2 The Nature of Knowledge

In the previous chapter, we provided an introduction to the basic concepts of knowledge management. This chapter takes the next step by explaining in detail what we mean by **knowledge**. It also distinguishes knowledge from **data** and from **information** and illustrates these three concepts using some examples. This chapter also summarizes some of the perspectives commonly used to view knowledge, including both subjective and objective viewpoints. Moreover, it describes some of the ways to classify knowledge and identifies some attributes that may be used to characterize different types of knowledge. It also relates knowledge to the concept of **intellectual capital** and its various dimensions. Finally, the chapter also explains the various reservoirs, or locations, in which knowledge might reside.

What Is Knowledge?

"Knowledge" is quite distinct from "data" and "information," although the three terms are sometimes used interchangeably. However, they are quite distinct in nature. In this section, we define and illustrate these concepts and differentiate among them. This discussion also leads to our definition of knowledge.

Data comprise facts, observations, or perceptions (which may or may not be correct). By itself, data represent raw numbers or assertions and may therefore be devoid of context, meaning, or intent. Let us consider three examples of what is considered to be data. We will then build upon these examples to examine the meaning of information and knowledge.

Example 1: That a sales order at a restaurant included two large burgers and two medium-sized vanilla milkshakes is an example of data.

Example 2: The observation that upon tossing a coin it landed heads also illustrates data.

Example 3: The wind component (u and v) coordinates for a particular hurricane's trajectory, at specific instances of time is likewise considered data.

Although data are devoid of context, meaning, or intent it can be easily captured, stored, and communicated using electronic or other media.

Information is a subset of data, only including those data that possess context, relevance, and purpose. Information typically involves the manipulation of raw data to obtain a more meaningful indication of trends or patterns in the data. Let us continue with the three aforementioned examples:

Example 1: For the manager of the restaurant, the numbers indicating the daily sales (in dollars, quantity, or percentage of daily sales) of burgers, vanilla milkshakes, and other products are information. The manager can use such information to make decisions regarding pricing and raw material purchases.

Example 2: Let us assume that the context of the coin toss is a betting situation where John is offering to pay anyone $10 if the coin lands heads but take $8 if the coin lands tails. Susan is considering whether to take up John's bet, and she benefits from knowing that the last 100 times the coin was tossed, it landed heads 40 times and tails on 60 occasions. The result of each individual toss (head or tail) are data, but is not directly useful. It is therefore data but not information. By contrast, that 40 heads and 60 tails resulted from the last 100 tosses are also data, but they can be directly used to compute probabilities of heads and tails and hence to make the decision. Therefore, they are also information for Susan.

Example 3: Based on the *u* and *v* components, hurricane software models may be used to create a forecast of the hurricane trajectory. The hurricane forecast is information.

As can be seen from these examples, whether certain facts are information or only data depends on the individual who is using those facts. The facts about the daily sales of burgers represent information for the store manager but only data for a customer. If the restaurant is one out of a chain of 250 restaurants, these facts about daily sales are also data for the CEO of the chain. Similarly, the facts about the coin toss are simply data for an individual who is not interested in betting.

Knowledge has been distinguished from data and information in two different ways. A more simplistic view considers knowledge as being at the highest level in a hierarchy with information at the middle level and data at the lowest level. According to this view, knowledge refers to information that enables action and decisions or information with direction. Hence, knowledge is intrinsically similar to information and data, although it is the richest and deepest of the three, and is consequently also the most valuable. Based on this view, data refer to bare facts void of context, for example a telephone number. Information is data in context, for example a phone book. Knowledge is information that facilitates action, for example, individuals who are the domain experts within an organization. An example of knowledge includes recognizing that a phone number belongs to a good client who needs to be called once per week to get his orders.

Although this simplistic view of knowledge may not be completely inaccurate, we feel it doesn't fully explain the characteristics of knowledge. Instead, we use a more complete perspective, according to which knowledge is intrinsically different from information. Instead of considering knowledge as a richer or more detailed set of facts, we define knowledge in an area as *justified beliefs about relationships among concepts relevant to that particular area.* This definition has support in the literature (Nonaka 1994). Let us now consider how this definition works for the above examples.

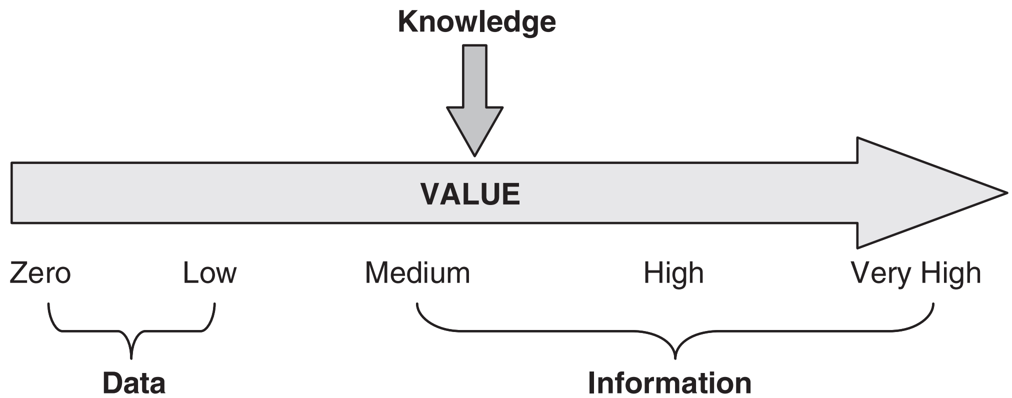
Example 1: The daily sales of burgers can be used, along with other information (e.g., information on the quantity of bread in the inventory), to compute the amount of bread to buy. The relationship between the quantity of bread that should be ordered, the quantity of bread currently in the inventory, and the daily sales of burgers (and other products that use bread) is an example of knowledge. Understanding of this relationship (which could conceivably be stated as a mathematical formula) helps to use the information (on quantity of bread in the inventory and daily sales of burgers, etc.) to compute the quantity of bread to be purchased. However, the quantity of bread to be ordered should itself be considered information and not knowledge. It is simply more valuable information.

Example 2: The information about 40 heads and 60 tails (out of 100 tosses) can be used to compute the probability of heads (0.40) and tails (0.60). The probabilities can then be used, along with information about the returns associated with heads ($10 from Susan's perspective) and tails (–$8, again from Susan's perspective) to compute the expected value to Susan from participating in the bet. Both probabilities and expected values are information, although more valuable information than the facts that 40 tosses produced heads and 60 produced tails. Moreover, expected value is more useful information than the probabilities; the former can directly be used to make the decision, whereas the latter requires computation of expected value.

The relationship between the **probability** of heads, the number of times the coin lands heads, and the total number of tosses (i.e., that probability of heads, or $p_H = n_H/(n_H + n_T)$, assuming that the coin can only land heads or tails) is an example of knowledge. It helps compute the probability from the data on outcomes of tosses. The similar formula for probability of tails is knowledge as well. In addition, the relationship between expected value (EV) and the probabilities (p_H, p_T) and returns (R_H, R_T) for heads and tails (i.e., $EV = p_H*R_H + p_T*R_T$) is also knowledge. Using these components of knowledge, probability of heads and tails can be computed as 0.40 and 0.60, respectively. Then, the expected value for Susan can be computed as 0.40*(+$10) + 0.60*(–$8) =–$0.80.

Example 3: The knowledge of a hurricane researcher is used to analyze the *u* and *v* wind components as well as the hurricane forecast produced by the different software models, to determine the probability that the hurricane will follow a specific trajectory.

Figure 2.1 **Data, Information, and Knowledge**

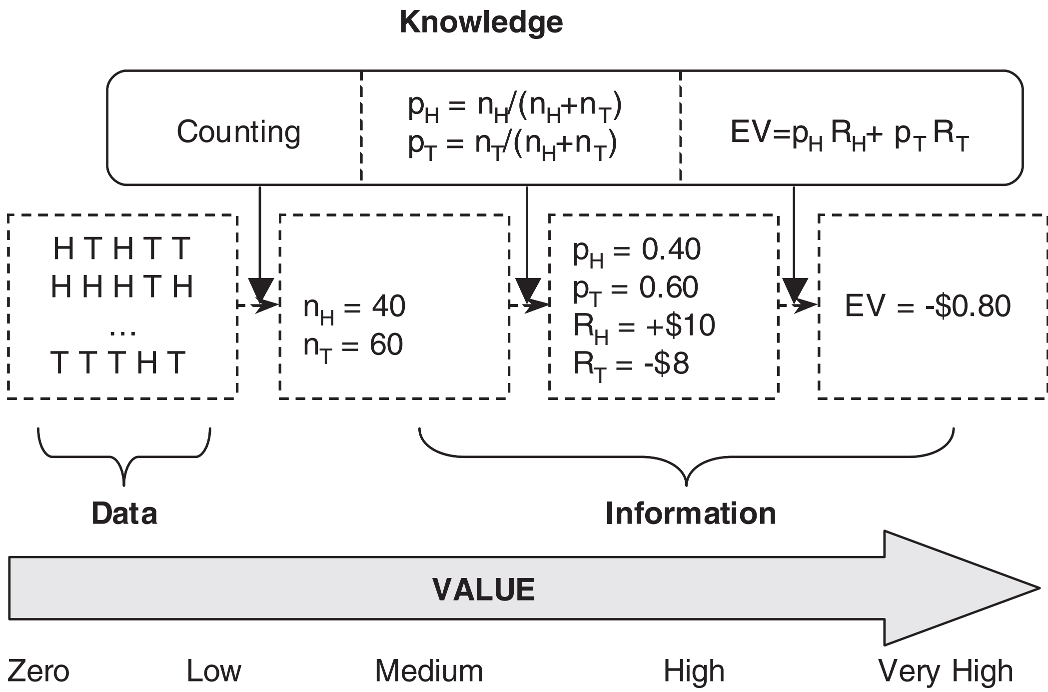


Thus, knowledge helps produce information from data or more valuable information from less valuable information. In that sense, this information facilitates action such as the decision of whether to bet or not. Based on the new generated information of the expected value of the outcome as well as the relationship with other concepts, such as Susan's anticipation that the coin may be fair or not, knowledge enables Susan to decide whether she can expect to win at the game. This aspect of the relationship between data and information is depicted in Figure 2.1, which shows the relationship between data (which has zero or low value in making the decision), and information (which has greater value than data, although different types of information might have differing values).

The above relationships between data, information, and knowledge are illustrated using Example 2 in Figure 2.2. As may be seen from the figure, knowledge of how to count helps convert data on coin tosses (each toss producing a head or tail, with the set of 100 tosses producing 100 such observations, shown as H and T, respectively) into information (number of heads and number of tosses). This information is more useful than the raw data, but it does not directly help the decisionmaker (Susan) to decide on whether to participate in the bet. Using knowledge of how to compute probabilities, this information can be converted into more useful information—that is, the probabilities of heads and tails. Moreover, combining the information about probabilities with information about returns associated with heads and tails, it is possible to produce even more information—that is, the expected value associated with participation in the bet. In making this transition, knowledge of the formula for computing expected value from probabilities and returns is utilized. Figure 2.2 illustrates how knowledge helps produce information from data (e.g., probabilities based on outcomes of tosses of 60 heads and 40 tails) or more valuable information (expected value) from less valuable information (e.g., probabilities and payoffs associated with heads and tails).

The above distinctions among data, information, and knowledge is consistent with Nonaka and Takeuchi's (1995) definition of knowledge as "*a justified true belief.*" It is also consistent with Wiig's (1999) view of knowledge as being fundamentally different from data and information:

Figure 2.2 **An Illustration of Data, Information, and Knowledge**



> Knowledge consists of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies, and know-how. It is possessed by humans, agents, or other active entities and is used to receive information and to recognize and identify; analyze, interpret, and evaluate; synthesize and decide; plan, implement, monitor, and adapt—that is, to act more or less intelligently. In other words, knowledge is used to determine what a specific situation means and how to handle it.

Figure 2.3 depicts how knowledge, data, and information relate to information systems, decisions, and events. As discussed, knowledge helps convert data into information. The knowledge could be stored in a manual or computer-based information system, which receives data as input and produces information as output. Moreover, the use of information to make the decision requires knowledge as well (e.g., in the context of the second example above, the knowledge that expected value above zero generally suggests that the decision is a good one). The decisions, as well as certain unrelated factors, lead to events, which cause generation of further data. The events, the use of information, and the information system might cause modifications in the knowledge itself. For example, in the context of example 1 on ordering raw materials based on sales, information about changes in suppliers (e.g., a merger of two suppliers) might cause changes in the perceived relationship (i.e., knowledge) between the quantity on hand, the daily sales, and the quantity to be ordered. Similarly, in example 2 on betting on the outcome of a coin toss, the individual's risk aversion, individual wealth, and so forth, might cause changes in beliefs related to whether expected value above zero justifies the decision to participate in the bet.