Information System Basics 3

3.1 Introduction

Every domain usually has its own terminology, which often differs from the ordinary understanding of concepts and terms. This chapter presents the terminology for information systems and their management, as used in this book. It is, therefore, essential to read this chapter carefully. All relevant concepts can also be found in the Thesaurus at the end of the book.

After reading this chapter, you should be able to answer the following questions:

- What is the difference between data, information, and knowledge?
- What are information systems, and what are their components?
- What is information management?

3.2 Data, Information, and Knowledge

Data constitute reinterpretable representations of information, or knowledge, in a formalized manner suitable for communication, interpretation, or processing by humans or machines. Formalization may take the form of discrete characters or of continuous signals (e.g., sound signals). To be reinterpretable, there has to be an agreement on how data represent information. For example, "Peter Smith" or "001001110" are data. A set of data that is put together for the purpose of transmission and that is considered to be one entity for this purpose is called a message.

There is no unique definition of information. Depending on the point of view, the definition may deal with a syntactic aspect (the structure), a semantic aspect (the meaning), or a pragmatic aspect (the intention or goal of information). We will simply define information as specific determination about entities such as facts, events, things, persons, processes, ideas, or concepts. For example, when a physician determines the diagnosis (facts) of a patient (person), then he or she has information.

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Knowledge is general information about concepts in a certain (scientific or professional) domain (e.g., about diseases, therapeutic methods). Knowledge contrasts with specific information about particular individuals of the domain (e.g., patients). The knowledge of a nurse, for example, comprises how to typically deal with patients suffering from decubitus.

For the sake of simplicity, we will often use the term information processing when we mean processing of data together with its related information and knowledge.

3.3 Information Systems and Their Components

3.3.1 Systems and Subsystems

Before talking about information systems, let us first define the concept system. As defined here, a system is a set of persons, things, events, and their relationships that forms an integrated whole. We distinguish between natural systems and artificial (man-made) systems. For example, the nervous system is a typical natural system, consisting of neurons and their relationships. A man-made system is, for example, a hospital, consisting of staff, patients, and relatives, and their interactions. If a (man-made) system consists of both human and technical components, it can be called a socio-technical system.

A system can, in principle, be divided into subsystems that comprise a subset of the components and the relationships between them. For example, a possible subsystem of the nervous system is the sympathetic nervous system. A subsystem of a hospital is, for example, a ward with its staff and patients.

Subsystems themselves are again systems.

3.3.2 Information Systems

An information system is that part of an institution that processes and stores data, information, and knowledge. It can be defined as that socio-technical subsystem of an institution, which comprises all information processing as well as the associated human or technical actors in their respective information processing roles. This means that, for example, the computers, printers, telephones, as well as the staff using them to manage information are part of the information system of an institution.

"Socio-" refers to the people involved in information processing (e.g., health care professionals, administrative staff, and computer scientists), whereas "technical" refers to information processing tools (e.g., computers, telephones, and patient records). The people and machines in an institution are considered only in their role as information processors, carrying out specific actions following established rules.

An information system that comprises computer-based information processing and communication tools is called a computer-based information system. An information

system can be divided into subsystems, which are called sub-information systems. For example, the information system of an institution can be split into two sub-information systems: the part where computer-based tools are used is called the computer-based part; the rest is called the non-computer-based part of an information system.

3.3.3 Components of Information Systems

When describing an information system, it can help to look at the following typical components of information systems: enterprise functions, business processes, application components, and physical data processing systems.[1]

An enterprise function describes what acting human or machines have to do in a certain enterprise to contribute to its mission and goals. For example, *patient admission*, *medical and nursing care planning*, or *financial accounting* describe typical enterprise functions. Enterprise functions are ongoing and continuous. They describe what is to be done, not how it is done. Enterprise functions can be structured into a hierarchy of enterprise functions, where an enterprise function can be described in more detail by refined sub-functions. Enterprise functions are usually denoted by nouns or gerunds (i.e., words ending with -ing). The actions summarized by an enterprise function are in most cases significantly dealing with information processing. Later on we will focus more strictly on this aspect and therefore restrict to information processing enterprise functions (see Sect. 5.3.2.1).

For the sake of simplicity, we will refer to enterprise functions as hospital functions, if the respective enterprise is a hospital.

An activity is an instantiation of an enterprise function. For example, "the physician admits the patient Smith" is an activity of the enterprise function *patient admission*. In contrast to enterprise functions, activities have a definite beginning and end.

To describe how an enterprise function is performed, not only may information about its refined sub-functions be needed, but information about their chronological and logical sequence may also be needed. With business processes, the sequence of (sub-)functions together with the conditions under which they are performed can be described. Business processes are usually denoted by verbs, which can be followed by a noun (e.g., "admitting a patient," "planning care" or "writing a discharge letter"). Process instances are composed of the individual activities; hence they also have a definite beginning and end. While enterprise functions concentrate on the "what," business processes focus on the "how" of activities. Enterprise functions can be considered as representatives of business processes.

Whereas enterprise functions describe what is done, we now want to consider tools for processing data, in particular application components and physical data processing systems. Both are usually referred to as information processing tools. They describe the means used for information processing.

Application components support enterprise functions. We distinguish computer-based from non-computer-based application components. Computer-based application components are controlled by software products. A software product is an acquired or self-developed

[1]We will give little bit more formal definition of these terms later on in Sect. 5.3.2.

piece of software that can be installed on a computer system. For example, the computer-based application component *patient administration system* stands for the installation of a software product to support enterprise functions such as *patient admission* and *administrative discharge and billing*.

Non-computer-based application components are controlled by working plans that describe how people use certain physical data processing systems. For example, a non-computer-based application component called nursing management and documentation system is controlled by rules regarding how, by whom, and in which context given forms for nursing documentation have to be used. In this example, the paper-based forms that are used represent physical data processing systems (see Fig. 3.1).

Communication and cooperation among application components must be organized in such a way that the enterprise functions are adequately supported.

Physical data processing systems, finally, describe the information processing tools that are used to implement computer-based as well as non-computer-based application components. Physical data processing systems can be human actors (such as the person delivering mail), non-computer-based physical tools such as forms for nursing documentation, paper-based patient records or telephones, or computer systems (such as terminals, servers, and personal computers). Computer systems can be physically connected via data wires, leading to physical networks. Figure 3.2 shows some typical physical data processing

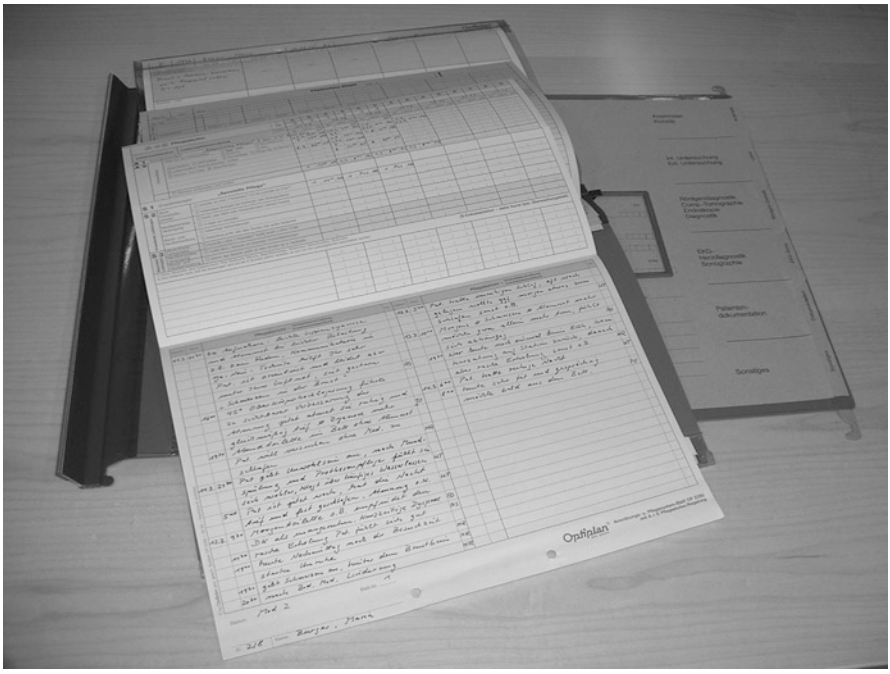

Fig. 3.1 An example for forms and folders for nursing documentation, representing a physical data processing system. The rules that describe who may use these forms, and how they should be used, make up the application component

systems. The printer, for example, could contribute in the implementation of the application component *medical documentation system* by printing documentation forms.

Details on the most relevant information processing tools in hospitals can be found in Sects. 6.4 and 6.6.

3.3.4 Architecture and Infrastructure of Information Systems

The architecture of an information system describes its fundamental organization, represented by its components, their relationships to each other and to the environment, and by the principles guiding its design and evolution.[2] The architecture of an information system can be described by the enterprise functions, the business processes, the information processing tools, and their relationships.

There may be several architectural views of an information system, for example, a functional view looking primarily at the enterprise functions, a process view looking primarily at the business processes, etc. Architectures that are equivalent with regard to certain characteristics can be summarized in a certain architectural style.

Fig. 3.2 Typical physical data processing systems in an outpatient unit (e.g., printer, telephone, and non-computer-based patient record)

[2]Institute of Electrical and Electronics Engineers (IEEE). Std 1471-2000: Recommended Practice for Architectural Description of Software-Intensive Systems. September 2000. http://standards.ieee.org

When the focus is put onto the types, number, and availability of information processing tools used in a given enterprise, this is also called the infrastructure of an information system.

3.4 Information Management

In general, management comprises all leadership activities that determine the institution's goals, structures, and behaviors. Accordingly, information management (or management of information systems) comprises those management activities that deal with the management of information processing in an institution, for example, a hospital. The goal of information management is systematic information processing that contributes to the institution's strategic goals (such as efficient patient care and high satisfaction of patients and staff in a hospital). Information management therefore directly contributes to the institution's success and ability to compete.
The general tasks of information management are planning, directing, and monitoring. In other words, this means

- planning the information system and its architecture,
- directing its establishment and its operation , and
- monitoring its development and operation with respect to the planned objectives .

Information management encompasses the management of all components of an information system – the management of enterprise functions and business processes, of application components, and of physical data processing systems.

Information management can be differentiated into *strategic, tactical*, and *operational information management*. *Strategic information management* deals with information processing as a whole. *Tactical information management* deals with particular enterprise functions or with application components that are introduced, removed, or changed. *Operational information management*, finally, is responsible for operating the components of the information system. It cares for its smooth operation, for example, by planning necessary personal resources, by failure management, or by network monitoring. Information management in hospitals is discussed in detail in Sect. 9.2.

3.5 Exercises

3.5.1 On the Term Information System

Try to describe in your own words, what the term information system, as introduced in Sect. 3.3, means.

3.5.2 On Enterprise Functions

Choose two different types of enterprises, for example, a bank and a theatre. Try to list five major enterprise functions for these enterprises.

3.5.3 On Application Components

Please look at Fig. 3.1. It shows a physical data processing system. Please try to formulate some rules as to how the different parts are to be used, and by whom, to implement a non-computer-based nursing documentation system as application component. Do you need any other physical data processing systems to implement this application component?

3.5.4 On Architectures and Infrastructures

Let us for this exercise focus on the architecture of houses (not on the architecture of information systems). Describe two different architectural styles for houses. Identify five items, which are important to describe the infrastructure of a certain house.

3.5.5 On Information Management

What does information management mean? Describe three information management tasks in your everyday life.

3.6 Summary

When working on information systems, we must distinguish between data, information, and knowledge:

- Data can be defined as a representation of information, or knowledge in a formalized manner, suitable for communicating, interpreting, or processing.
- Information can be defined as specific determination about entities, such as facts, events, things, persons, processes, ideas, or concepts.
- Knowledge can be defined as general information about concepts in a certain domain.

A system is a set of persons, things, events, and their relationships that form an integrated whole. Systems can be divided into subsystems.

An information system can be defined as the socio-technical subsystem of an institution, which comprises all information processing as well as the associated human or technical actors in their respective information processing roles. Typical components of information systems are:

- the enterprise functions supported;
- the business processes that take place;
- the application components that support the enterprise functions;
- the physical data processing systems the application components are executed on.

The subsystem of an information system where computer-based tools are used is called the computer-based part of the information system. The architecture of an information system describes its fundamental organization, represented by its components, their relationships to each other and to the environment, and by the principles guiding its design and evolution.

Information management comprises those management activities in an institution that deal with the management of information processing and therefore with the management of the institution's information system.