

# STUDY UNIT ELEVEN

## INFORMATION TECHNOLOGY I

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This study unit is the first of five covering information technology (IT). Business information today is largely produced through the use of computer-based systems. A CPA, as a provider of a portion of this information, is involved with these systems in three roles:

1. Designer -- as a consultant in the development of systems
2. Auditor -- as an evaluator of the quality of the system's output, composition, and security
3. User -- as a recipient of the systems' output and as a source of input for decision making

Accordingly, a CPA must understand IT before (s)he can design, audit, or use computer-based systems. In particular, a CPA must understand how the use of specific systems affects the risks associated with the unique nature and characteristics of IT.

### 11.1 ROLE OF BUSINESS INFORMATION SYSTEMS

1. A **business information system** is any combination of people, procedures, and computing equipment employed to pursue a business objective (business in this context means any organization that needs data to carry out its mission: publicly held corporation, institution of higher education, not-for-profit, etc.).
  - a. The first generation of business information systems served the finance and accounting functions, since computing lends itself so readily to quantitative tasks.
  - b. Business information systems have evolved to serve the needs of **users at all levels** of the organizational hierarchy, and even, with the advent of fast telecommunications, **users outside the organization**.
  - c. **Stakeholders** in business information systems are those who affect, or are affected by, the output of the information system. They have an interest in the system's effective and efficient functioning.
    - 1) Hence, they include users such as managers, employees, IT personnel, suppliers, and customers.
  - d. Any information system performs **four major tasks**:
    - 1) **Input.** The system must acquire (capture) data from within or outside of the entity.
    - 2) **Transformation.** Raw materials (data) are converted into knowledge useful for decision making (information).
    - 3) **Output.** The ultimate purpose of the system is communication of results to internal or external users.
    - 4) **Storage.** Before, during, and after processing, data must be temporarily or permanently stored, for example, in files or databases.

- 5) **EXAMPLE:** All four tasks can be identified in the following description:

A firm collects sales and expense data in its automated accounting system. At year-end, adjusting and closing entries are added to the system, and the data are processed into a special format, from which the annual report is produced. The firm owns a number of high-speed, high-capacity hard drives on which all of its transactions and formatted financial statements are kept.

- e. Business information systems can be classified by their **level of complexity**.

## 2. Transaction Processing System (TPS)

- a. A transaction is a **single, discrete event** that can be captured by an information system.
- 1) Examples include the movement of raw materials from storage to production, the taking of a reservation, the recording of a new employee's personal data, or the sale of a piece of merchandise.
- b. A TPS therefore captures the **fundamental data** that reflect the economic life of an organization.

## 3. Management Information System (MIS)

- a. A MIS typically receives **input from a TPS**, aggregates it, then reports it in a format useful by **middle management** in running the business. For this reason, MISs are often classified by function or activity:
- 1) **Accounting:** general ledger, accounts receivable, accounts payable, fixed asset management, tax accounting
  - 2) **Finance:** capital budgeting, operational budgeting, cash management
  - 3) **Manufacturing:** production planning, cost control, quality control
  - 4) **Logistics:** inventory management, transportation planning
  - 5) **Marketing:** sales analysis, forecasting
  - 6) **Human resources:** projecting payroll, projecting benefits obligations, employment-level planning, employee evaluation tracking.
- b. These single-function systems, often called **stovepipe systems** because of their limited focus, are gradually being replaced by **integrated systems** that link multiple business activities across the enterprise.

## 4. Data Warehouse

- a. A data warehouse is a **central database** for transaction-level data from more than one of the organization's TPSs. Data warehouses are very large and require that the transaction records be converted to a standard format.
- 1) The ability of the data warehouse to relate data from multiple systems makes it a very powerful tool for ad hoc queries.
  - 2) The data warehouse can also be accessed using analytical and graphics tools, a technique called **online analytical processing (OLAP)**.
    - a) An important component of OLAP is **drill-down analysis**, in which the user is first presented with the data at an aggregate level and then can display successive levels of detail for a given date, region, product, etc., until finally reaching the original transactions.
  - 3) A data warehouse is strictly a query-and-reporting system. It is not used to carry on the enterprise's routine operations.
    - a) In other words, a data warehouse does not take the place of a TPS. Rather, a data warehouse gets its input from the various TPSs in the organization.

- b) A data warehouse is optimized for data retrieval and reporting. A TPS is optimized for data entry.
- b. A **data mart** is a subset of an enterprise-wide data warehouse.
  - 1) A data mart is designed primarily to address a specific function or department's needs, whereas a data warehouse is generally meant to address the needs of the entire enterprise.
- c. A data warehouse enables **data mining**, i.e., the search for unexpected relationships between data.
  - 1) The classic example of the use of data mining was the discovery by convenience stores that diapers and beer often appeared on the same sales transaction in the late evening.
  - 2) Special software and a large amount of processing power are needed for effective data mining.

## 5. Decision Support System (DSS)

- a. A DSS is an **interactive** system that is useful in solving **structured and semistructured problems**, that is, those requiring a management decision maker to exercise his or her insight and judgment.
  - 1) This latter point requires emphasis: a DSS **does not automate a decision**. It examines the relevant data and presents a manager with choices between alternative courses of action.
- b. A DSS has **three basic components**: the database, the model, and the dialog.
  - 1) The **database** consists of the raw data that are relevant to the decision. In this context, a data warehouse (see item 4. on the previous page) is very useful. The data can come from both within and outside of the organization.
  - 2) The **model** is the set of equations, comparisons, graphs, conditions, assumptions, etc., into which the data will be fed.
  - 3) The **dialog** is the user interface which allows the user to specify the appropriate model and the particular set of data to which the model should be applied.
- c. **EXAMPLE**: A manufacturer wishes to improve its inventory management.
  - 1) The firm creates a database of the past five years of inventory and purchasing history, along with projections for future production, transportation costs, and forecasts of the prices of raw materials.
  - 2) The firm creates a model containing the formula for economic order quantity, an algorithm for calculating safety stock, and graphs of inventory levels over time.
  - 3) The firm creates a dialog screen allowing the decision maker to specify time periods, particular products, and the variables for displaying on graphs.
- d. A **group DSS** aids in the collaborative solution of unstructured problems. Users in separate areas of the organization can specify parameters pertinent to their functions.

## 6. Expert System (ES)

- a. An expert system is an interactive system that attempts to imitate the reasoning of a human expert in a given field. It is useful for addressing unstructured problems when there is a local shortage of human experts.
- b. An expert system, like a decision support system, has three components:
  - 1) The **knowledge database** consists of facts and the relationships among those facts.
  - 2) The **inference engine** is often a series of if/then decisions.
  - 3) The **dialog** allows the user to input data relevant to the current problem, which are then filtered through the inference engine and used to query the knowledge database. A suggested optimal solution is returned to the user.

- c. The knowledge base and inference engine are relevant to a limited domain of human expertise. The inference procedures use symbolic processing based on heuristics rather than algorithms.
  - 1) A heuristic procedure is an exploratory problem-solving technique that uses self-education methods, e.g., the evaluation of feedback, to improve performance. These systems are often very interactive and provide explanations of their problem-solving behavior.
- d. **EXAMPLE:** A physician in a remote area inputs a patient's unfamiliar symptoms into an expert system. The system then asks him/her a series of questions. Unseen by the doctor, each question results from a series of if/then conditions. Once the system has gathered answers to all the relevant questions, it references the knowledge database and delivers a conclusion.
- e. Experimental work is being done with expert systems in taxation, financial accounting, managerial accounting, and auditing.

## 7. Artificial Intelligence (AI)

- a. Even more sophisticated than expert systems is computer software designed to **perceive, reason, and understand**.
  - 1) Expert systems work through a series of if/then questions, in which every operation has exactly two possible outcomes (yes/no, on/off, true/false, one/zero).
    - a) Human reasoning, on the other hand, is extremely complex, based on deduction, induction, intuition, emotion, and biochemistry, resulting in a range of possible outcomes.
  - 2) AI attempts to **imitate human decision making**, which hinges on this combination of knowledge and intuition (i.e., remembering relationships between variables based on experience).
  - 3) The advantage of AI in a business environment is that, relative to human experts, they
    - a) Can work 24 hours a day
    - b) Will not become ill, die, or be hired away
    - c) Are extremely fast processors of data, especially if numerous rules (procedures) must be evaluated
- b. **Fuzzy logic systems** are a form of artificial intelligence that deal with imprecise data and problems that have many solutions.
  - 1) Fuzzy logic, a departure from classical two-valued sets and logic, uses soft linguistic system variables (e.g., large, hot, or tall) and a continuous range of truth values rather than strict binary (true or false) decisions and assignments.
  - 2) Fuzzy rule-based systems apply these methods to solve many types of real-world problems, especially when a system is difficult to model, when it is controlled by a human operator or expert, or when ambiguity or vagueness is common.
  - 3) Fuzzy set theory allows objects to belong partly to multiple sets. Fuzzy logic is useful for describing **the vagueness of things in the real world**, where belonging to a set is really a matter of degree.
    - a) Fuzzy logic is particularly useful in **the design of industrial controls**, in data retrieval, and in systems in which the user is not intimately familiar with all the data. It is also useful when absolute accuracy is costly or judgments of value must be synthesized from multiple inputs.

- b) Fuzzy logic has emerged as a profitable tool for the controlling of subway systems and complex industrial processes, as well as for household and entertainment electronics, diagnostic systems, and other expert systems.
- 4) The key benefits of a fuzzy design are a simplified and reduced development cycle, ease of implementation, and more user-friendly and efficient performance.
- c. **Other AI topics** include the following:
  - 1) Neural networks are a collection of processing elements working together to process information much like the human brain, including learning from previous situations and generalizing concepts.
  - 2) Case-based reasoning systems use a process similar to that used by humans to learn from previous, similar experiences.
  - 3) Rule-based expert systems function on the basis of set rules to arrive at an answer. These cannot be changed by the system itself. They must be changed by an outside source (i.e., the computer programmer).
  - 4) Intelligent agents are programs that apply a built-in or learned knowledge base to execute a specific, repetitive, and predictable task, for example, showing a computer user how to perform a task or searching websites for particular financial information.

## 8. **Business Intelligence (BI)**

- a. Business intelligence is what gives upper management the information it needs to know where the organization is and how to steer it in the intended direction. BI gives an executive immediate information about an organization's critical success factors.
  - 1) BI has replaced the older executive support system and executive information system models.
- b. BI tools display information about the organization as bar graphs, pie charts, columnar reports, or any other format considered appropriate to upper management's decision making. These displays are sometimes grouped by a particular executive's needs into what is termed a **digital dashboard**.
  - 1) Stock price trend, sales by region and date, on-time delivery performance, instantaneous cash balances, and profitability by customer are possible metrics to be included.
- c. BI tools use data both from within and outside the organization.

## 9. **Enterprise Resource Planning (ERP)**

- a. ERP is the latest phase in the development of computerized systems for managing organizational resources. ERP is intended to integrate enterprise-wide information systems by creating one database linked to all of an organization's applications.
  - 1) At its most comprehensive, ERP subsumes materials requirements planning (MRP), manufacturing resource planning (MRP II), supply chain management (SCM), and customer relationship management (CRM).

- b. In the **traditional ERP system**, subsystems share data and coordinate their activities. Thus, if marketing receives an order, it can quickly verify that inventory is sufficient to notify shipping to process the order.
    - 1) Otherwise, production is notified to manufacture more of the product, with a consequent automatic adjustment of output schedules.
    - 2) If materials are inadequate for this purpose, the system will issue a purchase order.
    - 3) If more labor is needed, human resources will be instructed to reassign or hire employees.
    - 4) The foregoing business processes (and others) should interact seamlessly in an ERP system. Moreover, the current generation of ERP software also provides the capability for smooth (and instant) interaction with the business processes of external parties.
  - c. The subsystems in a traditional ERP system are internal to the organization. Hence, they are often called **back-office** functions. The information produced is principally (but not exclusively) intended for internal use by the organization's managers.
  - d. The **current generation** of ERP software (**ERP II**) has added **front-office** functions. These connect the organization with customers, suppliers, owners, creditors, and strategic allies (e.g., the members of a trading community or other business association).
    - 1) An ERP II system's integration with the firm's back-office functions enables supply-chain management, customer relationship management, and partner relationship management.
  - e. Because ERP software is costly and complex, it is usually installed only by the largest enterprises, but mid-size organizations are increasingly likely to buy ERP software.
    - 1) Major ERP packages include R/3 from SAP AG and Oracle e-Business Suite, PeopleSoft, and JD Edwards EnterpriseOne, all from Oracle Corp.
  - f. The disadvantages of ERP are its extent and complexity, which make implementation difficult and costly.
10. **Office Automation Systems (OASs)**
- a. The familiar word processing, spreadsheet, digital document storage, and desktop publishing applications of most office workers are part of any organization's information systems environment.
11. The tremendous variety of forms that information systems can take and the diverse needs of users have led to the concept of **information resources management (IRM)**, which takes a global view of the information holdings and needs of an organization.
- a. This view is promoted by the Information Resources Management Association of Hershey, PA (<http://www.irma-international.org/>).
12. **Financial reporting** systems generate information for use primarily by external parties, such as investors, regulators, and creditors. External financial reporting is commonly in the form of financial statements (balance sheet, income statement, and statement of cash flows). Thus, financial reporting is often backward looking.
- a. Internal financial reporting is also useful for management decision making, especially with regard to profitability and cost control.

- b. An organization's financial accounting system processes transactional inputs stated in monetary terms. The traditional audit trail permits the tracking of these inputs as they flow through the system.
  - 1) The audit trail reflects the accounting cycle, which starts with initial entry of transactions and culminates with external reporting. The following is the general form of the accounting cycle:
    - a) Entry of source data and filing of documentation, which may be paperless in modern systems
    - b) Making entries in general and special journals
    - c) Posting entries to accounts in the general and subsidiary ledgers
    - d) Preparing a trial balance
    - e) Preparing financial statements or other financial information to be reported
  - 2) Processing is performed electronically, with journals and ledgers maintained on magnetic disks or other storage media.
  - 3) Reports and other analyses can be generated quickly and at any time by the computer system.
  - 4) An audit trail permits the vouching of balances and other amounts in reports back through the system to the source data or the tracing of source data through the system to an amount in a report.
  - 5) Because computer processing may leave no hard-copy audit trail, systems should be designed to record transactions and balances before and after processing.
- 13. **Management reporting** has an internal focus on planning, control, and decision making that is primarily forward looking.
  - a. It involves nonfinancial as well as financial data that may be reported in flexible formats on a nonroutine basis.
  - b. Management reports are directed toward internal users, so they need not conform with GAAP.
  - c. One major element of a management reporting system is cost accounting, which applies to an organization's purchasing, production, distribution, and marketing functions. Regardless of the nature of the organization (manufacturing, service, governmental, or nonprofit), the emphasis of its cost accounting system is ultimately on the value added by its activities.
  - d. Another major element of a management reporting system is budgeting, a planning and managerial control tool. Budgets may have short-term (e.g., up to a fiscal year), intermediate (e.g., 2 to 5 years), and strategic (e.g., 5 to 10 years) horizons.

## 11.2 RISKS ASSOCIATED WITH BUSINESS INFORMATION SYSTEMS

1. The **goals** of a business information system are the same regardless of whether it is manual or computer-based. The **risks**, on the other hand, can be quite different.
  - a. **System availability.** The ability to make use of any computer-based system is dependent on
    - 1) An uninterrupted flow of electricity
    - 2) Protection of computer hardware from environmental hazards (e.g., fire and water)
    - 3) Protection of software and data files from unauthorized alteration
    - 4) Preservation of functioning communications channels between devices
  - b. **Volatile transaction trails.** In any computer-based environment, a complete trail useful for audit purposes might exist for only a short time or in only computer-readable form. In online and real-time systems, data are entered directly into the computer, eliminating portions of the audit trail provided by source documents.
  - c. **Decreased human involvement.** Because employees who enter transactions may never see the “final results,” the potential for detecting errors is reduced. Also, output from a computer system often carries a mystique of infallibility, reducing the incentive of system users to closely examine reports and transaction logs.
  - d. **Uniform processing of transactions.** Computer processing uniformly subjects like transactions to the same processing instructions, therefore virtually eliminating clerical error. Thus, it permits consistent application of predefined business rules and the performance of complex calculations in high volume.
    - 1) However, programming errors (or other similar systematic errors in either the hardware or software) will result in all like transactions being processed incorrectly.
  - e. **Unauthorized access.** When accounting records were kept in pen-and-ink format, physical access to them was the only way to carry out an alteration. Once they are computer-based, however, access can be carried out from multiple terminals throughout the organization or from anywhere in the world by determined “hackers” using the Internet.
    - 1) Security measures, such as firewalls and user id-and-password combinations, are thus vital to maintaining security over data in an automated environment.
  - f. **Data vulnerability.** Destruction of a few hardware devices or units of storage media could have disastrous consequences if they contain the only copies of crucial data files or application programs.
    - 1) For this reason, it is vital that an organization’s computer files be duplicated and stored offsite periodically.
  - g. **Reduced segregation of duties.** Many functions once performed by separate individuals may be combined in an automated environment.
    - 1) For example, receiving cash, issuing a receipt to the payor, preparing the deposit slip, and preparing the journal entry may once have been performed by separate individuals. In a computer-based system, the receipt, deposit slip, and journal entry may be automatically generated by the computer. If the same employee who receives the cash is also responsible for entering the relevant data into the system, the potential for error or fraud is increased.



- h. **Reduced individual authorization of transactions.** Certain transactions may be initiated automatically by a computer-based system. This is becoming ever more widespread as an increasing number of business processes become automated.
  - 1) For example, an ERP system at a manufacturing concern (see item 9. in Subunit 11.1) may automatically generate a purchase order when raw materials inventory reaches a certain level. If the company shares an EDI system with the vendor (see Subunit 15.2), the purchase order may be sent to the vendor electronically without any human intervention.
  - 2) This reduced level of oversight for individual transactions requires careful coding to ensure that computer programs accurately reflect management's goals for business processes.
- i. **Specialized knowledge.** From the beginning of the computer era in the 1950s, the ability to operate computer-based systems has depended on a high level of specialization and training among computer professionals.
  - 1) Even as computing has become more "democratized" by the prevalence of personal computers and the Internet, organizations require groups of employees dedicated to keeping their automated systems running.
  - 2) Attracting and retaining employees with the necessary skillsets can be time-consuming and expensive. This situation has led to the practice of **outsourcing**, the hiring of an outside firm to take over all or part of an organization's computer operations.
    - a) Advantages of outsourcing include, in addition to greater expertise, superior service quality, avoidance of changes in the organization's IT infrastructure, cost predictability, the freeing of human and financial capital, and avoidance of fixed costs.
    - b) Risks of outsourcing include the inflexibility of the relationship, the loss of control, the vulnerability of important information, and often dependency on a single vendor.

### 11.3 ROLES AND RESPONSIBILITIES WITHIN THE IT FUNCTION

#### 1. Typical IT Personnel

- a. **Database administrators (DBAs)** are responsible for developing and maintaining the organization's databases and for establishing controls to protect their integrity.
- b. **Network technicians** maintain the bridges, hubs, routers, switches, cabling, and other devices that interconnect the organization's computers. They are also responsible for maintaining the organization's connection to other networks, such as the Internet.
- c. The **webmaster** is responsible for the content of the organization's website. (S)he works closely with programmers and network technicians to ensure that the appropriate content is displayed and that the site is reliably available to users.
- d. **Computer (console) operators** are responsible for the moment-to-moment running of the organization's medium- and large-scale computers, i.e., servers and mainframes.
  - 1) Computers in this size range, unlike desktop computers, require 24-hour monitoring. Operators respond to messages received from the system by consulting run manuals that detail the steps for processing.
- e. **Librarians** maintain control over and accountability for documentation, programs, and data storage media.

- f. **Systems programmers** maintain and fine-tune the operating systems on the organization's medium- and large-scale computers. The operating system is the core software that performs three of a computer's four basic tasks, namely input, output, and storage (the transformation task is generally handled by application software; see item 2.a. in Subunit 12.2).
- g. **Applications programmers** design, write, test, and document computer programs according to specifications provided by the end users.
  - 1) These duties are often combined with those of systems analysts. A **systems analyst** uses his/her detailed knowledge of the organization's databases and applications programs to determine how an application should be designed to best serve the users' needs.
- h. **Help desk** personnel log problems reported by users, resolve minor difficulties, and forward more difficult problems to the appropriate person, such as a database administrator or the webmaster. Help desk personnel are often called on to resolve such issues as desktop computers crashing or problems with email.

## 2. Segregation of Duties within the IT Function

- a. **Information security.** Information systems pervade every part of a modern organization's operations. Therefore, the area of security over information systems is a distinct function within the larger IT function. The **chief information security officer** is responsible for formulating and enforcing a formal information security policy for all employees and outside parties, such as EDI partners, who have access to the organization's systems.
  - 1) Such a policy should, among other things, inform all those with access to the organization's systems that the organization's hardware, software, and network connections are purely for the benefit of the organization and not to be used for personal reasons.
  - 2) In addition, the IT security function is responsible for ensuring that persons both inside and outside the organization can only gain access to those programs and data elements which are appropriate for their job duties. This requires that the IT security officer and his/her subordinates are well trained in the use of the organization's security software.
- b. **Systems development and maintenance.** Users within the organization are constantly requesting the creation of new systems to help manage business processes and changes and enhancements to existing systems.
  - 1) **Systems analysts and applications programmers** are responsible for designing, building, and maintaining the organization's applications. Analysts and programmers should never be able to make changes directly to programs that are used in "live" production. A separate processing area devoted to development and testing should be set up and dedicated to the use of analysts and programmers.
  - 2) In addition, analysts and programmers should never have access to live production data; the data used to test new or altered programs should be stored in the separate development area along with the programs.
- c. **Computer operations.** Console operators are responsible only for the smooth running of the organization's medium- and large-scale computers, i.e., the scheduling of jobs and production of output.
  - 1) **Operators** should therefore have no access to make changes to applications programs. Ideally, computer operators should have no programming knowledge or access to documentation not strictly necessary for their work ("ignorance is a good internal control").

- 2) **Librarians** are responsible for “checking out” applications programs to analysts and programmers for modification and testing and for ensuring that the properly tested version gets “checked in” to production. Ideally, they too should have no programming knowledge.
- d. **Data administration.** The totality of an organization’s data is an extremely valuable asset. Hardware can be replaced for a price, but each organization’s data bundle is unique and is indispensable to carrying on business. In large organizations, the task of organizing and storing data is often divided into two subfunctions.
  - 1) **Data administrators** determine how the organization’s data should be stored and what relationships among the data best achieve the organization’s business objectives.
    - a) Confusingly, this function is also called database analyst.
  - 2) **Database administrators (DBAs)** keep the organization’s databases running efficiently.
    - a) Every database is a unique combination of
      - i) The relationships among the data (the schema),
      - ii) The database management system (the software), and
      - iii) The equipment on which the database is stored (the hardware).
    - b) Keeping a complex database “tuned” is a demanding task requiring a great deal of technical knowledge.
  - 3) Depending on the size of the organization, the functions of data administrator and database administrator are often combined in a single job.
    - a) Because they have unfettered access to the organization’s production data, employees in these functions should have no access to the application programs that process the data.
- e. **End users.** In an organizational sense, the “**owners**” of data are the end user departments; the accounting function is responsible for the accuracy of accounting data, the marketing function is responsible for the accuracy of marketing data, etc. The IT function is merely the **custodian** of the data.
  - 1) User departments should be able to access and alter only the data pertaining to their job duties; e.g., credit managers should not be able to alter accounts payable data. End users should never be able to access the code underlying applications programs.

## 11.4 SYSTEMS DEVELOPMENT AND DESIGN

1. Developing a computer-based information system is a creative and demanding task that can and should produce economic benefits for an organization.
  - a. However, systems development can be a disaster, with labor and financial resources being expended with no observable return and perhaps even a system that cannot be completed.
    - 1) Positive results are more frequently obtained if the process is **formally structured, documented, and subject to management controls.**
  - b. By far the the most common methodology for building new information systems is the **systems development life-cycle (SDLC) approach.**
    - 1) The SDLC approach is highly structured and, if properly followed, can help an organization deploy maintainable, well-documented systems with the functionality that was intended.

2. The steps in the systems development life-cycle are as follows:

- a. The **project definition phase** includes
  - 1) Preparing the project proposal
  - 2) Determining project priority
  - 3) Submitting the proposal for approval
- b. A **feasibility study** consists of
  - 1) An investigation of the current system
  - 2) Determination of the information and processing requirements
  - 3) Evaluation of the possible applications of computer data processing
  - 4) Selection of the best option
  - 5) An evaluation of the proposed design choice's cost effectiveness and impact on the organization
- c. A **cost-benefit analysis** is the analysis tool to use in selecting the best system alternative.
  - 1) Feasibility studies should include an analysis of the cost-benefit ratio of any system alternatives.
  - 2) In many cases, the best possible system may not be cost effective.
  - 3) Thus, once the decision makers have determined that two or more system alternatives are acceptable, the cost-benefit relationship should be used to select the best system for a particular application.
- d. The **project initiation phase** includes
  - 1) Promptly informing managers and employees about the project
  - 2) Assembling the project team (possibly including systems analysts, programmers, accountants, and users)
  - 3) Training selected personnel to improve necessary skills and enhance communication among team members
  - 4) Establishing project controls (e.g., by implementing a project scheduling technique such as PERT)
- e. **Systems analysis** is the process of learning how a system functions, determining the needs of users, and developing the logical requirements of a proposed system.
  - 1) A systems analysis requires a survey of the existing system, the organization itself, and the organization's environment to determine (among other things) whether a new system is needed.
  - 2) The survey results determine not only what, where, how, and by whom activities are performed but also why, how well, and whether they should be done at all.
  - 3) Ascertaining the problems and informational needs of decision makers is the next step.
  - 4) The **systems analyst** must consider the entity's key success variables (factors that determine its success or failure), the decisions currently being made and those that should be made, the factors important in decision making (timing, relation to other decisions, etc.), the information needed for decisions, and how well the current system makes those decisions.
  - 5) Finally, the systems analysis should establish the requirements of a system that will meet user needs.

- f. The process of developing specifications for the components of a system is **systems design**.
  - 1) Detailed systems design involves developing specifications regarding input, processing, internal controls and security measures, programs, procedures, output, and databases.
  - 2) The three major activities of systems design are user interface design, data design, and process design.
  - 3) Systems design determines how information requirements will be met.
  - 4) It concerns how users will interact with the system to meet their needs, how data will be organized, and the formulation of processing steps.
- g. **Physical database design** depends on the existing system.
  - 1) New files or a new database may have to be designed.
  - 2) Modifying an existing database may be feasible.
  - 3) If the existing database provides for the new application, modification may not be necessary.
- h. **Program development** entails coding programs in accordance with the specifications in the physical design phase and then testing the results.
  - 1) **Structured programming** divides the system's set of programs into discrete modules by functional specifications.
    - a) The objective is to create modules that are independent logical units, each of which has one entry and one exit point.
    - b) This reduces the complexity resulting from instructions that jump back and forth among different sections of the program (called "spaghetti code").
    - c) Data sharing among modules should also be minimized.
  - 2) Each module can be coded by a separate team to
    - a) Facilitate security, because no one group knows the complete set of programs
    - b) Expedite the development process, because several programming teams can work simultaneously
    - c) Facilitate maintenance, because a change or patch need only be module-specific, a less complicated procedure than fitting a patch to a complex, multifunction program
- i. **Procedure development** includes writing technical manuals, forms, and other materials for all persons who will use, maintain, or otherwise work with the system.
- j. **Installation and operation** are the final phases of the SDLC.
  - 1) Training and educating system users is important not only for proper use of the system but also to offset the resistance of users whose jobs may have been substantially changed.
  - 2) Acceptance testing by users of inputs, outputs, programs, and procedures is necessary to determine that the new system meets their needs.
  - 3) Systems conversion is the final testing and switchover.
    - a) **Parallel operation** is the operation of the old and new systems simultaneously until satisfaction is obtained that the new system is operating as expected.
    - b) **Pilot operation** (modular or phase-in conversion) is the conversion to the new or modified system by module or segment, e.g., one division, department, function, or branch of the company at a time. One disadvantage is the extension of the conversion time.

- 4) Systems follow-up or post-implementation evaluation is a subsequent review of the efficiency and effectiveness of the system after it has operated for a substantial time (e.g., 1 year).
- k. **Errors** can be corrected most easily and clearly when they are found at an early stage of systems development. Their correction becomes more costly as the life cycle progresses.
- l. **Systems maintenance** must be undertaken by systems analysts and applications programmers continuously throughout the life of a system.
  - 1) Maintenance is the redesign of the system and programs to meet new needs or to correct design flaws.
  - 2) Ideally, these changes should be made as part of a regular program of preventive maintenance.