checks with the audited department that there are no factual errors. In addition, the auditor checks with the audited department whether or not recommendations that are made by him/her for the findings are feasible.

The system auditor puts in place the appropriate organizational structure for managing all audit activities from the creation of the system audit plans to system audit reporting up to giving improvement suggestions. Here, when it is found necessary and appropriate for achieving the purpose of system audits, the system auditor at his/her discretion may consider getting support from other professionals (e.g., network specialists, database specialists, system analysts, attorneys, certified public accountants).

In addition, for obtaining audit evidence, an audit trail may also be used. An audit trail is a mechanism that allows tracking and validating whether the information system or the respective control function is useful for ensuring rightfulness and soundness of an information system. It includes a transaction trail that can track the process from input to output of an information system, an access trail that can track causal relationships related to access to various resources of the information system, and their records. It is possible to get audit evidence in time sequence from the audit trail.

2 Internal Control

Internal control is a mechanism where companies themselves build and operate the sound and efficient organizational structure, and it contributes to achieving IT governance.

2 - 1 What is Internal Control?

Internal control is a mechanism (e.g., internal regulations, institutions, procedures) of monitoring the organizational activities of all members of the organization, and if there are any problems, it makes improvements and increases the organizational capability. Internal control is defined in the "Standards for Management Assessment and Audit concerning Internal Control Over Financial Reporting" which is released by the "Financial Services Agency" as follows:

[Definition of internal control]
Internal control is defined as a process performed by everyone in an organization and incorporated in the organization's operating activities in order to provide reasonable assurance of achieving four objectives: effectiveness and efficiency of business operations, reliability of financial reporting, compliance with applicable laws and regulations relevant to business activities, and safeguarding of assets. Internal control consists of six basic components: control environment, risk assessment and response, control activities, information and communication, monitoring, and response to IT (Information Technology).

- Control environment
  It determines the tone of an organization, influences the awareness of its people toward control, and lays the foundation for all other basic components.
- Risk assessment and response
  It identifies, analyzes, and assesses factors that represent risks that could adversely affect the achievement of the organization's objectives, and selects appropriate responses to those risks.
- Control activities
  It defines policies and procedures established to ensure that the orders and instructions of the management are followed in an appropriate manner. Control activities include segregation of duties that clearly define the division of responsibility and authority of work.
- Information and communication
  It involves ensuring that necessary information is identified, understood, processed,

and accurately communicated throughout the organization and among parties involved.

- Monitoring (monitoring activity)

  It continuously monitors/assesses/corrects whether or not internal control is functioning effectively. There are separate monitoring conducted from perspectives (e.g., internal auditor) that are independent of business operations, and ongoing monitoring that is conducted by the business operations department itself.

- Response to IT (Information Technology)

It refers to establishing appropriate policies and procedures to achieve goals and to respond appropriately to IT inside/outside the organization during the course of business activities. It consists of responses to IT environment and also the use and control of IT.

Laws related to internal control are the Companies Act, Financial Instruments and Exchange Act, and so on. Specifically, Article 24.4.4 (Internal control report) of the Financial Instruments and Exchange Act, also called internal control report system (J-SOX Act), makes it mandatory to submit an internal control report to the prime minister. Therefore, management has been forced to continuously evaluate and improve internal control. In addition, there is another method called CSA (Control Self Assessment) where not just management but every person who actually performs control activities verifies and evaluates effectiveness of the his/her own control activities. CSA workshop is used as an effective tool for implementing the COSO framework.

- COSO framework

  It is a framework of internal control published by COSO (the Committee of Sponsoring Organization of the Treadway Commission). If we compare the definition of internal control in COSO with the definition given by the Financial Services Agency, COSO's definition does not have the purpose "safeguarding of assets" and the basic component "response to IT (Information Technology)."

The mechanism for achieving four objectives of internal control is called the internal control system, and it is classified into overall control that affects a wide range such as the entire organization or the entire department, and operation processing control that affects a narrow range such as a specific business operation. In addition, if we classify internal control in terms of purpose, it can be classified into preventive control that prevents incorrect operations or fraudulent acts from occurring and detective control that finds incorrect operations or fraudulent acts. For example, preventive control designs the data input screen where operational errors cannot easily occur, while detective control compares the output list of data input results with the input forms.

Internal control has the following limitations.

- Internal control may not operate effectively because of misjudgment, carelessness, or collusion among two or more individuals.
- When the user department and the information system department are not independent, checks and balances do not function effectively, and integrity of data may be lost.
- Internal control may not necessarily respond to unexpected changes in internal or external environments or non-routine transactions.
- Convenience and cost effectiveness are required in design and operation of internal control.
- Internal control may be ignored because of fraudulent behavior or illegitimate objectives by the management.

2 - 2 IT Governance

IT governance is the organizational capability that controls the creation and execution of IT strategy and leads in the desired direction, or the framework of corporate governance for controlling the creation and execution of IT strategy. Initiatives for achieving IT governance include several items such as IT control which is IT-based internal control on the information systems carried out by a CIO (Chief Information Office), a system audit, an information security audit, and software asset management.

Chapter 7 Exercises

Q1

Which of the following is an appropriate description of an audit?

a) An external audit is an audit that is conducted by an external auditor, usually by external associations such as certified public accountants or auditing organizations.
b) A business operations audit is an audit related to an accounting service, and it is conducted for the purpose of verifying the reliability of financial statements.
c) An information security audit is an audit that verifies information security measures of a company, and it is conducted for the purpose of registering the audited company in the list of information security audit companies.
d) A statutory audit is an audit where the implementation method of the audit is defined by law, and it is conducted as an optional audit according to the purpose of the company.

Q2

Which of the following is an appropriate description of characteristics of a system audit?

a) A system audit verifies and evaluates information system auditability on the basis of risk assessment for contributing to implementing IT governance.
b) A system audit is an audit of information systems that is conducted from a standpoint independent of the audit target, and it is not responsible for planning, development, operations, or maintenance of the system.
c) A system audit is an audit that ascertains whether or not the information system is compliant with the "System Audit Standards."
d) A system audit is an audit that is conducted in the closing phase of a project for information system construction, and it is conducted by the project manager to confirm official closure of the project.

Q3

In a certain company, the audit department that has system auditors who mainly audit the internal information systems is directly under the control of management. Among the qualifications for a system auditor, what does this organization structure try to ensure?

a) Apparent independence
b) Practical obligations
c) Professional ethics and honesty
d) Quality management

Q4

Which of the following is an appropriate description of the implementation procedure of system audits?

a) In the preparation of system audit plans, a system auditor prepares an individual plan for each audit target according to the basic plan that is submitted by the department to be audited.
b) In system audit implementation, the actual state of the audit target that is collected during the hearing of a preliminary audit is checked in the main audit, and audit evidence that supports audit results is collected.
c) In the system audit evaluation, the department to be audited evaluates the system auditor on the basis of the status of the system audit implementation and matters that are described in the system audit report.
d) In system audit reporting, a system auditor presents an audit opinion that is derived from audit evidence or audit results to the prime minister.

Q5

Which of the following is an appropriate description of the documents to be attached to an audit working paper?

a) Documents should be attached after advance approval of the audited department is obtained.
b) Not copies of the documents but originals of the documents should be attached.
c) Documents should be prepared so that the background for arriving at the conclusion of the audit can be understood.
d) Documents that are collected by the system auditor himself/herself should be attached.

Q6

Among CAATs (Computer Aided Audit Techniques), which of the following is the technique in which the program to be audited and the program that is prepared by the system auditor process the same data and the processing results of both programs are compared?

a) Audit module method
b) Test data method
c) Integrated test method
d) Parallel simulation method

Q7

In the audit of an information system, which of the following is a finding that is related to availability?

a) A call center is outsourced in order to provide 24-hour support.
b) In preparation for an emergency, a contract related to a backup line is entered into with the provider.
c) For cost reduction, system configuration devices are used without multiplexing.
d) The procedure for using the system is documented as a manual so that anyone can use it.

Q8

"Standards for Management Assessment and Audit concerning Internal Control Over Financial Reporting" which is released by the "Financial Services Agency" shows "Response to IT" as one of the basic components of internal control. Which of the following is an appropriate description of this "Response to IT"?

a) It is also defined as one of the constituent components in COSO's "Internal Control—Integrated Framework."
b) It consists of response to IT environment and also the use and control of IT.
c) With the control activities based on manual operation without using IT, the purpose of internal control cannot be achieved.
d) It exists independently from other basic components of internal control.

Q9

Which of the following is a description concerning a limitation specific to internal control?

a) It does not have the function of detecting fraudulent acts by the management.
b) It cannot detect deviation from authority by a staff member.
c) It cannot prevent fraudulent acts that arise from the concentration of authority in a specific person.
d) It does not have rational safety measures based on risk recognition.

Q10

When IT control is classified into preventive control and detective control, which of the following corresponds to detective control for the quotation preparation system that a member of the sales department uses to prepare a quotation?

a) User training of the quotation preparation system is periodically conducted for sales department members, and it is mandatory for new employees and employees assigned to the sales department to participate in this training.
b) If customer code is entered, the corresponding customer name appears automatically. In addition, if the product code is entered, the corresponding product name and unit price appear automatically.
c) It is linked to the workflow system where the quotation that is prepared by a staff member is checked and approved by the sales department manager.
d) For using the quotation preparation system, a unique user ID is assigned to each sales department member and sales department manager.

Index

Numbers

— 1 —

— 3 —

— 5 —

— 7 —

Alphabets

— A —

— D —

— E —

— F —

— G —

— H —

— I —

— J —

— K —

— L —

— M —

— N —

— O —

— P —

— Q —

— R —

— S —

— T —

— U —

— V —

— W —

— X —

— Z —

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