INFORMATION SYSTEMS ENGINEERING

1.1 DEFINITION: An **information system** (**IS**) is a computerized <u>database</u> designed to accept, store, process, transform, make useful, and analyze data and to report results, usually on a regular, ongoing basis. It is often construed as a larger system including not only the database and the software and hardware (see <u>information technology</u>) used to manage it but also including the people using and benefiting from it and also including all necessary manual and machine procedures and communication systems.

The term is however also used in the broader sense of "any means for communicating knowledge from one person to another, such as by simple verbal communication, punched-card systems, optical coincidence systems based on coordinate indexing, and completely computerized methods of storing, searching, and retrieving of information". The term is also sometimes used in more restricted senses to refer to only the software used to run a computerized database or to refer to only a computer system.

The plural term *information systems* (construed as singular) is also used for the actual academic study of the field, in other words for the study of complementary networks of hardware and software that people and organizations use to collect, filter, process, create and distribute <u>data</u>.

Any specific information system aims to support operations, management and <u>decision making</u>. In a broad sense, the term is used to refer not only to the <u>information and communication technology</u> (ICT) that an organization uses, but also to the way in which people interact with this technology in support of business processes.

Some authors make a clear distinction between information systems, <u>computer systems</u>, and <u>business processes</u>. Information systems typically include an ICT component but are not purely concerned with ICT, focusing instead on the end use of information technology. Information systems are also different from business processes. Information systems help to control the performance of business processes.

Alter argues for advantages of viewing an information system as a special type of <u>work system</u>. A work system is a system in which humans and/or machines perform work (processes and activities) using resources to produce specific products and/or services for customers. An information system is a work system

whose activities are devoted to processing (capturing, transmitting, storing, retrieving, manipulating and displaying) information.

As such, information systems inter-relate with data systems on the one hand and activity systems on the other. An information system is a form of communication system in which data represent and are processed as a form of social memory. An information system can also be considered a semi-formal language which supports human decision making and action.

Information systems are the primary focus of study for organizational informatics.

History

Numerous legacy information systems still exist today that are continuously updated to promote ethnographic approaches, to ensure data integrity, and to improve the social effectiveness & efficiency of the whole process.[17] In general, information systems are focused upon processing information within organizations, especially within business enterprises, and sharing the benefits with modern society.

Overview

Silver et al. (1995) provided two views on IS that includes software, hardware, data, people, and procedures. Zheng provided another system view of information system which also adds processes and essential system elements like environment, boundary, purpose, and interactions. The Association for Computing Machinery defines "Information systems specialists as focusing on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises."

There are various types of information systems, for example: transaction processing systems, decision support systems, knowledge management systems, learning management systems, database management systems, and office information systems. Critical to most information systems are information technologies, which are typically designed to enable humans to perform tasks for which the human brain is not well suited, such as: handling large amounts of information, performing complex calculations, and controlling many simultaneous processes.

Information technologies are a very important and malleable resource available to executives. Many companies have created a position of Chief Information Officer

(CIO) that sits on the executive board with the <u>Chief Executive Officer</u> (CEO), <u>Chief Financial Officer</u> (CFO), <u>Chief Operating Officer</u> (COO) and <u>Chief Technical Officer</u> (CTO). The CTO may also serve as CIO [Chief Information Officer], and vice versa. The <u>Chief Information Security Officer</u> (CISO) focuses on information security management.

Components

The 5 components that must come together in order to produce a computer-based information system are:

1. Hardware: The term hardware refers to machinery. This category includes the computer itself, which is often referred to as the central processing unit (CPU), and all of its support equipment. Among the support equipment are input and output devices, storage devices and communications devices.

2. Software: The term software refers to computer programs and the manuals (if any) that support them. Computer programs are machine-readable instructions that direct the circuitry within the hardware parts of the system to function in ways that produce useful information from data. Programs are generally stored on some input / output medium, often a disk or tape.

3. Data: Data are facts that are used by programs to produce useful information. Like programs, data are generally stored in machine-readable form on disk or tape until the computer needs them.

4. Procedures: Procedures are the policies that govern the operation of a computer system. "Procedures are to people what software is to hardware" is a common analogy that is used to illustrate the role of procedures in a system.

5. People: Every system needs people if it is to be useful. Often the most over-looked element of the system are the people, probably the component that most influence the success or failure of information systems.

Types of information systems

A four level pyramid model of different types of information systems based on the different levels of hierarchy in an organization

The "classic" view of Information systems found in the textbooks in the 1980s was of a pyramid of systems that reflected the hierarchy of the organization, usually

transaction processing systems at the bottom of the pyramid, followed by management information systems, decision support systems, and ending with executive information systems at the top. Although the pyramid model remains useful, since it was first formulated a number of new technologies have been developed and new categories of information systems have emerged, some of which no longer fit easily into the original pyramid model.

Some examples of such systems are:

- data warehouses
- enterprise resource planning
- enterprise systems
- expert systems
- search engines
- geographic information system
- global information system
- office automation.

A **computer (-based) information system** is essentially an IS using computer technology to carry out some or all of its planned tasks. The basic components of computer based information system are:

- *Hardware-* these are the devices like the monitor, processor, printer and keyboard, all of which work together to accept, process, show data and information.
- *Software-* are the programs that allow the hardware to process the data.
- *Databases-* are the gathering of associated files or tables containing related data.
- *Networks-* are a connecting system that allows diverse computers to distribute resources.
- *Procedures-* are the commands for combining the components above to process information and produce the preferred output.

The first four components (hardware, software, database, and network) make up what is known as the information technology platform. Information technology workers could then use these components to create information systems that watch over safety measures, risk and the management of data. These actions are known as information technology services.

Certain information systems support parts of organizations, others support entire organizations, and still others, support groups of organizations. Recall that each

department or functional area within an organization has its own collection of application programs, or information systems. These functional area information systems (FAIS) are supporting pillars for more general IS namely, business intelligence systems and dashboards. As the name suggest, each FAIS support a particular function are within the organization, e.g.: accounting IS, finance IS, production/operation management (POM) IS, marketing IS, and human resources IS. In finance and accounting, managers use IT systems to forecast revenues and business activity, to determine the best sources and uses of funds, and to perform audits to ensure that the organization is fundamentally sound and that all financial reports and documents are accurate. Other types of organizational information systems are FAIS, Transaction processing systems, enterprise resource planning, office automation system, management information system, decision support system, expert system, executive dashboard, supply chain management system, and electronic commerce system. Dashboards are a special form of IS that support all managers of the organization. They provide rapid access to timely information and direct access to structured information in the form of reports. Expert systems attempt to duplicate the work of human experts by applying reasoning capabilities, knowledge, and expertise within a specific domain.

Information system development

Information technology departments in larger organizations tend to strongly influence the development, use, and application of information technology in the organizations. A series of methodologies and processes can be used to develop and use an information system. Many developers now use an engineering approach such as the system development life cycle (SDLC), which is a systematic procedure of developing an information system through stages that occur in sequence. An information system can be developed in house (within the organization) or outsourced. This can be accomplished by outsourcing certain components or the entire system. A specific case is the geographical distribution of the development team (offshoring, global information system).

A computer based information system, following a definition of Langefors, is a technologically implemented medium for:

- recording, storing, and disseminating linguistic expressions,
- as well as for drawing conclusions from such expressions.

Geographic information systems, land information systems, and disaster information systems are examples of emerging information systems, but they can

be broadly considered as spatial information systems. System development is done in stages which include:

- Problem recognition and specification
- Information gathering
- Requirements specification for the new system
- System design
- System construction
- System implementation
- Review and maintenance.

The academic discipline

The field of study called *information systems* encompasses a variety of disciplines such as: the analysis and design of systems, computer networking, information security, database management and decision support systems. *Information management* deals with the practical and theoretical problems of collecting and analyzing information in a business function area including business productivity tools, applications programming and implementation, electronic commerce, digital media production, data mining, and decision support. *Communications and networking* deals with the telecommunication technologies. Information systems bridges business and computer science using the theoretical foundations of information and computation to study various business models and related algorithmic processes within a computer science discipline.

Computer information system(s) (**CIS**) is a field studying computers and algorithmic processes, including their principles, their software and hardware designs, their applications, and their impact on society, whereas IS emphasizes functionality over design.

Several IS scholars have debated the nature and foundations of Information Systems which has its roots in other reference disciplines such as Computer Science, Engineering, Mathematics, Management Science, Cybernetics, and others. Information systems also can be defined as a collection of hardware, software, data, people and procedures that work together to produce quality information.

The impact on economic models

- Microeconomic theory model
- Transaction cost theory
- Agency theory

Differentiating IS from related disciplines

Information Systems relationship to Information Technology, Computer Science, Information Science, and Business.

Similar to computer science, other disciplines can be seen as both related and foundation disciplines of IS. The domain of study of IS involves the study of theories and practices related to the social and technological phenomena, which determine the development, use, and effects of information systems in organization and society. But, while there may be considerable overlap of the disciplines at the boundaries, the disciplines are still differentiated by the focus, purpose, and orientation of their activities.

In a broad scope, the term *Information Systems* is a scientific field of study that addresses the range of strategic, managerial, and operational activities involved in the gathering, processing, storing, distributing, and use of information and its associated technologies in society and organizations.[48] The term information systems is also used to describe an organizational function that applies IS knowledge in industry, government agencies, and not-for-profit organizations.[48] *Information Systems* often refers to the interaction between algorithmic processes and technology. This interaction can occur within or across organizational boundaries. An information system is the technology an organization uses and also the way in which the organizations interact with the technology and the way in which the technology works with the organization's business processes. Information systems are distinct from information technology (IT) in that an information system has an information technology component that interacts with the processes' components.

One problem with that approach is that it prevents the IS field from being interested in non-organizational use of ICT, such as in social networking, computer gaming, mobile personal usage, etc. A different way of differentiating the IS field from its neighbours is to ask, "Which aspects of reality are most meaningful in the IS field and other fields?" This approach, based on philosophy, helps to define not just the focus, purpose and orientation, but also the dignity, destiny and responsibility of the field among other fields

Information systems career pathways

Information Systems have a number of different areas of work:

- IS strategy

- IS management
- IS development
- IS iteration
- IS organization

There is a wide variety of career paths in the information systems discipline. "Workers with specialized technical knowledge and strong communications skills will have the best prospects. Workers with management skills and an understanding of business practices and principles will have excellent opportunities, as companies are increasingly looking to technology to drive their revenue."

Information technology is important to the operation of contemporary businesses, it offers many employment opportunities. The information systems field includes the people in organizations who design and build information systems, the people who use those systems, and the people responsible for managing those systems. The demand for traditional IT staff such as programmers, business analysts, systems analysts, and designer is significant. Many well-paid jobs exist in areas of Information technology. At the top of the list is the chief information officer (CIO).

The CIO is the executive who is in charge of the IS function. In most organizations, the CIO works with the chief executive officer (CEO), the chief financial officer (CFO), and other senior executives. Therefore, he or she actively participates in the organization's strategic planning process.

Information systems research

Information systems research is generally interdisciplinary concerned with the study of the effects of information systems on the behavior of individuals, groups, and organizations. Hevner et al. (2004) categorized research in IS into two scientific paradigms including *behavioral science* which is to develop and verify theories that explain or predict human or organizational behavior and *design science* which extends the boundaries of human and organizational capabilities by creating new and innovative artifacts.

Salvatore March and Gerald Smith proposed a framework for researching different aspects of Information Technology including outputs of the research (research outputs) and activities to carry out this research (research activities). They identified research outputs as follows:

1. *Constructs* which are concepts that form the vocabulary of a domain. They constitute a conceptualization used to describe problems within the domain and to specify their solutions.
2. A *model* which is a set of propositions or statements expressing relationships among constructs.
3. A *method* which is a set of steps (an algorithm or guideline) used to perform a task. Methods are based on a set of underlying constructs and a representation (model) of the solution space.
4. An *instantiation* is the realization of an artifact in its environment.

Also research activities including:

1. *Build* an artifact to perform a specific task.
2. *Evaluate* the artifact to determine if any progress has been achieved.
3. Given an artifact whose performance has been evaluated, it is important to determine why and how the artifact worked or did not work within its environment. Therefore *theorize* and *justify* theories about IT artifacts.

Although Information Systems as a discipline has been evolving for over 30 years now, the core focus or identity of IS research is still subject to debate among scholars. There are two main views around this debate: a narrow view focusing on the IT artifact as the core subject matter of IS research, and a broad view that focuses on the interplay between social and technical aspects of IT that is embedded into a dynamic evolving context. A third view calls on IS scholars to pay balanced attention to both the IT artifact and its context.

Since the study of information systems is an applied field, industry practitioners expect information systems research to generate findings that are immediately applicable in practice. This is not always the case however, as information systems researchers often explore behavioral issues in much more depth than practitioners would expect them to do. This may render information systems research results difficult to understand, and has led to criticism.

To study an information system itself, rather than its effects, information systems models are used, such as EATPUT.

The international body of Information Systems researchers, the Association for Information Systems (AIS), and its Senior Scholars Forum Subcommittee on Journals (23 April 2007), proposed a 'basket' of journals that the AIS deems as 'excellent', and nominated: Management Information Systems Quarterly (MISQ), Information Systems Research (ISR), Journal of the Association for Information

Systems (JAIS), Journal of Management Information Systems (JMIS), European Journal of Information Systems (EJIS), and Information Systems Journal (ISJ).

A number of annual information systems conferences are run in various parts of the world, the majority of which are peer reviewed. The AIS directly runs the International Conference on Information Systems (ICIS) and the Americas Conference on Information Systems (AMCIS), while AIS affiliated conferences include the Pacific Asia Conference on Information Systems (PACIS), European Conference on Information Systems (ECIS), the Mediterranean Conference on Information Systems (MCIS), the International Conference on Information Resources Management (Conf-IRM) and the Wuhan International Conference on E-Business (WHICEB). AIS chapter conferences include Australasian Conference on Information Systems (ACIS), Information Systems Research Conference in Scandinavia (IRIS), Conference of the Italian Chapter of AIS (itAIS), Annual Mid-Western AIS Conference (MWAIS) and Annual Conference of the Southern AIS (SAIS).