CHAPTER

10

APPLICATIONS: MANAGEMENT/ ADMINISTRATIVE AND FINANCIAL SYSTEMS

Learning Objectives

1. Describe the components typically included in an enterprise resources planning system.
2. Provide examples of transaction processing applications, and discuss how they support financial management.
3. Discuss desirable features of an automated enterprise scheduling system.
4. Distinguish between clinical decision support software and executive information systems.
5. Understand the use of computer applications as tools for research and medical education.

Overview

For many years, the healthcare field lagged other businesses in the design and implementation of robust information systems. Problems have included undercapitalization of the system development process and management failure to oversee system implementation effectively. However, the situation has changed substantially due to heightened competition, increased regulation, and changing payment mechanisms affecting the entire industry. Changes in the delivery and financing of healthcare since the late 1980s have been pivotal to establishing information management as a key strategic resource in most healthcare organizations. Healthcare managers have come to rely on information systems as essential tools for robust growth, effective competition and, in some cases, survival.

Most healthcare organizations began their automated information processing activities with computer systems that supported administrative operations—in particular, financial and accounting systems. While a significant number of current healthcare applications still serve financial purposes, the drive for robust clinical information systems has become a top priority for most healthcare organizations. Note, however, that clinical information systems not only provide direct support to patient care processes but also populate the data repositories essential for performance measurement, external reporting, cost management, and other organizational accountability activities. Thus, the "ideal" clinical and administrative applications integrate into a comprehensive system that supports the continuum of information needs in an enterprise.

Most early information system applications in healthcare organizations were designed as stand-alone systems, and purchase decisions were based on maximizing desired specific functionality at acceptable costs. In the current environment, however, clinical and administrative applications are expected to integrate, sharing functionality and transferring data across various elements of the enterprise information system as well as exchanging information with systems external to the enterprise. Purchase decision criteria now include interoperability, compliance with data transmission standards, and many other complex factors.

Migrating these stand-alone *legacy* systems into an integrated environment proved to be one of the most difficult challenges that healthcare information technology (HIT) teams encountered in building systems to meet the expanding information needs of healthcare enterprises (Gilchrist et al. 2008; Hicken, Thornton, and Rocha 2004; Kraatz, Lyons, and Thompkinson 2010). In fact, some teams concluded that "starting from scratch" would be easier than retrofitting various systems from multiple vintages. As technologies and system configurations continue to evolve, however, repeated "start-overs" usually are not a realistic option for several reasons. Purchase and implementation costs of full-scale systems can be prohibitive, although purchase price has become almost the least important criterion in system selection. Operations and planning are dependent on data and information stored in existing systems, and migrating data archives may be difficult or even impossible. In light of the extent of technology dependence in healthcare organizations, the disruption in service delivery and business operations during a full-system transition could be tremendous. Thus, managers must select system components with forethought for the capability to transition to next-generation products for better interconnectivity and interoperability in both clinical and administrative applications.

Enterprise resources planning (ERP) systems are bundled applications, or "single vendor solutions" (Raths 2006), that integrate operational information derived from financial, human resources, materials management, and other function-based areas into a robust database used to achieve business management objectives (Legnick-Hall and Legnick-Hall 2006). These systems connect inventory and facilities management, resource scheduling, accounting and financial management, and other business events in a real-time environment. As with clinical systems, the market for ERP applications

emerged from the need to update legacy software. However, a large number of vendors continue to develop and market applications that will operate as stand-alones or that can be integrated or interfaced with other applications. The administrative applications typically incorporated in an ERP include the following:

- Financial information systems
- Human resources information systems
- Resource utilization and scheduling systems
- Materials management systems
- Facilities and project management systems
- Office automation systems

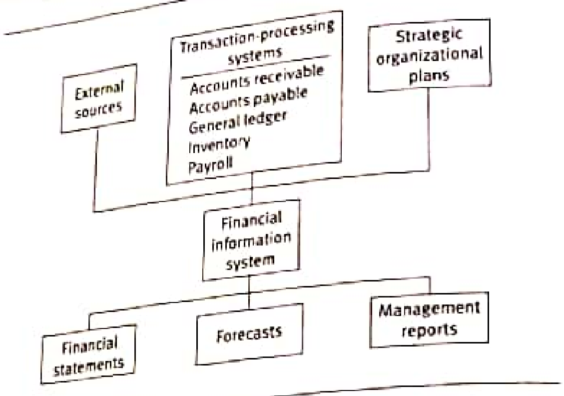
Each of these system components is described in this chapter with illustrative examples. Special features of these types of applications designed to meet the needs of nonhospital healthcare organizations, such as physician practices and home health care, are addressed. Additional uses of information systems in healthcare, such as medical research, education, and decision support, are discussed briefly.

Financial Information Systems

The highly competitive and regulated environments in which healthcare organizations operate require timely and accurate financial information that enables managers to monitor and guide operational performance. In the face of answering demands for accountability and cost containment while still providing high-quality services, managers are acutely aware of the importance of sound financial management in guiding operational performance. Financial information systems support operational activities such as general accounting, patient accounting, payroll, contract management, and investment management. Financial systems also provide information to management for controlling and evaluating organizational performance. Analysis of current and historical information helps in projecting future financial needs of the organization.

Financial information systems require input from transaction-processing systems, external sources, and strategic organizational plans (see Exhibit 10.1). Transaction-processing systems record the organization's routine activities, collecting information from other administrative subsystems, including payroll, accounts payable, accounts receivable, general ledger, and inventory control. These transactions are the basis for many financial reports required by management. To support effective financial decisions, financial

EXHIBIT 10.1
Financial Information System



systems also need external data such as government statistics, inflation rates, and information about the marketplace. An organization's strategic plan should contain financial goals and objectives that help provide the framework for preparation of financial reports.

A fully integrated financial information system brings related information together for planning, monitoring, and control. Individual financial subsystems include the following:

- Payroll preparation and accounting, linked to a human resources information system
- Processing of accounts payable, linked to purchasing and inventory control systems
- Patient accounting, patient and third-party billing, and accounts receivable processing
- Cost accounting and cost allocation of non-revenue-generating activities and general overhead expense
- General ledger accounting
- Budgeting and budget control
- Internal auditing
- Financial forecasting
- Investment monitoring and analysis
- Financial statement preparation

- Financial reporting for operating supervisors, executive management, board members, external regulators, and third-party financing agencies

The development of a financial information system depends on the existence of a good accounting system. Sophisticated cost accounting, essential in a negotiated pricing environment, enables the financial information system to generate accurate information on personnel and other physical resources used to deliver services. For services provided under managed care contracts, providers, managed care organizations, and employers need cost information to help negotiate rates and monitor contract performance. Integrated financial reporting based on a solid cost accounting system provides information for product costing, analysis of labor productivity, inventory control, and examination of the productivity return on capital investments.

Significant proportions of total payments for healthcare services provided are based on either a fixed payment per case (e.g., diagnosis-related groups) or a fixed payment per person per month (i.e., capitation payment systems). For effective management in this environment, a financial information system must have the capability to convert or link cost and net revenue information to multiple units of payment.

A market analysis prepared by the Dorenfest Institute for HIT Research and Education (2006) for the HIMSS Foundation reported that ten suppliers dominate in sales of financial applications software, suggesting a highly concentrated market. This concentration is due in part to two high-profile mergers that produced two powerhouses in the HIT industry: McKesson, which acquired HBOC, Inc., and Siemens, which merged with Shared Medical Systems. These two companies hold significant market share in every type of financial application.

Human Resources Information Systems

Employees of a healthcare organization constitute its most important resource. Most organizations spend more than 60 percent of their operating budget on employee salaries and benefits. Thus, a good human resources information system (HRIS) is a very important tool to assist managers in personnel planning, staffing, and productivity analysis. The common functions of an HRIS include, but certainly are not limited to, the following:

- Maintaining, updating, and retrieving information from a database of employee personnel records
- Providing automatic position control linked to the budget
- Producing labor analysis reports for each operating unit or cost center

- Producing reports used for assessing personnel problems, such as turnover and absenteeism
- Maintaining an inventory of special skills and required certifications of employees
- Producing labor cost allocations with linkage to the payroll system
- Providing information on employee productivity and quality control, assuming that appropriate labor standards have been developed
- Managing employee sick leave, vacation, and other earned time off
- Comparing the organization's compensation and benefit packages with industry norms

Large amounts of data are required to provide these types of reports and others that may be needed. The HRIS information processing and reporting functions are supported by information drawn from various databases that contain individual employee data, wage and salary data, the organization's job-classification structure, benefit packages, employment contracts, and many other related data elements. Actual ownership of the various databases may be distributed among multiple departments. Thus, the structure of the databases is an important factor in data transfer from one element of the system to another.

Although essential for efficient business practices, the availability of computerized employee-record files creates a security issue. Because protecting the employee's right to privacy is essential, organizations need to establish software and hardware security systems and set policies for accessing and updating electronic files containing personnel data and information. (See Chapter 5 for discussion on data security policies.)

In addition to supporting operational work in the human resources department, a well-designed HRIS will produce reports for management planning and control (see Exhibit 10.2). For example, HRIS management reports can be used to monitor turnover rates, unfilled positions, labor costs, employee productivity, and utilization of benefits. Attitudes of employees and physicians can be monitored through periodic satisfaction surveys. This survey data used in conjunction with activity and utilization data can be an important component of planning changes to benefits provided to employees.

Software applications are used to maintain records related to verifying physician credentials and defining practice privileges in the organization as well as for ongoing evaluation of physician clinical performance. Credentials and privileging systems are important for monitoring quality standards and for maintaining documentation required by accrediting and regulatory bodies. The task of verifying academic and training credentials and malpractice exposure is frequently outsourced to a certified *credentials verification organization* (CVO), such as Healthplex (www.Healthplexcvo.com) and Professional

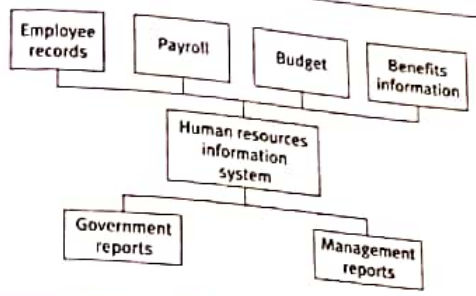


EXHIBIT 1
Human Resources Informatio System

Credentials Verification Service, Inc. (www.pcvs.net). Data transmitted by the CVO must be connected to relevant data from the organization's clinical and administrative systems to develop practice profiles for monitoring physician productivity and conformance to quality standards. Often, there is a need to integrate external benchmark and industry standards for comparison with actual performance data. Because of the sensitive nature of the data in this system and the specificity of facility accreditation requirements for this function, a stand-alone system often is used to achieve the desired functionality and system security. Example applications include MD-Staff (www.mdstaff.com), a cloud-based network that includes background screening, credentialing, and provider management options. In early 2012, MD-Staff reported more than 600 installations.

Resource Utilization and Scheduling Systems

Under fixed-price and capitation payment systems, cost containment and efficient resource utilization are pivotal to success. External mandates for utilization review by regulatory agencies and insurance companies are more than balanced by internal drivers for ensuring that resource utilization is optimized. Managers must ensure that services are available when needed and that personnel and technology are efficiently allocated and scheduled. These efficiency needs are met through computerized monitoring and scheduling systems.

Information systems monitor inpatient occupancy rates, clinic and emergency department activity, and utilization of individual service facilities such as the operating suite or diagnostic units. Patient scheduling systems are used for advance booking and scheduling of facilities—both for patient and physician convenience and for efficient allocation of resources, particularly staffing. Comprehensive and timely data are essential to monitor use of expensive diagnostic and treatment technologies to achieve optimal revenue returns on capital investments.

Advance bed-booking and preadmission systems are particularly useful in situations where most of the admissions are elective (e.g., a specialized surgical facility). Advance booking also provides time for necessary precertification for managed care patients and others covered by insurance plans that require review and certification of medical necessity for procedures and inpatient admission. Preadmission information systems can be linked to individual physicians' offices as well. Computer programs can project the average length of stay for each elective admission once historical data (including diagnosis, surgical procedure, age of patient, and gender of patient) have been accumulated. After admissions are scheduled and the data are entered into the computer's master files, the system keeps track of projected occupancy levels for each day.

Admissions monitoring and scheduling systems improve staffing and workflow in healthcare organizations. These systems can reduce daily fluctuations in a hospital's census and improve the effectiveness of flexible staffing systems. Acute care general hospitals must maintain an accurate accounting of bed census and occupancy if they are to survive. Census information helps administrators compare projected income against projected budgets. Administrators can also track demands for specific services and adjust staffing levels and scheduling of facilities as demand patterns change.

Computer programs are also available for scheduling operating rooms in hospitals and ambulatory surgery centers. These systems are designed to improve operating room utilization, contain costs, facilitate planning, and aid in the scheduling of specific surgical procedures. Outpatient clinic appointment and scheduling systems are common in organizations with a large volume of outpatient activity.

Resource utilization and scheduling systems may be designed for use at the department level or for a small entity such as a physician practice, but enterprisewide scheduling systems that meet multiple objectives are becoming common. These robust integrated systems support fiscal objectives such as balanced schedules, optimum staffing, and management of resources across the enterprise. From a patient perspective, the ability to schedule multiple diagnostic procedures in one session, and perhaps schedule all procedures in a single day, contributes to satisfaction with the encounter experience.

The scheduling system can include modules that capture patient insurance and billing information during the registration process, which can be matched against stored contract data to produce appropriate charge records. Most systems can produce automated appointment reminders in a variety of formats, including computer-generated telephone calls, e-mails, or text messages, in addition to mailed documents.

Scheduling systems can be linked with materials management systems to ensure that equipment and supplies are available for scheduled procedures, including initiating the process to transport the supplies to the treatment area. As items are removed from inventory, ordering and restocking procedures are triggered.

Materials Management Systems

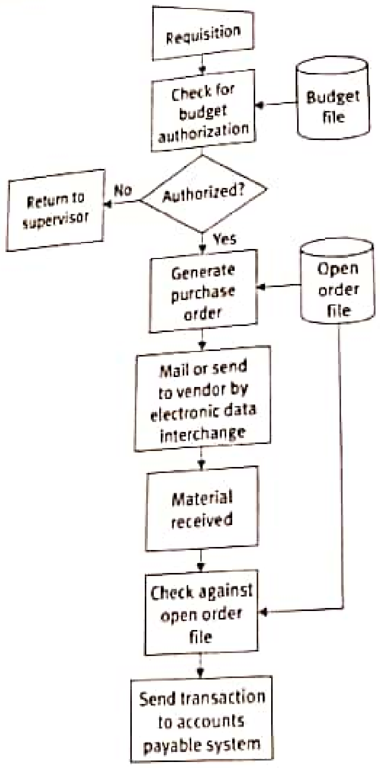
Computer systems are invaluable in effective management of supplies and materials, including data exchange with suppliers, automated purchase orders, inventory control, use of bar-code devices for encoding supplies and materials, and computerized menu planning and food service management.

In a typical materials management system, requisitions for supplies and materials are electronically generated and matched against budgetary authorization for financial control. Reports of overdrafts on supply accounts are transmitted to the appropriate supervisor for follow-up action. Once requisitions are cleared, often using an automated workflow process for sequential authorizations, the system generates purchase orders. Purchase orders can be transmitted electronically to suppliers via established data-exchange protocols. As materials are received, bar-coded products can be scanned and matched against an open order file. Many automated purchasing systems also include direct linkage to the accounts payable system if system integration has been planned. Some systems also provide the capability for automatic reordering of selected items as inventory is depleted (see Exhibit 10.3). Supply chain applications reduce processing costs and obtain materials on a just-in-time basis to minimize the need to carry a large inventory.

Detroit Medical Center divides its materials resource management department into several functional areas: linen services, clinical engineering, contract administration, logistics management, procurement, supplier diversity, and systems development (www.dmc.org/vendor). The department communicates with current and potential business associates via a website, providing information about open requests for proposals, standard contracts and policies, and status on open purchase orders. Some areas of the website are open access, which may generate interest from potential vendors, but areas that store proprietary or contract-related information are protected with a secure login and are accessible only to current business partners.

Coding standards are an important element of automated purchasing and materials management systems. Bar codes for all types of medical supplies and pharmaceuticals have become standard and are essential to efficient purchaser–vendor relationships in healthcare.

EXHIBIT 10.3
Materials Management System



Computerized menu-planning systems store and analyze data on patients' nutritional and dietary requirements, food items in inventory and their costs, and decision rules for selecting from among alternative menus. Decision criteria might include patient preferences or visual appearance of food in addition to nutritional adequacy and cost. (See the sidebar on the next page for an example.)

Healing the Body by Stimulating the Appetite

UAB Hospital in Birmingham, Alabama, has implemented a novel alternative to routine menu plans for inpatients who want more choice in their meal selections. Patients can order "room service" for delivery to their rooms between 6:30 am and 7:00 pm. Meal choices include breakfast foods, soups, salads, hot and cold sandwiches, pizza, meat-based entrees, and desserts. For the adventurous, a seasonal meal planned by a renowned local restaurateur is available.

Patients with dietary restrictions are flagged in the information system to be automatically connected with a dietary representative who will address their meal requests appropriately. Online menus include designations to aid patients in selecting "heart healthy" foods or those allowed on a diabetic diet.

This meal option is supplemented by nutritional education available on the patient education television channel and with telephone access to a registered dietitian.

More information is available at www.uabmedicine.org/patient-and-visitor-guide/patient-information-room-service.

Facilities and Project Management Systems

Computerized systems can help organizations plan, manage, and maintain physical facilities. Examples include preventive maintenance systems, energy management systems, and project scheduling and control systems (particularly useful in new construction and remodeling projects).

Preventive maintenance systems help extend the life of equipment and facilities and reduce costly failures. Routine maintenance can help organizations achieve significant cost savings by preventing repair and replacement costs. Additional benefits accrue, including preventing nonproductive downtime, improving the safety of the workplace, and decreasing the risk of patient or employee injury due to equipment malfunction. Exhibit 10.3 shows the framework for a materials management system.

Energy conservation is an important cost-saving strategy for healthcare organizations as it is in all major industries. Computer applications assist in monitoring routine and peak energy use, providing information to tactics for reducing consumption. Actual utilization figures can be compared against calculated requirements, and a computer model can be developed to find economies and efficiencies. The energy management system also can be employed to implement the selected tactics, such as automatically lowering or raising room temperatures in areas that are unused at night or on the weekend.

Healthcare organizations frequently are involved in capital construction and major remodeling projects, and computer systems are an extremely useful aid in project management. These project scheduling and control systems typically employ a combination of integrated tools to manage personnel and activity scheduling, labor and materials costs, required resources, and periodic progress reporting. As a key component, these tools are used to document (1) all activities required to complete the project; (2) the relationships of these activities to one another, including those that can be carried out simultaneously and those that must follow a time sequence; and (3) time estimates for completing each activity. These data are used to generate a diagram of activities that shows the critical path (longest time required) for project completion and any opportunities for concurrent or fast-tracked activities. As activities are completed, actual completion times can be entered back into the calculation, and more accurate schedules can be prepared for the remaining work. These systems are excellent tools for dynamic scheduling and control of major projects. More detailed coverage of project management related to HIT is provided in Chapter 11.

Office Automation Systems

Office automation helps to coordinate and manage people and workflow, link organizational units and projects, and coordinate work in the organization across levels and functions. Healthcare organizations use a variety of computing tools to carry out general office functions, such as word processing, e-mail, project management, meeting scheduling, and maintenance of personnel calendars for work-related activities. These functions may be conducted using desktop workstations; laptop computers; or a variety of handheld devices, including personal mobile telephones or smart phones. Use of systems for integrated word and graphic processing, scheduling, electronic filing of documents, and message/document transmission can dramatically improve administrative efficiency and reduce the costs of office operations.

Office systems can link parts of the organization together by scheduling meetings using electronic calendars and e-mail or text communication. E-mail systems link offices and individuals, allowing electronic files to be forwarded to others or to be archived in a shared storage area for access by members of a workgroup. Mobile computing using laptops and handheld devices, wireless technology, and the Internet have changed the way people work alone or together. Workgroups and teams can meet and collaborate from anywhere—in the same conference room or in geographically separated offices—with full access to necessary software programs and organizational files.

This work environment is supported by *groupware*—collaborative software that enables sharing of information via an interactive network (e.g., a virtual workspace). This software-hardware combination not only facilitates real-time interaction among members of the group to improve problem solving and project management but also supports independent work tasks.

Audio- and videoconferencing allow real time interaction among team members. Group members may work asynchronously on project activities while maintaining the integrity of a shared work product. When used effectively, and provided employees are trained to use the electronic tools, the virtual office can be as productive as the traditional office. Typical groupware activities include the following:

- E-mail and discussion forums
- Teleconferencing
- Interactive videoconferencing
- Relational databases (used to search for data and information)
- Document editing and management, including archiving and version tracking
- Group calendars and scheduling

SharePoint, a Microsoft product, is an example of groupware. A description of SharePoint functionality is available at www.sharepoint/microsoft.com. SharePoint can be deployed as an on-premises system or in a hybrid environment that employs cloud computing (Robinson 2011).

Information Systems for Nonhospital Healthcare Organizations

As changes to payment models in the 1980s led to changes in delivery models during the 1990s, nonhospital healthcare organizations began implementing information systems to manage clinical services and business operations. Vendors quickly began designing and marketing software products to meet the special information needs of these organizations. Organization types that fall under the nonhospital category include ambulatory clinics; long-term care (LTC) facilities; home health agencies; physician practices; and many others, including retail clinics. Software applications used in these settings typically include multiple modules that meet the organizations' needs for clinical documentation, operations management, and financial management.

Ambulatory Care Information Systems

Significant components of the healthcare continuum are delivered in outpatient and ambulatory care settings. Information systems that support ambulatory care and assist primary care providers in their practices have become a niche market. The availability of powerful and inexpensive microcomputers and practice management software packages has brought this technology within the reach of even small medical groups and solo practitioners.

A typical practice management system (Slovensky et al. 2006) includes modules to support such business functions as the following:

- Operations management (e.g., scheduling, reminders, billing, authorizations)
- Services (e-mail, groupware)
- Claims processing
- Document processing, spreadsheets, and databases
- Transcription
- Personnel management
- Inventory management
- Waste management
- Energy management

Clinical applications in medical practices and freestanding clinics include electronic health records (EHRs), prescription management, and disease management resources. Patient applications—an emerging software market—include electronic communication, monitoring, educational resources, and telehealth applications. Various vendor products offer full-service suites or selected modules based on the practice's needs.

Automating practice functions increases operational efficiency and reduces errors in information processing, both of which contribute to patient satisfaction and reduced risk and liability exposure. Automating or using web-based patient communication for services—such as callbacks, prescription renewals, and similar activities—can be helpful as well.

Office practice computers can be linked to local hospitals in addition to serving the management needs of the practice. Many hospitals or integrated delivery systems have developed computer linkages with physician offices to enable clinicians to pre-admit patients; order diagnostic tests; and query the patient information system for lab results, progress notes, and other current clinical information. Healthcare organizations use such linkages as incentives to attract physicians to use their facilities in a highly competitive environment. Under some conditions, hospitals may be able to offer financial support to physician practices for the purpose of implementing an EHR that links with the hospital system (Babitch 2009).

An alternative to linking with a hospital system is for two or more clinics or health centers to partner and purchase a shared system. This approach may be an excellent option for a multisite group practice or for affiliated professional groups. One example of this approach is provided by the Metropolitan Collaborative of Health Information Technology (METCHIT), a health center network of four organizations in New York City (Egleson et

al. 2010). This initiative was clinician-led, which contributed to the successful deployment of the system components across the network. An important factor in the success of this EHR application was the ability to modify system templates to accommodate mandatory reporting requirements.

Long-Term Care Information Systems

The LTC industry has been a late adopter in implementing computer systems, in part because software vendors have been slow to develop products tailored to the needs of nursing homes and continuing care communities. This situation is changing as the scope and volume of healthcare delivered in subacute care and postacute-care facilities increase. Typical requirements for LTC systems include census management, initial and periodic resident assessments, documentation of care services provided, documentation of physician orders, nutritional assessments and menu planning in the dietary department, and pharmacy applications.

The ability to communicate clinical information between caregivers and the admitting physician is especially important, as the physician usually is not physically present on a daily basis. Remote access to clinical documentation facilitates timely intervention in an acute episode and contributes to better health outcomes. As with other HIT applications, remote access can be achieved using various computing devices or telephone systems. System security and controlled system access are extremely important.

As LTC facilities become components of larger integrated delivery systems, electronic sharing of clinical and administrative information with hospitals, clinics, ambulatory care facilities, and other system components becomes a business essential. Once again, data sharing among the enterprise units and IT strategic partners is a key driver in system design. However, insufficiency of data standards and security concerns remain as significant barriers to achieving the desired level of connectivity, along with issues related to proprietary systems (Edwards et al. 2010).

Home Health Care Information Systems

Home health care services have expanded rapidly in recent years as an alternative to more costly institutional care. As service volume has increased and the scope of services expanded, information systems have been developed specifically to meet the needs of home care provider organizations.

Many home health agencies use laptop computers and other remote access devices for on-site documentation of patient care and for access to treatment plans and previous encounter documentation. Home health nurses and other caregivers enter information directly at the treatment sites for uploading to the centralized data repository. Relevant data can be accessed during a service visit by any provider. These systems reduce the amount of administrative work needed to document care, allowing nurses and home health aides to spend more time providing patients the care and services they need to achieve desired clinical outcomes.

Electronic devices also can transmit clinical information via telephone lines or the Internet for the purpose of routine health monitoring between visits. Patients and family members follow the documented treatment plan, take and record measurements as indicated, and submit data for evaluation by the clinical personnel overseeing their care.

Other Information System Applications in Healthcare

Information systems support most processes in healthcare. While many applications can be categorized by their use for a defined function, many serve the needs of multiple providers and managers in disparate service areas. Clinical information may be combined with administrative information or used for an administrative purpose exclusively. Alternatively, administrative information may be applied in the delivery of clinical care.

Clinical Decision-Support Systems

Clinical decision-support (CDS) systems are designed to assist physicians and other providers in diagnosis and treatment planning. CDS systems fall into two categories: (1) passive CDS systems and (2) active CDS systems.

Passive CDS systems use the computer to collect, organize, and communicate clinical data for interpretation and analysis by the physician. They make clinical information, including medical history, physical examinations, and diagnostic tests, more readily available and usable but do not process the information for further analysis. Clinical information systems—such as laboratory, pharmacy, radiology, and other clinical services applications—are examples of passive CDS systems in that they capture clinical data and make them available to caregivers. These applications become more useful to clinicians for decision support when they are fully integrated and can provide complete medical information (both current data and historical information on the patient) through simple, user-friendly access. For example, caregivers could view temperature, heart rate, and blood pressure readings over time to see patterns in relation to medication administration, physical activity, or food ingestion.

Active CDS systems provide direct assistance to the physician in diagnosis and treatment planning. They combine patient-specific data with generalized medical knowledge to reach a conclusion or make a recommendation to the caregiver. These systems may use a branching logic or rule-based structure, or a statistical probability algorithm, to suggest an appropriate diagnostic or treatment response to a clinical condition described by the physician.

These systems incorporate validated clinical guidelines and treatment protocols that represent current best practices in clinical medicine. The National Guideline Clearinghouse (www.guideline.gov) is an excellent resource to learn more about this type of resource available to clinicians.

Types of active CDS systems are as follows:

1. *Expert systems* contain three major components—knowledge base, patient-specific information, and inference engine. A general knowledge base of medical information, obtained from a panel of experts in a given medical specialty, has been rigorously validated through scholarly research, clinical practice, and consensus support from the medical community. This knowledge base is matched against patient-specific information retrieved from the healthcare organization's clinical database and may include subjective information as well as objective clinical findings. A rule-based inference engine generates conclusions for consideration by the physician. The system is dependent on the quality of the expert knowledge base and the "reasoning power" of the rules used by the inference engine.
2. *Probabilistic algorithms* employ statistical probabilities, which include a calculated element of randomness, rather than rely solely on knowledge collected from expert human beings. Expert knowledge is based on a combination of academic preparation and experiential learning, and variation may occur in either component of an expert's knowledge base. Extrapolations outside an expert's existing knowledge contribute to experiential learning. While a consensus viewpoint among experts incorporates nonquantifiable variability, a statistical probability allows the decision maker to control the degree of uncertainty tolerated in the system's output.
3. *Clinical reminders and alerts*, incorporated into clinical computer applications, suggest potential medical conditions or other problems that should be given attention in setting treatment plans. Examples include pharmacy information systems that alert the physician to potentially negative interactions between two drugs prescribed for the same patient as well as systems that suggest certain drugs or treatments should not be employed when specific laboratory results contraindicate their use. This function can also be used to suggest less expensive (but equally effective) alternatives when a high-cost drug has been ordered. Alternative drugs may also be suggested when the prescribed drug has significant risks for certain types of patients.

Computers can aid decision making by simplifying access to data needed to make decisions, providing reminders and prompts, assisting in order entry, assisting in diagnosis, and reviewing new clinical data to issue alerts when important patterns are recognized. Systems are more likely to be successful when they give patient-specific suggestions, save time, and are incorporated into the regular workflow of the organization. Researchers at the University of Alabama at Birmingham found that physicians using a decision-support rule accessed via a handheld device (e.g., personal digital assistant [PDA]) made better prescribing decisions than those who did not have the PDA for CDS access (Berner et al. 2006). The study, a randomized controlled trial, examined ordering practices for nonsteroidal anti-inflammatory drugs (NSAIDs). Physicians accessing the rule were more likely to order NSAIDs that were considered "safer" when considering gastrointestinal risk factors.

CDS systems that are well integrated with the enterprise EHR offer great promise for personalized medicine (Downing et al. 2009). Responding to variability among individual patients and applying the ever-increasing body of medical knowledge require information processing on a scale that cannot be achieved by human means. Well-designed systems can process large volumes of knowledge-based data filtered by personal clinical data and even by personal preferences for options among treatment modalities. Patients can be evaluated for risk factors for specific conditions, be advised about prevention and early detection strategies, and be assessed for probable effectiveness of various treatment options should the condition occur.

Executive Information Systems

The business corollary to CDS systems is the executive information system (EIS). Sometimes referred to collectively as *business intelligence*, EIS includes systems designed to access and merge internal and external data into meaningful information reports. Executives identify critical environmental trends and facility performance indicators related to strategic objectives to guide their information capture and analysis. Data to support the EIS may be extracted from clinical and administrative databases serving the healthcare enterprise as well as from public and proprietary data repositories. The information needed from an EIS for decision support generally is not met through standard reports. Users must be able to select the variables and data sources needed to answer specific questions, so ad hoc reporting capability is essential. In many analysis scenarios, it is important to begin with general data aggregations and then reduce subsets of the data to increasingly greater detail, a process referred to as *drilling down*. The EIS must support this type of processing through an easily managed user interface.

Evidence-Based Medicine and Disease-Management Systems

Evidence-based clinical practice guidelines, also referred to in application as *evidence-based medicine* (EBM), are intended to assist clinicians and healthcare

organizations in standardizing decisions about the care of individual patients to achieve cost and quality benefits. Accumulated evidence from clinical research is used to formulate statements of the "right" things to do for patients with a given diagnosis or condition. Ideally, guidelines ensure that patients receive appropriate diagnostic tests and treatments in an efficient and cost-effective manner. Guidelines are assumed to lower treatment costs by avoiding unnecessary tests. Hundreds of guidelines have been developed and are archived in the National Guideline Clearinghouse sponsored by the Agency for Healthcare Research and Quality (www.ahrq.gov). Although managed care organizations and health insurers employ such guidelines to make decisions about treatment options, covered services, and other aspects of patient care, practice guidelines are not without significant limitations. Among these limitations are differences in local standards of care, access to recommended technologies, and unique patient characteristics.

While linkages to EBM resources are commonly incorporated in clinical systems for large inpatient facilities or integrated healthcare delivery systems, small clinics or medical practices may rely on independent access to EBM resources via the Internet. In these types of primary care settings, the clinician typically is using some component of the office automation system—desktop computer, laptop, or handheld mobile device—for Internet access. In this type of environment, convenience is an important factor in determining whether the clinician will seek external information. Recent research has shown that primary care providers who report using HIT resources as part of their patient encounter routines are likely to conform to evidence-based standards of care (Davis and Pavur 2011). An important caveat to this finding, however, is that providers who used PDAs as their primary computing device did not have the same level of compliance with these standards. As noted in Chapter 6, the size of the display screen relative to the output being displayed is an important system design characteristic. The small screens on handheld devices and the difficulty of entering precise input data using an ultra-compact keyboard make PDAs a poor choice for this purpose.

Disease management information systems and software products are designed to assist healthcare organizations in designing processes to provide quality care at the most reasonable cost possible. For the most part, they are disease specific and focus on high-volume, high-cost chronic conditions such as asthma, diabetes, and congestive heart failure. The typical approach is to involve patients in self-management of their condition and to create monitoring and feedback processes that encourage compliance with treatment plans. The information system may include capturing blood or urine test data, blood pressure readings, and other clinical information in the patient's home and transmitting it to the healthcare organization via digital telephony or other remote monitoring devices. Communication between patients and providers may be via telephone or the Internet. While routine patient monitoring assists in daily decision making, analyzing aggregated data can guide case managers and physicians in modifying treatment plans for better long-term clinical outcomes.

Computer-Assisted Medical Instrumentation

Virtually every piece of medical equipment used for diagnostic testing and treatment now contains a microprocessor. The processors are used for instrument control, image enhancement, or processing medical data and interpreting the results of the testing or treatment process. Common examples include electrocardiograms, electroencephalograms, and pulmonary function testing. Computer systems interface directly with patient-monitoring devices for continuous surveillance of a patient's vital signs and periodic display of physiological data. These systems are particularly useful in critical care and postsurgical units.

The first step in the process is acquiring data from monitoring equipment attached to the patient and then converting that data for computer processing and display. Data are stored and made available for periodic display or display on demand. Computer programs enhance the measured data through structured analysis of clinical data in accordance with programmed decision rules. Trend data are followed to monitor changes in patient vital signs over time. Patient-monitoring systems can operate at the individual patient bedside, at a central station designed to monitor a small number of intensive care beds, or at a remote location linked back to the critical care unit by telecommunication equipment. For example, output from cardiac monitors may be monitored remotely by trained monitoring personnel, who in turn alert caregivers about aberrant readings. Many of these systems also have electronic linkages for transmission of clinical data to the central EHR.

Coupling automated patient identification with electronic biomedical devices can produce significant efficiency gains in many routine tasks. UAB Hospital in Birmingham, Alabama, for example, uses a bar-code scanner to read codes on the patient's electronic monitor and armband, and then the device transmits recorded vital signs to the EHR. This approach has resulted in a 92 percent efficiency gain in recording vital signs and has decreased the number of errors in documentation significantly (Hicks 2009).

Telemedicine

Telemedicine—now sometimes referred to as telehealth or e-health systems—is the application of computer and communications technologies to support healthcare provided to patients at locations remote from the provider. Telemedicine often involves telephone and online communication between a primary care physician, nurse practitioner, or physician's assistant who is treating

patients in a rural area and specialty physicians located at a distant medical center. Audio communications and videoconferencing equipment are used in conjunction with computer access to patient records to establish primary diagnoses or provide expert consultation and second opinions. The systems often employ teleradiology for transmission of medical images for review by specialty physicians. Telemedicine systems can save patients travel time and costs as well as deliver healthcare cost savings.

The University of Texas Medical Branch's Electronic Health Network, self-described as "the largest telemedicine system in the world" (UTMB 2007), provides medical services to indigent populations and correctional facilities across Texas, in addition to corporate and school programs. One of UTMB's more interesting programs is providing telemedicine services to the National Science Foundation researchers in Antarctica.

Telemedicine applications have increased in recent years, due in part to the advent of mobile computing, which has enabled the deployment of *mHealth*—health-focused applications accessible to the general public. These user-friendly and low-cost applications allow patients to monitor and report health indicators such as blood pressure or blood glucose easily and conveniently. However, for traditional telemedicine applications such as specialist consultation or remote diagnostic procedures, issues remain related to reimbursement for remote services, state licensure of health professionals when the system crosses state borders, patient privacy protection, and government regulations (Thompson 2006). Clinical outcome benefits achieved through various telemedicine applications differ, as do cost savings.

The types of articles published in the *Journal of Telemedicine and Telecare* over the past few years suggest that the number and variety of telemedicine applications continue to increase as technology innovations offer more opportunities. Research on patient satisfaction with telemedicine applications appears to be declining. As computer technology pervades business and social environments, individuals may be more accepting of telemedicine and mHealth applications. Although age is sometimes identified as a barrier to technology acceptance, one nine-month study shows that frail elderly subjects are able to use a web-portal telehealth service to reduce their use of facility-based healthcare (Finkelstein et al. 2011). Subjects needed minimal training to use the web portal, and their self-ratings showed improvement in technology acceptance over the course of the study.

Research involving a US Department of Veterans Affairs cohort showed that patients rated service access and educational components of telehealth programs positively, but they reported frustration with equipment problems and slow responses to requests for assistance (Young et al. 2011). Incorporating routine monitoring of these elements of a telehealth service is pivotal to the long-term success of the service.

The ability to meet data-sharing requirements for telemedicine encounters are emerging as key factors in the sustainability of these e-health systems (Ganguly et al. 2009). Telemedicine providers need access not only to clinical data, such as that extracted from an EHR, but also to research findings and other knowledge-based information. Thus, the data-exchange protocol must address both standard format data and free-text formats.

Computer Applications in Medical Research and Education

Information systems and medical databases are used extensively to support biomedical education and research. Computerized patient records serve as the basis for epidemiological studies of a variety of diseases and their potential linkages to social and environmental factors. In addition, computers are used to support medical, dental, nursing, and allied health education, using such techniques as computer-aided instruction and patient-management simulation.

Computers are an integral component of most medical research projects. Effective project design requires close collaboration among clinicians, biostatisticians, and information systems specialists. Some research projects would not be possible without the high-speed computational capabilities and data-storage capacity of large computer systems. An excellent example is the Human Genome Project, which mapped all the genes of the *Homo sapiens* species. One element of the map detailed all sequences of DNA chemical bases—an astounding three billion pairs. Analytical work of this magnitude is inconceivable without supercomputing capabilities.

Hospitals, medical libraries, and individual clinicians use personal computers to access references to the medical literature and full-text online documents. The most widely used bibliographic databases are available through the National Library of Medicine (www.nlm.nih.gov). Articles from thousands of biomedical journals are indexed, stored in computer files, and available for searching and retrieval using standard medical subject headings and keyword searches. The Internet is used extensively to retrieve clinical information from a wide variety of specialty databases and sponsored websites.

Computers are an important tool for the education of clinicians. Computer based education for physicians and other health professionals engages the students actively in the learning process and builds foundational skills in preparation for clinical training. Learning activities range from presentation of information to students via the Internet or course management systems to sophisticated simulations of clinical problems. Students are presented initial cues and additional information on request as they proceed through a diagnostic process. Final diagnosis, patient management, and follow-up plans selected by the students are entered, and the system responds with a comparison to the "ideal" solution and critiques the process followed.

Increasingly, computerized mannequins are used to teach clinical skills in a laboratory environment before health professions students are assigned to healthcare organizations for clinical practice. These mannequins also can be used in continuing medical education as a tool for testing new technologies or exploring procedure innovations.

Summary

Most healthcare organizations began using electronic data processing by developing or purchasing financial information systems. Financial applications remain essential, but from a broader perspective, healthcare organizations use computers and information systems to support not only financial activities but also all administrative operations, including human resources management, resource utilization and scheduling, materials management, facilities and project management, and office automation.

As healthcare is delivered more frequently in outpatient and nonhospital settings, development of information systems specific to these delivery sites has accelerated. Typical functions for ambulatory settings include patient scheduling and appointments, electronic medical records and medical management, patient and third-party billing, managed care contract management, and electronic communication with other providers in a network of care. LTC systems support census management, residential care documentation, pharmacy, and other areas of operation in skilled nursing facilities. Home health providers use laptop computers or other remote-access devices to document care at the location where it is provided and to access clinical data from previous encounters.

Applications developed to assist physicians and other providers in the delivery of high-quality care include CDS systems and evidence-based medicine programs. These tools aid in diagnosis and treatment planning and comparing treatment plans with established "best practices" using large databases.

Computers have become an integral component of medical equipment for instrument control, image enhancement, and medical data processing. These foundation applications evolved into sophisticated integration of computer and communications technology in telemedicine applications that support patient care at remote locations.

Information systems are used extensively to support biomedical education and research. Automated databases of patient records support epidemiological studies of disease linkage to social and environmental factors. Computer-assisted instruction and patient-management simulation programs support the education of physicians and other health professionals.

Simply stated, no aspect of healthcare delivery or health services management is untouched by computers and information systems. The computer, in its various forms, has become a ubiquitous tool used by clinicians and managers alike. Technological evolution has brought forth powerful machines whose functional capabilities are optimized through the judicious selection of application software to meet business and care delivery needs.

Web Resources

A number of organizations (through their websites) provide more information on the topics discussed in this chapter:

- *Healthcare Informatics* (www.healthcare-informatics.com) is a magazine that provides information about vendors of information technology products and information systems management services.
- Health Level Seven (HL7) (www.hl7.org) is a leading healthcare standard-developing organization. HL7 is working as a coordinating agent for various active standard-setting groups.
- KLAS Enterprises (www.healthcomputing.com/VendorDirectory) offers information about vendors of software, services, and medical equipment.

Discussion Questions

1. Why are administrative systems more evolved than clinical systems?
2. Why do features of handheld devices make them inappropriate for some medical computing applications?
3. What are the key components of groupware as a resource to the management team?
4. What aspects of clinical applications support quality-management and cost-control programs?
5. Describe various functionalities of a pharmacy information system that can aid in reducing medication errors.
6. Distinguish between the logic used in an expert CDS system and systems that employ probabilistic algorithms.
7. What are some ways that HIT contributes to patient satisfaction?
8. Why has HIT development in some segments of the healthcare industry, such as long-term care, lagged other segments?

9. What challenges do legacy systems pose for enterprise system integration?
10. How are transaction-processing systems employed in financial information systems?
11. What are the key functions of a human resources information system?
12. How can centralized scheduling systems contribute to the financial bottom line?
13. List some of the key drivers and some of the challenges of employing telemedicine applications in a healthcare organization.
14. What are the typical elements of a physician practice management system?
15. Describe the basic documentation requirements for an LTC information system. How do these requirements differ from those for the information system used in an inpatient facility?

CHAPTER

11

HIT PROJECT PORTFOLIO MANAGEMENT

Learning Objectives

1. Identify some of the primary causes of HIT project failures.
2. Describe the main differences between HIT project management, HIT program management, and HIT portfolio management.
3. Describe the five key processes of project management.
4. Understand how project metrics and portfolio dashboards can facilitate HIT governance.
5. Describe the major roles and functions of the portfolio management office.
6. Identify the actions/changes that are necessary within an organization to reach the synchronized stage.

Overview

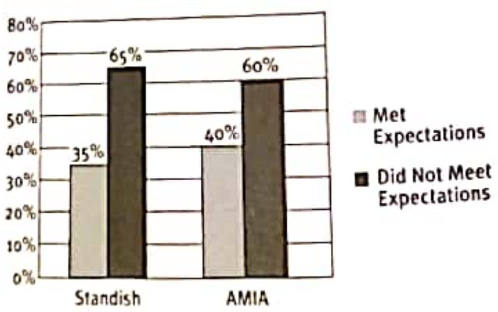
Healthcare in the United States now consumes more than 17 percent of the country's gross domestic product, yet US residents generally do not live longer nor are they healthier than those in other developed nations that spend less than half that amount on healthcare (Goldman and McGlynn 2005). The reality of these statistics, along with the Institute of Medicine's 1999 report (*To Err Is Human*) on preventable deaths in the United States, has energized the federal and state governments in ways that will continue to put pressure on healthcare organizations. For example, plans for reduced reimbursement rates will put a crimp on the increasing bottom-line pressures to ensure that any investments in capital gain the envisioned returns. Clearly, just by their sheer size—seven-, eight-, or even nine-figure expenditures—electronic health record (EHR) projects (depending on the size of the organization) should automatically create a heightened need for due diligence among healthcare executives; nothing can get an executive fired faster than spending $50 million with nothing to show for that investment.

In their presentation, titled "IT Disasters: The Worst IT Debacles and the Lessons Learned from Them" at the American College of Healthcare Executives Congress on Healthcare Leadership, Hunter and Ciotti (2006) provided ample evidence that risks are associated with large-scale healthcare information technology (HIT) projects. While inadequate planning and foresight are problematic in such projects, the single greatest cause of project failure is poor execution (Bossidy and Charan 2002; Hunter and Ciotti 2006). Furthermore, some studies have suggested that HIT systems may cause, rather than reduce, medical errors (Ash et al. 2007; Han et al. 2005; Koppel et al. 2005). However, a careful reading of the original academic articles shows the obvious system design and implementation problems indicating that medical errors are caused by human error and not the HIT itself.

Exhibit 11.1 depicts the results of a Standish Group study and an American Medical Informatics Association literature review. In the Standish Group (2010) study, only 35 percent of HIT projects reviewed achieved anticipated benefits. Organizations that fall into the category of the 65 percent who failed to achieve benefits often rely on the collective experience of the individuals who have previously implemented HIT at the organization but typically do not employ disciplined project management methodologies, such as those suggested by the Project Management Institute (www.pmi.org; discussed in more detail later in this chapter). Furthermore, in their review of the literature, Kaplan and Harris-Salamone (2009) found that only about 40 percent of HIT projects met their goals.

Healthcare delivery is a complex business with incredibly multifaceted, interdependent workflows, yet the field as a whole has been inexplicably slow to adopt professional project management approaches. Organizations that fall into this category typically implement a "go live" only to find that large

EXHIBIT 11.1
IT Project Success Rates



SOURCE: Information from Kaplan and Harris-Salamone (2009) and Standish Group (2011).

stakeholder groups or key workflows have been overlooked. These organizations must then scramble, after implementation, to reengineer processes that easily could have been proactively addressed had the organization followed disciplined project management methodologies.

This chapter provides an overview of HIT project management and encourages healthcare organizations to improve their project success rate by establishing an HIT project portfolio management office.

What Is an HIT Project Portfolio Management Office?

The following terms and their definitions are used in this chapter to clarify concepts related to portfolio management:

- A *project* is a temporary effort to create a unique product, service, or result (PMI 2008).
- *Project management* is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives (Kerzner 2003).
- A *program* is a group of related, often interdependent projects.
- A *portfolio* is a collection of programs and projects.
- *Portfolio management* encompasses managing the collections of programs and projects in a portfolio. This includes weighing the value of each project, or potential project, against desired organizational strategic business and clinical objectives. It also encompasses monitoring active projects to ensure adherence to specified objectives and desired outcomes, balancing the portfolio with other investments of the organization, using resources efficiently, and balancing return on investment with risk (Kaplan 2005).
- A *portfolio management office* (PMO) is a centralized organization dedicated to improving the practice and outcomes of projects via holistic management of all projects.

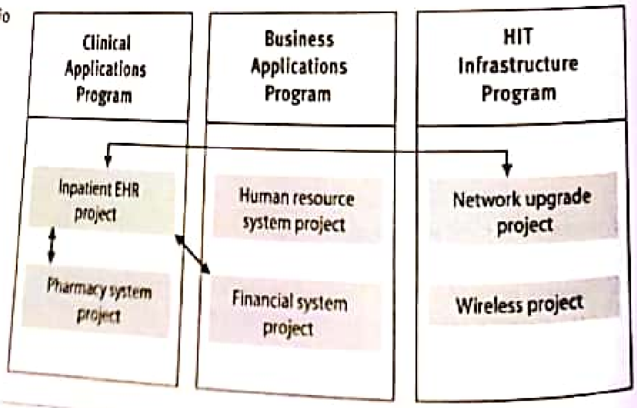
While definitions can help distinguish concepts, often the terms *project management office*, *program management office*, *portfolio management office*, and *project portfolio management office* are used interchangeably in the business press. All imply the professional management and oversight of an organization's entire collection of current projects. PMO, however, specifically refers to the activity of providing investment decision support capabilities to an organization's overall HIT governance structure and processes. The term *project management office* or *program management office* does not necessarily mean that decision support capabilities for these investments are in place. Organizations that use the term *PMO* or *project portfolio management office* are intentionally and accurately referring to a more expansive concept, reflecting the methodology's HIT portfolio investment decision support capabilities (Jeffery and Leliveld 2004). To be consistent, we use the term PMO throughout this chapter. Exhibit 11.2 illustrates how projects, and programs of projects, might interrelate within a typical HIT portfolio.

Individual projects, such as a new inpatient EHR or a new pharmacy system, are grouped into a clinical applications program. Ideally, clinical application projects are led or championed by an influential stakeholder from within the clinical leadership of an organization. Likewise, upgrades of an existing financial budgeting system and implementation of a new human resource system are grouped into a business applications program. Business application projects are ideally led or championed by an influential business stakeholder. Purely infrastructure-type projects, such as a network upgrade or implementation of wireless technology, are grouped into a HIT infrastructure program championed or led by the chief information officer (CIO) or one of the CIO's key directors. All of the projects in all program groupings then make up the entire HIT portfolio that can be professionally managed via formal HIT portfolio management structures and practices—an HIT PMO.

Why Is a PMO Essential?

As indicated earlier in this chapter, some studies have found that 65 percent of HIT projects fail to achieve anticipated benefits (Kaplan and Harris-Salamone 2009; Standish Group 2011). One of the primary causes of failed HIT projects is a "silo" project management mentality, which occurs when projects are initiated, planned, and fully executed without an effective consideration of their impact on other, preexisting systems or other parallel projects being planned and executed. As indicated in Exhibit 11.2, contemporary healthcare applications have significant interdependencies that, if not explicitly and deliberately addressed, can have unintended consequences. Exhibit 11.3 provides real-world examples of unintended consequences of HIT projects that were planned and executed in relative isolation.

HIBIT 11.2
IT Portfolio



EXHIBI
Exampl
Project
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Appro

IT Project	Project Outcome
New Pharmacy System: The pharmacy director sponsored a new best-of-breed pharmacy system project	The pharmacy system project was expertly managed and implemented on time and within budget. Unfortunately, only after the system was implemented did the pharmacist realize that this new proprietary best-of-breed system could not be reliably interfaced with the hospital's preexisting EHR system, which had built-in computerized physician order entry capability. As such, when a provider entered an order for a pharmaceutical into the EHR, that order had to be printed out in the pharmacy and then reentered into the new pharmacy system. From a pure project management standpoint, the project was successful. From an enterprise portfolio standpoint, however, a very inefficient, labor-intensive workflow was created to overcome the lack of integration that this silo-based project management approach created.
Voice Over Internet Protocol (VOIP) Project: A telecommunications director sponsored a switch to digital phone service	The telecommunications director of a large metropolitan hospital system wanted to save millions of dollars annually by switching from a basic traditional phone service model to a VOIP model, whereby the hospital system's existing computer network would be used to provide digital phone service. Unfortunately, the project did not consider the robustness of the existing computer network, which had single points of failure in many of its buildings. The digital phone service was implemented, and soon thereafter, any network outage to one of the buildings affected all phone service for the building. More than an inconvenience, these outages eroded consumer trust and market appeal. Using contingency funds, the hospital system scrambled to re-architect its computer network to provide the level of redundancy and reliability needed to ensure digital phone service. Had a portfolio management approach been taken for this project, computer network inadequacies could have been identified up front and computer network upgrades could have been built into the project plan.

While the examples described in Exhibit 11.3 may seem to be obvious, common sense mistakes, they are not uncommon because in reality healthcare delivery organizations have thousands of cross-departmental interrelated workflows that must be considered when embarking on a new HIT project. Exhibit 11.4 depicts sample high-level application interfaces that are in place at a typical academic medical center that is representative of any medium to large integrated delivery system. This graphic conveys an incredibly complex web that relies heavily on interfacing applications wherever possible. The sheer volume of interdependencies shown in this exhibit clearly makes a case that individual projects or programs of applications should not be managed in silos but rather in a professional PMO focused on successfully achieving envisioned benefits of particular projects.

In many ways, allowing informal, silo-based project management to occur in a healthcare organization is somewhat like attempting to minimize collisions at an airport without the benefit of a flight control tower. Not incidentally, Exhibit 11.4 resembles a typical major airline hub city with flights coming and going from all points on the compass; yet it depicts a real organization's current applications and how each is interfaced and interrelated. This level of interrelatedness strongly suggests the need for a professional control tower to manage HIT projects. In fact, Gartner Research suggests that "three

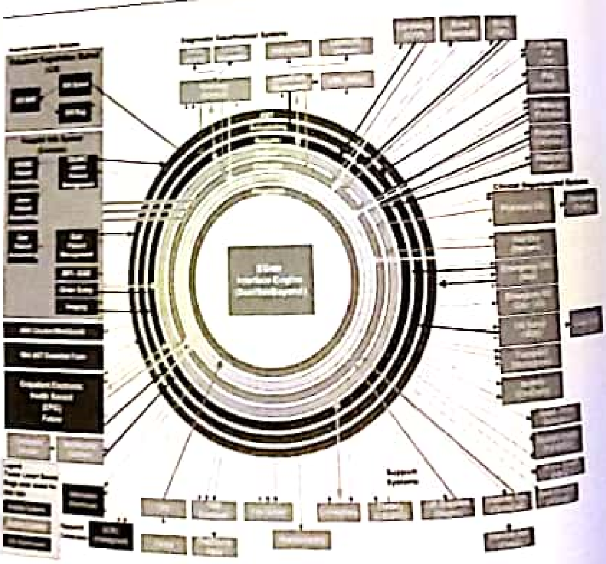


EXHIBIT 11.4 Example of Typical Hospital Application Interfaces

out of four successful $500,000 plus projects will be planned and tracked with project office support, while three out of four failed projects will not" (Light et al. 2005). An organization's ability to successfully and efficiently implement large HIT projects increases as its project management maturity moves from no professionally managed projects to simple project management to program management and ultimately to portfolio management.

Typically, as an organization's HIT project management matures, its overall cost of HIT projects decreases significantly and the success rate of these projects increases substantially. A nonintuitive overall time savings occurs as well, although one would suspect that it would take more time to accomplish the additional work of identifying and tracking interdependencies with other projects across the portfolio of projects. However, Kendall and Rollins (2003) suggest that this additional planning time, which is marginal, actually reduces the number of surprises and "gotchas" that occur later when unforeseen interdependencies invariably crop up in projects that are run in a more informal, silo approach, thus decreasing overall project time. One of the main causes of time delays in projects is *scope creep*—when the original agreed-on requirements for a system are continually expanded by the project sponsors. With project management methodologies in place, added or new requirements are collected and saved for a future version of the system so that the original system scope can be implemented within the established time frames.

The next section addresses project management methodologies. Thereafter, managing the collection of projects is discussed, and the suggestion is reiterated that a PMO is a logical organizational response to the increasing HIT complexity in healthcare organizations.

Project Management

Project management entails the following five processes (PMI 2008):

1. *Project initiation:* launch of a process that can result in the authorization of a new project
2. *Project planning:* definition of the objectives, scope, and plan of action to achieve the desired outcomes
3. *Project execution:* actions to complete the work defined in the project planning process
4. *Project monitoring and controlling:* measurements designed to assess how well a project is being executed per the budget and deliverables as well as to alert project managers to potential corrective actions that might be necessary from time to time

5. *Project closing:* actions to formally terminate all activities associated with the project either by delivering a finished product or by ceasing effort on a canceled project

Professionalizing project management at a healthcare delivery organization means that each HIT project should follow these five key processes. While project management frameworks are important, hiring professionally trained and ideally credentialed project managers is equally important. A number of project management credentialing organizations exist, including the Project Management Institute (PMI), which offers both the Project Management Professional (PMP) certification and the Program Management Professional certification. The PMP certification ensures that an individual has mastered a requisite body of knowledge on project management (see Exhibit 11.5 for a list of applicable knowledge areas) and has at least 60 months of project management experience. Furthermore, survey data suggest that increasing the number of individuals within the organization who have professional project management skills and experience and following an explicit HIT project management process framework raise the likelihood that the project will be a success (Lee 2006; Taylor 2004); see Exhibit 11.6.

Project Management Tools

A number of project management applications are available that provide the automated support to manage projects more professionally. While not intended to be an exhaustive list, the following are applications that can provide automation to support the five project management processes outlined earlier; many of these applications also carry the higher-level program/portfolio management capabilities discussed later in this chapter:

- Clarity (Computer Associates)
- Changepoint (Compuware)
- Project (Microsoft)
- Project Portfolio Management (Planview)
- Primavera P6 (Oracle)

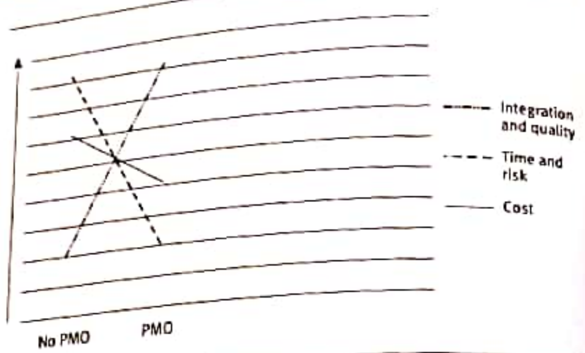
Standardizing HIT operations on a set of project and portfolio management tools provides a common way to establish the processes and business rules that an organization must follow for managing projects. For instance, a healthcare organization's applications group uses one tool (say, Microsoft Project software), the infrastructure group uses a different tool (say, Oracle's Primavera P6), and the informatics and analytics group uses no tool at all. Because there is no visibility into the total number of projects going on

EXHIBIT 11.5 Project Management Knowledge Areas

Project Management Knowledge Area	Individuals Must Know How To
Project integration management	Develop project charter Develop project management plan Direct and manage project execution Monitor and control project work Perform integrated change control Close project or phase
Project scope management	Collect requirements Define scope Create work breakdown structure Verify scope Control scope
Project time management	Define activities Sequence activities Estimate activity resources Estimate activity durations Develop schedule Control schedule
Project cost management	Estimate costs Determine budget Control costs
Project quality management	Plan quality Perform quality assurance Perform quality control
Project HR management	Develop human resource plan Acquire project team Develop project team Manage project team
Project communications management	Identify stakeholders Plan communications Distribute information Manage stakeholder expectations Report performance
Project risk management	Plan risk management Identify risks Perform qualitative analysis Perform quantitative analysis Plan risk responses Monitor and control risks
Project procurement management	Plan procurements Conduct procurements Administer procurements Close procurements

SOURCE: Information from Project Management Institute (2008).

EXHIBIT 11.6
Benefits of HIT PMO



among these groups, it becomes incredibly difficult to establish standardization of project management processes that is a prerequisite for managing interdependencies between projects; thus, it is difficult to achieve program or portfolio management capabilities.

Entire textbooks have been written on project management (e.g., Coplan and Masuda 2011) and the tools that support it. For illustrative purposes, we discuss project plans and Gantt charts as examples of key artifacts that are easily developed from within most project management/portfolio management tools.

Project Plans and Gantt Charts

All project management applications should have the ability to create a project plan and display it in a way that easily shows task interdependencies. Exhibit 11.7 shows a simple example of a Gantt chart for some tasks in an infrastructure project of a hospital system. This list of tasks is known as a *work breakdown structure* in project management parlance. Note how the interdependencies are clearly visible by the linking arrows that show which tasks must be fully completed before their successor tasks can begin. Other tasks without these interdependencies can be accomplished in parallel (i.e., they have no interdependencies but must nevertheless be accomplished to complete the project). Project management applications have the ability to collapse these tasks—these are all of the tasks that have predecessor (tasks that must be completed before the next tasks can be started) or successor (tasks that cannot begin until certain tasks have been completed) interdependencies—into the critical path of a project (see Exhibit 11.8). The reason critical

EXHIBIT 11.7
Project Plan in Gantt Chart Format

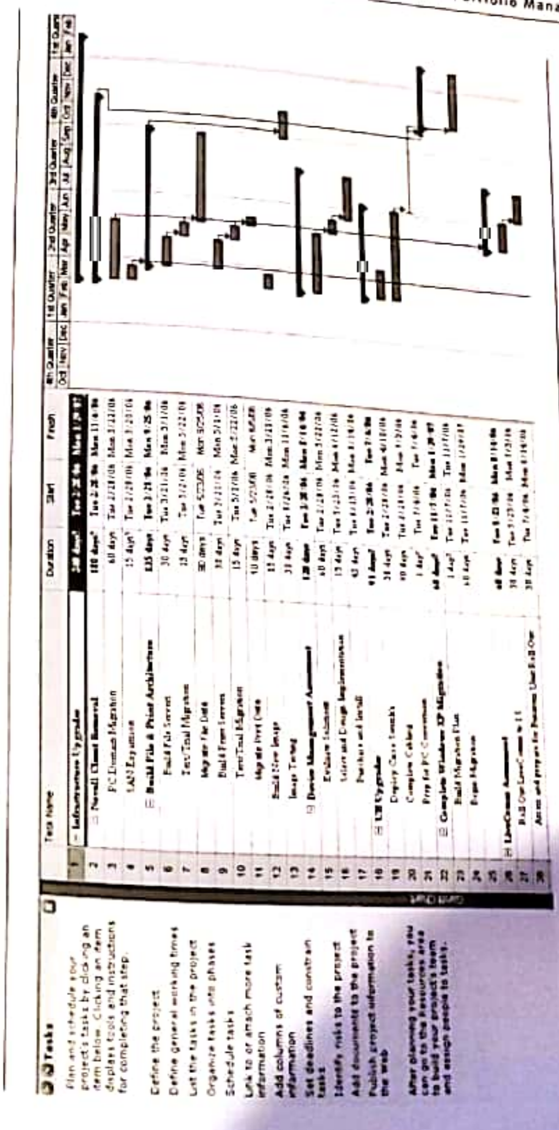


EXHIBIT 11.8
Collapsed Project Plan Gantt Chart Showing Only the Critical Path

path analysis is important is that it provides a forecast of the shortest possible time in which the overall project can be completed.

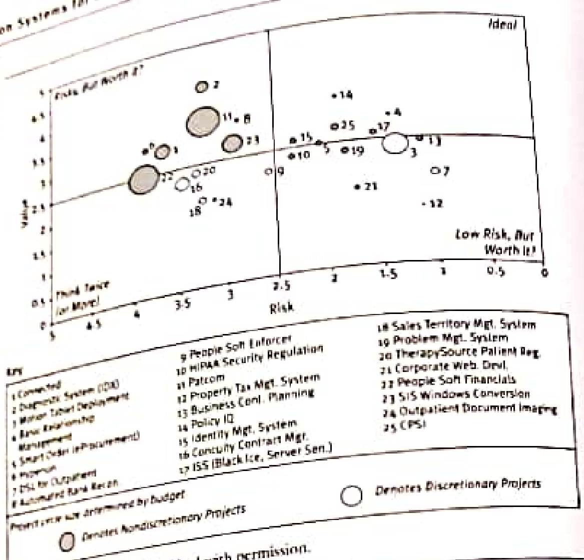
Program Management

As noted earlier, organizations that put in place program management capabilities have moved beyond managing individual projects to managing the interrelationships between projects and/or preexisting applications and systems. While managing this level of complexity takes slightly longer to plan up front, the extra time expended is recovered during the execution phase of the project in the form of reduced surprises and cost overruns associated with unforeseen interdependencies. In essence, the critical dependency analysis and management depicted in exhibits 11.7 and 11.8 are simply extended beyond a single project to interdependencies that exist within a particular program of projects or even across the HIT portfolio (Exhibit 11.2).

Portfolio Management

Along with the professional project management expertise described in the previous sections, organizations that employ a portfolio management approach also have tightly coupled HIT governance (essentially, making decisions about which information technology to invest in and which not to invest in) with its PMO (Smaltz, Carpenter, and Saltz 2007). In other words, think of project and/or program management as ensuring that things are done right within a particular project, whereas portfolio management concerns itself with doing the right kinds of projects that align with the organization's overall strategic goals and objectives. This distinction is why a PMO must work hand-in-hand with an organization's HIT governance structure (covered in Chapter 5). Illustrating this point is Exhibit 11.9, which shows a HIT portfolio of all the projects that are "in flight" at a for-profit healthcare organization. Prior to its annual HIT capital budget process, the particular organization, using the knowledge gained from professionally managing its portfolio of current HIT projects, put together a profile of all of the current HIT projects already in flight and rated them on the basis of value and risk. The organization further labeled each quadrant. The lower left quadrant, which represents low-value and high-risk HIT projects, is labeled "Think Twice (or More)." The upper right quadrant represents HIT projects that are deemed to both be of high value and have low risk associated with implementation; this quadrant is labeled "Ideal." The size of the bubbles in Exhibit 11.9 denotes the size in relative dollars of each individual project. Projects are categorized into nondiscretionary projects (e.g., some projects are mandated by law, such as the Sarbanes-Oxley Act) and discretionary projects. Much like an investor reviewing a portfolio of stocks before deciding which to divest and which to add to, an organization developing a graphic

EXHIBIT 11.9
Illustrative HIT Portfolio



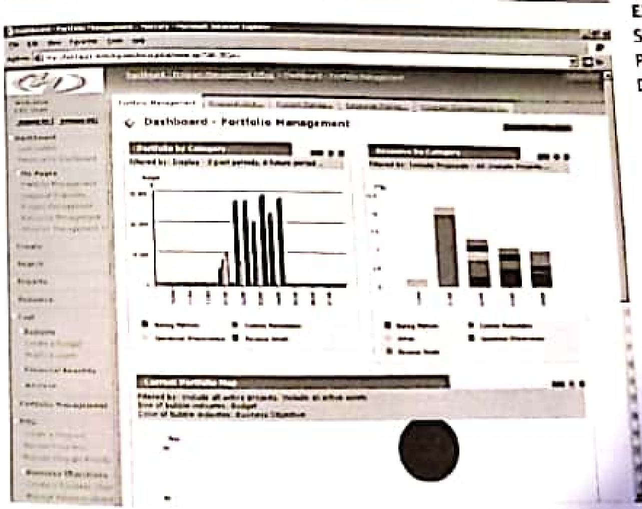
SOURCE: Carpenter (2005). Used with permission.

such as Exhibit 11.9 gains a powerful and succinct decision-support means to evaluate proposed HIT projects.

In addition to decision support, an HIT portfolio management capability also provides regular portfolio status reports to the HIT governance of an organization. For instance, an HIT portfolio dashboard is typically created—sometimes via one of the project/portfolio management applications and sometimes via an organization's overall quality or other enterprise dashboard tools—to give leadership a view of project progress. Exhibit 11.10 is a sample of one such view, showing all in-flight projects of the organization (listed in Exhibit 11.9) grouped by strategic categories that are important to the organization along with the dollar amounts budgeted for each category. The graph on the left of this exhibit, titled "Portfolio by Category," depicts the monthly expenditures of each project category. The graph on the right of this exhibit, titled "Resource by Category," depicts the amount of full-time equivalent resources being expended on each project category.

While an HIT portfolio dashboard can be set up to provide status along any number of dimensions, its greatest impact comes in providing strategic views into the myriad projects the organization is working on to benefit HIT governance decision making. In the examples provided in exhibits 11.9 and 11.10, this for-profit healthcare organization is trying to balance strategically the need for greater regulatory compliance with the Sarbanes-Oxley Act and other legislation with the need for revenue growth. Therefore, the dashboard is designed to quickly provide a view within the past three quarters and the next six quarters of the amount of money being (or slated to be) invested in compliance-related projects, operational effectiveness projects, and projects the organization hopes will generate increased revenue. While illustrative and not intended to be a definitive example, this example makes the point that organizations must be able to produce flexible data representations (like Exhibit 11.9) on the entire portfolio of HIT projects to aid their HIT governance bodies. Such data are essential to making informed investment decisions and monitoring progress.

EXHIBIT 11.10
Sample HIT Portfolio Dashboard



SOURCE: Carpenter (2005). Used with permission.

The PMO

Generally, these high functioning portfolio management capabilities are being formalized in many leading healthcare organizations via the establishment of an HIT PMO. Typically, the functions of a PMO include but are not limited to the following:

- Issuing regular *communications* to project stakeholders and the rest of the organization regarding progress or status, programs of projects, and the entire portfolio
- Providing authoritative ***management and oversight*** of all projects within the portfolio
- Serving as *staff support to the HIT governance* of the organization, including performing portfolio analyses as requested by HIT governance and recommending HIT investments
- Creating ***metrics and dashboards*** to facilitate transparency

These tasks can be accomplished without putting in place a formal PMO, but a number of consultants and researchers suggest that organizations that institute a PMO have a competitive advantage over those that do not (Cooke-Davies, Crawford, and Lechler 2009; Jeffery and Leliveld 2004; Kaplan 2005; Light et al. 2005). Do note that establishing a PMO is not a quick fix to whatever project management challenge the organization is facing, and it is an effort that likely will take between two and four years to generate significant benefits for the organization. Jeffery and Leliveld (2004), from data derived in their study of 130 *Fortune* 1000 companies, created the useful IT Portfolio Management Maturity Model, which outlines the four stages of maturity of any organization's portfolio management capabilities. Jeffery and Leliveld refer to these four stages as ad hoc, defined, managed, and synchronized; each stage indicates a higher, more capable PMO function.

Four Stages of Portfolio Management Maturity

In the *ad hoc stage*, no formal project management capability is in place at all. Projects are managed informally and inconsistently, and project results are equally inconsistent.

In the *defined stage*, the organization has created a centralized entity to maintain and inventory projects and to manage them centrally. In this stage, applications and infrastructure are well defined and documented.

In the *managed stage*, the organization has created processes for vetting and rationalizing or ranking projects on the basis of key strategic criteria.

Furthermore, investment decisions employ financial metrics to help prioritize projects (e.g., return on investment, return on assets, net present value) and conduct at least annual reviews with business unit leadership on how well the HIT portfolio is aligned with overall organizational strategies.

In the *synchronized stage*, organizations conduct much more frequent evaluations of the HIT portfolio with business unit leaders and include a consistent assessment of returns versus risks in their project portfolios. Typically, organizations at the synchronized level of HIT portfolio management maturity have created PMO scorecards or dashboards that serve to transparently communicate project status and value. They also consistently conduct post-project benefits realization assessments to see if benefits envisioned prior to the project's adoption are achieved.

Since Jeffery and Leliveld (2004) articulated this maturity model, there has been considerable debate within the project management community about the best framework to use for assessing an organization's project/program/portfolio management maturity (Lianying, Jing, and Xinxing 2012; Pasian 2011; PMI 2008). Each framework suggests more complex and granular approaches for assessing an organization's project management capabilities. While the debate continues, Jeffery and Leliveld's model continues to provide HIT leaders and professionals with a simple, quick way of assessing the maturity of their organization's HIT portfolio management capabilities.

Summary

This chapter makes the case that many HIT projects generally do not achieve the benefits envisioned and that implementing professional portfolio management capabilities is an important first step toward mitigating this project risk. Furthermore, identifying and managing the cross-project interdependencies that a portfolio management approach embodies is an important second step toward mitigating project risk. Finally, implementing an HIT PMO that is tightly coupled with an organization's HIT governance structures and processes and that provides the full complement of capabilities outlined in Jeffery and Leliveld's (2004) IT Portfolio Management Maturity Model represents the greatest return on HIT investments for a healthcare organization.

Web Resources

A number of organizations (through their websites) provide more information on the topics discussed in this chapter:

- *CIO* magazine, Project Management section (www.cio.com/topic/3198/Project_Management). *CIO Magazine*, a leading publication of senior IT executive practices, provides a web resource on project management.
- Computer Associates, Clarity Project and Portfolio Management software (www.ca.com/us/products/detail/ca-clarity-ppm.aspx). This is an example of a vendor that provides project and portfolio management software.
- Compuware, Changepoint Business Portfolio Management software (www.compuware.com/business-portfolio-management). Another example of a vendor that provides project and portfolio management software.
- Healthcare Information and Management Systems Society, Project Management Special Interest Group (www.himss.org/get-involved/sigs/project-management?navItemNumber=12549).
- Microsoft, Project software (www.microsoft.com/project/en-us/project-management.aspx). Another example of a vendor that provides project and portfolio management software.
- Planview, Project Portfolio Management software (www.planview.com/products/enterprise/project-portfolio-management). This is another example of a vendor that provides project and portfolio management software.
- Project Management Institute (PMI; www.pmi.org). Check out what PMI offers:
  1. PMI Healthcare Community of Practice (http://healthcare.vc.pmi.org/Public/Home.aspx), a web space reference for practitioners in the field of project management.
  2. PMI Information Systems Community of Practice (http://is.vc.pmi.org/Public/Home.aspx), a web space reference site for practitioners in the field of information systems.
- Oracle, Primavera P6 Enterprise Project Portfolio Management software (www.oracle.com/us/products/applications/primavera/overview/index.html). This is yet another example of a vendor that provides project and portfolio management software.

Discussion Questions

1. Discuss some of the primary reasons an HIT implementation project might fail in a healthcare organization.

2. What are the main differences between HIT project management, HIT program management, and HIT portfolio management?
3. What are the five processes of project management?
4. What requirements should be considered when selecting project management tools for an organization?
5. Why are project metrics and portfolio dashboards important to HIT governance?
6. List and describe the major roles and functions of the PMO.
7. Which two project management knowledge areas described in Exhibit 11.5 do you consider to be the most important? Why?
8. What actions/changes are necessary within an organization to reach the synchronized stage of maturity of Jeffery and Leliveld's IT Portfolio Management Maturity Model?
9. Even with the development of a PMO, will there be instances in which an HIT venture fails? Explain your rationale.

CHAPTER

12

THE KNOWLEDGE-ENABLED ORGANIZATION

Learning Objectives

1. Describe the impact of knowledge on quality of care.
2. Articulate the differences between knowledge and information.
3. Define sensemaking, and describe how it can be applied to healthcare organizations.
4. Define knowledge management.
5. Articulate what it means to "bake in" knowledge into organizational workflows, and provide some examples of how that is being done in the healthcare field.
6. List some reasons that healthcare organizations invest in enterprise data warehousing, data mining, and data analytics capabilities.

Overview

The Institute of Medicine (IOM) 1999 report, *To Err Is Human*, suggests that each year up to 98,000 patients in the United States die as a direct result of errors made in the course of their care. More recent studies (e.g., Healthgrades 2009) indicate that the actual number of deaths attributable to medical errors may be significantly higher than the rate initially proposed by the IOM. A key contributing cause of these errors, according to the IOM report, is a lack of relevant information. A follow-up IOM report released in 2001 (*Crossing the Quality Chasm*) specifically recommends significant investments in healthcare information technology (HIT) to achieve its six goals of making healthcare safe, effective, patient centered, timely, efficient, and equitable. In 2009, the American Recovery and Reinvestment Act went a step further by providing significant financial incentives to healthcare organizations that meaningfully use electronic health record (EHR) systems to deliver patient care.

While information technology has great potential, a solution to the quality problem transcends simple information. The complexity of healthcare delivery has increased as diagnostic and therapeutic technologies have advanced. Another factor that contributes to the complexity of delivering patient care is the exponential expansion of medical knowledge, making it virtually impossible for a physician to stay abreast of the latest medical information (AMA 2006). Compounding this problem is that many physicians perceive that the impact of managed care practices has essentially limited the amount of time they could spend with a patient and the amount of cognitive time they could spend thinking about diagnoses and treatment options for any given patient (Morrison and Smith 2000).

These dynamics create increasing decision complexity, which affects what a caregiver notices and what a caregiver ignores. Weick (1995) notes that "information load is a complex mixture of the quantity, ambiguity, and variety of information that people are forced to process. As [information] load increases, people take increasingly strong steps to manage it. They begin with omission, and then move to greater tolerance of error, queuing, filtering, abstracting, using multiple channels, escape, and end with chunking." Weick's seminal work suggests that to adequately overcome complexity and information load, organizations must put in place deliberate systems of ***sensemaking***—the ability to more accurately make sense of any given situation. Leading healthcare organizations are adopting sensemaking strategies to reduce medical errors and increase operational efficiency. Knowledge management principles and practices adopted in a sensemaking environment help optimize decision making with the limited time and ambiguous information available to contemporary providers (Middleton et al. 2004).

Knowledge Management

While a relatively new concept to healthcare delivery organizations, knowledge management is being successfully used by many other industries, particularly industries that gain from reusing knowledge (e.g., consulting firms) or quickly leveraging new discoveries into new products and services (e.g., manufacturing research and development). From Peter Senge's (1990) *The Fifth Discipline* to Nonaka and Takeuchi's (1995) *The Knowledge Creating Company* to Davenport and Prusak's (1998) *Working Knowledge*, ample resources are available to inform the healthcare field about the basics of knowledge management and how to apply its principles within a complex organizational setting. The key underlying tenet of the seminal knowledge management literature is that when individuals within organizations have the knowledge they need to be able to make decisions and accomplish their

individual jobs, organizational efficiency and effectiveness are significantly improved. Often, however, healthcare workers do not have key information, and errors and suboptimal outcomes may follow.

Knowledge management is the organizational practice of explicitly and deliberately building, renewing, and applying relevant intellectual assets to maximize an enterprise's effectiveness (Wiig 2000). Knowledge management practices seek to leverage as much of the information and knowledge that exists within and beyond an organization as possible. Smaltz and Cunningham (2005, 126) suggest that "this knowledge can either be in explicit form (such as in databases, spreadsheets, presentation slides, documents, or other media) or in tacit form (such as the 'know-how' in an individual's head). The task of knowledge managers is to explicitly and deliberately build the organizational processes and toolsets that bring this knowledge asset to bear on the thousands of daily tactical and strategic decisions that are made each day in a healthcare organization."

Building the Knowledge-Enabled Healthcare Organization

One mistake many healthcare organizations make is that they expect to achieve better decision making, more efficient operations, and better healthcare outcomes by simply providing more and more data to caregivers and administrators. As noted by Weick (1995), such approaches merely increase the information load on caregivers, thereby making it more difficult to arrive at quality decisions. In response, leading healthcare organizations are taking systematic and deliberate steps to reduce the information load on caregivers by focusing attention on the data and information that truly matter in a given situation. They accomplish this primarily by using the following two practices:

1. *Baking in*, or embedding, knowledge into clinical and administrative workflows. This may be done via alerts, reminders, evidence-based order sets, and "click through" capability to relevant medical literature and evidence.
2. Achieving excellence in data warehousing, data mining, and analytics. This excellence is often evidenced through front-line patient safety dashboards, real-time process and outcomes reporting, and real-time feedback loops. An example is between patient care systems such as an electronic medical record (EMR) and the organization's data warehouse.

Knowledge-Enabled Workflows

A typical twenty-first century healthcare organization has thousands of workflows. Some examples of workflows include the process of admitting a patient to the hospital, scheduling a patient appointment in an outpatient clinic, and assessing a patient's condition in the emergency department. On the surface, these seem fairly innocuous examples, but consider the implications of missing information, too much information, or ambiguous information on any of these workflows. Being alerted that a patient is allergic to amoxicillin, is currently already taking a beta-blocker for an unrelated condition, or is epileptic can make a profound difference in the treatment plan initiated by the caregiver team (not to mention the patient outcome). Exhibit 12.1 provides some examples of how healthcare organizations are baking in knowledge into their workflows to increase patient safety and ensure more quality outcomes for the services they provide.

While not infallible, the practice of placing relevant knowledge directly within the workflow creates an organizational system that will maximize quality decision making, reduce medical errors, and significantly increase the quality of care provided to patients (Bates et al. 1998; Berner and La Lande 2007).

EXHIBIT 12.1 Baking-In Healthcare Knowledge with Workflow Examples

Types of Baked-In Knowledge	Workflow Example
Alerts	Within an electronic medical record (EMR) system, an alert is triggered when a provider orders a new drug for a patient that interacts negatively with another drug that either the physician has ordered previously or the patient is already taking
Reminders	On a nursing unit, a nurse is reminded that a patient is due for another dose of a particular medication at a prescribed time
Evidence	Within an EMR system, providing click-through capability to access relevant medical literature (often via an electronic subscription service) pertinent to the current patient situation
Order sets	Within an EMR system, physicians often place orders for various drugs or treatments (Creating order sets is the practice of prepopulating orders into groups that evidence has shown to be effective together; rather than having to place individual orders, a physician may select an entire order set.)
Automatic billing codes	During an outpatient visit, E&M (evaluation and management) codes are automatically generated to facilitate billing via information that the caregiver team annotates in the EMR

Excellence in Data Warehousing, Data Mining, and Analytics

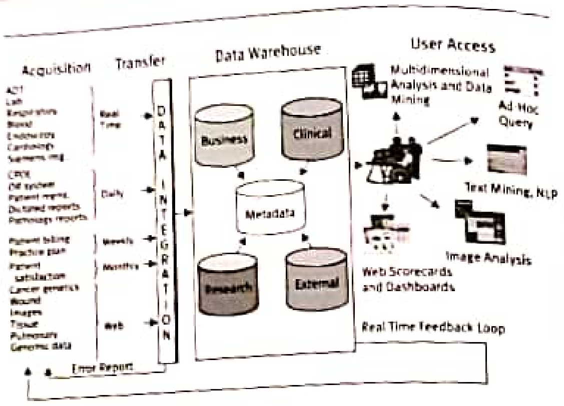
Contemporary healthcare organizations produce mass quantities of data often housed within siloed, transaction-based systems. For instance, vast quantities of test results sit in a typical hospital laboratory system; vast quantities of drug orders for various patients at various points in time sit in a pharmacy system; and a growing body of text reports and notes describing signs, symptoms, and diagnoses for various patients sit in an EMR. To aid organizational efforts to holistically assess patient outcomes, improve patient safety, and enhance organizational efficiencies, these data must be aggregated into a data warehouse to facilitate analyses, thereby aiding continuous process improvement efforts. Smaltz and Cunningham (2005, 118) note that

> enterprise data warehouses essentially provide a homogeneous location for the data that heterogeneously resides in your various information systems.... The way an enterprise data warehouse typically functions is that data collected from the main transaction-based systems (appointing and scheduling, laboratory, pharmacy, and the like) is copied over to the data warehouse for use in organizational analyses and performance measurement activities. Once in the data warehouse, it serves as the one-stop shopping for management engineering studies, operations research studies, clinical process studies, and other decision support processes. Most recently, enterprise data warehouses have enabled the new field of data mining (large variable data set correlation and associative studies).

Exhibit 12.2 depicts a typical hospital data warehouse. Data from various source systems are acquired and transferred to the data warehouse. The data integration is accomplished via a process commonly known as ***extraction, transformation, and load*** (ETL). Because the data formats within the source systems on the left of Exhibit 12.2 are often quite heterogeneous, the ETL process transforms the data into homogeneous data fields for ease of management and further analysis. When data-quality errors are encountered during the extraction and transformation stages, action is taken to improve the data quality within the source system, as opposed to within the data warehouse itself. The actual data warehouse may be organized into logical groups of data marts. A ***data mart*** is a subset of the data that resides within a data warehouse, often organized into logical groupings. In this example, the data warehouse is made up of business, clinical, research, and external (benchmarking) data marts.

The organization benefits from the data warehouse by being able to accomplish a variety of data queries and multidimensional analyses and can

EXHIBIT 12.2 Notional Depiction of a Data Warehouse



support management dashboards and scorecards designed to focus organizational attention on a metrics-driven approaches to improvement. Pioneering healthcare organizations are also creating real-time feedback loops whereby novel groupings of data from the data warehouse are fed back into source systems (often via web portals) to facilitate real-time quality improvements.

Smaltz and Cunningham (2005, 115) note that

> most organizations would agree that realization of investments in HIT fall[s] short when attempting to truly assess population health, to manage disease processes within that population, to analyze variation in practice patterns among physicians, to determine the efficacy of long-term health promotion programs, to gauge the benefit of outsourcing to other healthcare providers, or, in some cases, to gain a true picture of their own organizations' performance in spite of the mounds of data available to do so. Interestingly, the HIT functionality (for the most part) currently exists to create these capabilities. However, responsibility for ensuring that the HIT assets are used effectively and efficiently has primarily fallen on users who, in general, know little about the systems or their full capabilities (beyond what they need to know to accomplish transactions within their responsibility), making it impossible to achieve full realization of HIT benefits. While some might call for more training or for vendors to make information systems easier to use (which certainly is beneficial), *organizations cannot avoid investing in people, processes and capabilities that are expressly focused on leveraging enterprise-wide data, information and knowledge . . . if they want to truly achieve and sustain superior clinical and business results.*

The Health Information Technology for Economic and Clinical Health Act (HITECH) Act of 2009 and the incentives it provides for healthcare organizations to not only invest in but also meaningfully use an EHR has dramatically increased investment in HIT. When organizations make these investment decisions, they also typically invest in the requisite people and process redesign to gain full benefit from the applications that they implement. Ironically, our anecdotal observations suggest that few healthcare delivery organizations are adequately investing in the people and processes needed to leverage the data these systems create. As profit margins continue to be challenged by increasingly difficult reimbursement mechanisms, data warehousing, data mining, and analytics will increasingly become vital in efforts to analyze business and clinical processes and outcomes and to maximize efficiencies and effectiveness (Smaltz and Cunningham 2005).

Summary

Medical knowledge is increasing at a rate impossible for physicians and caregivers to comprehend and retain. Furthermore, physicians and caregivers are often faced with limited time to make clinical decisions with imperfect information about their patients. The practice of knowledge management attempts to systematically and deliberately take steps to reduce the information load on physicians and caregivers by focusing attention on the data and information that truly matter in a given situation. Knowledge management also attempts to create organizational competencies that leverage the hordes of data produced from myriad healthcare applications. Healthcare delivery organizations' knowledge management foci are typically in two key areas:

1. Baking in knowledge into clinical and administrative workflows
2. Achieving excellence in data warehousing, data mining, and data analytics

While quality in the delivery of healthcare has been highlighted as a systemic problem within the US healthcare system, organizations can—at least in part—overcome such systemic problems by investing in resources focused on building a knowledge-enabled organization. In fact, Garets and Lazerow (2012) suggest that healthcare organizations can expect to enjoy increasing levels of competitive advantage to the extent that they empower their employees at all levels with integrated information to drive organizational performance improvement. Healthcare organizations are well served to invest more resources focused on creating a knowledge-enabling core competency.

Web Resources

A number of organizations (through their websites) provide more information on the topics discussed in this chapter.

- Brint Institute, Knowledge Management Think Tank Discussions Archives (www.brint.com/km). This website is a virtual knowledge management community of practice that provides a plethora of information on the field of knowledge management.
- eKnowledge Center (www.eknowledgecenter.com). The eKnowledge Center provides online training to knowledge management practitioners and certifications in knowledge management.
- Google Scholar, index of knowledge management articles (http://scholar.google.com/scholar?hl=en&q=Knowledge%20Management). This is a list of scholarly articles indexed by Google Scholar.
- KM World (www.kmworld.com). This is a publisher of knowledge management, content management, and document management material.
- Knowledge Management Professional Society (KMPro; www.kmpro.org). KMPro is a professional association for knowledge management practitioners. It offers both reference information and certifications in knowledge management.
- The Data Warehouse Institute (http://tdwi.org). This organization provides education, training, and certifications in the field of data warehousing and business intelligence.

Discussion Questions

1. What is the impact of knowledge on quality of care?
2. What, if any, are the major differences between knowledge and information?
3. What is sensemaking, and how can it be applied to healthcare organizations?
4. Define knowledge management.
5. What does it mean to bake in knowledge into organizational workflows?
6. What are some of the ways that knowledge can be baked into information technology–enabled workflows?
7. Why should an organization invest in enterprise data warehousing, data mining, and data analytics capabilities?

CHAPTER 13

HIT VALUE ANALYSIS

Learning Objectives

1. Specify why making healthcare information technology (HIT) investment decisions on the basis of realized value rather than on "anecdote, inference, and opinion" leads to better outcomes.
2. Describe five changes that make today's HIT investment decisions more challenging than in the past.
3. Provide examples of HIT costs and outcomes changes that will "always" be adopted and examples that will "never" be adopted.
4. Analyze how the major techniques used for evaluation of an HIT investment differ.
5. List the eight key steps in cost evaluation.
6. Analyze why certain types of HIT applications are less likely to be performed.
7. Describe value realization and total cost of ownership methodologies.

Overview

Up to this point in the book, the discussions surrounding healthcare information technology (HIT) have explicitly recognized that the organization, financing, and delivery of healthcare services are different from those of other goods and services. While we consider this to be fundamentally true, some aspects of healthcare, especially HIT, should adhere to core business processes. HIT can be considered an input into the "production" process just as are inputs of nursing time, allied health staff, medical supplies, and physician services. In that context, the decisions regarding how much and what type of HIT inputs to use should fall under a valuation paradigm. Johnston, Pan, and Middleton (2002) make this point strongly in their argument for finding value from HIT.

Firmly establishing value in many healthcare investments has proven to be a challenge, however. Clinical technologies have increasingly been subject to critical valuation, or benefits received relative to costs incurred, and this notion has taken hold for HIT as well (Board 2004; Bower 2005; Buntin et al. 2011, Miller et al. 2005, Wiley and Daniel 2006). Issues related to data collection, methodology, and application make the realization of value from and widespread use of evidence based management a challenge. The health economics literature is replete with methodologies of cost, cost-benefit, and cost effectiveness analyses and quality adjusted life years (e.g., Chaudhry et al. 2006; Gold et al. 1996; Rahimi and Vimarlund 2007; Shekelle, Morton, and Keeler 2006, Simon and Simon 2006; Warner and Luce 1982). Most of these studies involve developing the methodology for assessing complex medical applications, and only a few are applied. In addition, large organizations have become sources for clinical intervention evaluations (see University HealthSystem Consortium at www.uhc.edu or Blue Cross and Blue Shield Technology Evaluation Center at www.bcbs.com/betterknowledge/tec). Surprisingly, only a few studies look specifically at HIT interventions (e.g., Chaudhry et al. 2006; Featherly et al. 2007; Rahimi and Vimarlund 2007; Shekelle, Morton, and Keeler 2006; Simon and Simon 2006). Some earlier studies still serve the literature well (e.g., Glandon and Shapiro 1988). The Center for Information Technology Leadership (www.citl.org) now serves as one of the sources of information regarding HIT value.

Because of the complexity of the problem and the lack of comprehensive data, healthcare executives have largely been forced to make decisions about HIT investments on the basis of cursory evidence at best and instinct or hope at worst. In the words of Johnston, Pan, and Middleton (2002), HIT decisions are often based on "anecdote, inference, and opinion." Inevitably, this approach produces decisions that may not yield the hoped-for benefits. As a result, HIT may fall short in addressing the problems plaguing healthcare.

This is not totally unexpected, however. A host of problems arise from performing these analyses including the following:

- Need for complex (econometric) techniques rather than straightforward finance and accounting techniques to find meaningful results (Meyer and Degoulet 2008)
- Indirect measurement of benefits because of the interdependent nature of the production process and because benefits are found in areas not expected (Bower 2005; Encinosa and Bae 2011; Featherly et al. 2007)
- Physician and other clinicians' resistance to change once cost data are delivered (Asch, Hershey, and Ubel 2003)
- Indication from the market that some portions of HIT investments are not appropriate (If people do not realize the value, why should we force them to use it? [Loomis et al. 2002])

As organizations struggle to meet patient and community health needs and improve quality with tight budgets, performing a strict value assessment of all investments has become even more important. To give some idea of the magnitude of the issue at an individual hospital level, according to an American Hospital Association (AHA 2007) survey, in 2006, the median hospital spent $5,556 per bed for health information technology capital. This translates to more than $1 million in capital expenditures for a 200-bed hospital. Among the hospitals responding to the survey, 54 percent reported that capital costs were a significant barrier to information technology adoption, and 32 percent reported that operating costs were a significant barrier to adoption. Financial barriers exceeded interoperability, acceptability by clinical staff, availability of qualified staff, and inadequate technology in importance as perceived barriers to adoption. By 2011, capital costs per bed had increased to at least $6,300 per bed using survey data and author's calculations (*Trustee* 2011). However, the estimates from this *Trustee* article suggest that capital spending on HIT declined in recent years, so note that HIT spending is hard to forecast for some of the reasons discussed in Chapter 4. The diffusion of HIT workers across an organization makes budget estimates less precise. In 2012, 14 percent of HIT leaders participating in the annual HIMSS survey cited financial factors as a barrier to implementing HIT in their organization, a concern second only to adequate staffing—cited by 22 percent of respondents as the top barrier. Both vendor ability to deliver and difficulty in end user acceptance were named as significant barriers as well, selected by 12 percent and 9 percent of respondents, respectively (HIMSS 2012a, Figure 12).

Even as the government and competitive pressures induce healthcare delivery organizations to implement interoperable electronic health records (EHRs) that enable the exchange of information within and across institutions, these organizations must still focus on value creation. Early evidence indicates that the financial benefits of interoperable EHRs to the healthcare system may be substantial. Walker and colleagues (2005) estimate that health information exchange (HIE) and interoperability, when fully implemented, may generate upwards of $77 billion in savings to the US healthcare system. Providers will come to expect electronic HIE. They increasingly work in healthcare delivery teams consisting of physicians, nurses, pharmacists, therapists, and others who require a real time exchange of information. The Health Information Technology for Health and Clinical Health (HITECH) Act provides significant incentives to providers that fully implement an HIE. Value has not been identified yet, and some analysts (e.g., Vest and Gamm 2010) recommend that organizations examine the partially effective past efforts to facilitate HIE for evidence that the potential benefits may be less

Scanned with CamScanner

than estimated. Interestingly, according to the 2012 HIMSS survey data (Figure 18), while 49 percent of hospital leaders said they participated in an HIE, 26 percent had no plans to participate, 22 percent had an HIE in their area but did not participate, and 2 percent were unfamiliar with HIE.

Supported by the health reform legislation, consumers will demand new delivery modes for their care and expect coordination of care across provider segments. Consequently, the ability to assess value will be crucial for the HIT leader of the future, and information technology will play a vital role in that value delivery.

This chapter first outlines why the evaluation problem is more complex today because of the systems nature of healthcare delivery. Then, it presents what is known about how HIT investments are analyzed and provides the steps for conducting these analyses. Next, it details value realization as a method to implement evaluation. Last, it presents selected findings from cost evaluation studies.

Systems Challenges

Despite its costs, at one level, HIT is essential in the provision of high-quality care in today's environment. However, technology acquisition is not an all-or-nothing proposition. Questions of scale, scope, application, integration, and timing must be addressed, all of which make the decision complex. Do you purchase and install some applications and not others? Do you wait another year? How do you ensure that the appropriate mix of information technologies is selected? Furthermore, once that set of decisions is made, how do you implement so that costs stay at the expected level and the benefits promised are actually realized? In the face of these questions, some have come to challenge the wisdom of assumed value and even the benefits of HIT investments (e.g., Carr 2003; Koppel 2005; Koppel et al. 2005; Loomis et al. 2002).

If these considerations did not make this problem difficult enough, the interdependence of providers in a healthcare "system" complicates the decision further. As detailed in Chapter 2, problems of cost, quality, and access plague those responsible for healthcare delivery. In a general discussion regarding the transformation of the US healthcare system, Adams and colleagues (2007) identify the following five features that make today's challenges different from challenges in the past:

1. Globalization
2. Consumerism
3. Aging and overweight populations

4. Diseases that are more expensive to treat
5. New medical technologies and treatments

To respond successfully to these challenges, Adams and colleagues argue that value decisions must extend beyond an individual organization's considerations to the perspective of society as a whole. For example, medical tourism may become common as the financial incentives for care delivered outside of the United States could eventually drive select care overseas (see Exhibit 13.1).

Adams and colleagues' recommendations for successful transformation of the healthcare system include many features, but most important, they argue that there will be different perspectives on value. The US healthcare system will transform from one that emphasizes individual value and cost containment to one with an emphasis on balancing "stakeholder value across dimensions (cost, quality, access, and choice)" (Adams et al. 2007, 42). The latter emphasis will usher in a transformation from the current state of data management to electronic, evidence-based, standard, shared, and interoperable information (Adams et al. 2007). Similarly, Enthoven and Tollen (2005) make the point that to address cost and quality concerns, rather than introduce competition to the healthcare market, healthcare organizations need to consider moving away from market changes that foster independent competing business units. In their opinion, to capture potential cost savings and quality improvements, the US government should encourage organizations within local and regional markets to form "integrated delivery systems, with incentives for teams of professionals to provide coordinated, efficient, evidence-based care, supported by state-of-the-art information technology" (Enthoven and Tollen 2005, 420).

Procedure	US	Mexico	Costa Rica	Thailand
Appendectomy	$17,600	$ 15,136	$ 15,312	N/A
Angioplasty	$23,900	$13,384	N/A	$12,848
Heart bypass	$52,500	N/A	$27,300	$10,384
Hip replacement	$25,000	$ 11,250	$12,750	$ 8,448
Knee replacement	$24,500	$ 11,515	$13,198	$ 9,152
Dentures	$ 2,700	$ 1,782	$ 2,214	N/A
Meniscectomy	$25,200	$20,664	$21,672	$14,080
Radical prostatectomy	$25,300	$ 15,180	$ 16,192	$ 7,392

EXHIBIT 13.1 Approximate Costs of Key Procedures in Four Countries from a Single Source

SOURCE: Information from www.allmedicaltourism.com.

Evaluation Problem

At the most fundamental level, business decisions faced by the chief informa- tion officer (CIO), and indirectly by the CEO and board of trustees, come down to a challenge of deciding among competing alternatives. The ques- tions they must ask are as follows: Does the investment in HIT increase, have no effect on, or decrease organizational outcomes? Does it increase, have no effect on, or decrease the costs to the organization?

Exhibit 13.2 presents a simple paradigm that can effectively support HIT decisions. The matrix consists of nine cells or potential outcome/cost combinations, and, in some cells, the decision to adopt the technology or not to adopt it is straightforward. For example, if adopting the technology results in a reduction in outcomes and an increase in costs (cell 3), most CIOs will not adopt (never). Similarly, if outcomes improve with the new technology and costs are reduced (scenario 7), the decision to adopt is straightforward (always). Combinations of costs and outcomes that place the organization in scenarios 2, 3, or 6 are *never* adopted. Similarly, combinations of costs and outcomes that place the organization in scenarios 4, 7, or 8 are *always* adopted.

The interesting cases involve combinations of costs and outcomes that place the organization on the diagonal in scenarios 1, 5, or 9. For these cases, a methodology must be put in place to more rigorously measure the magni- tude of the changes in outcomes and the magnitude of the changes in costs. Formal benefit–cost or cost-effectiveness analyses need to be applied to assess the relative changes for these three cases: both outcomes and costs increase, neither benefits nor costs change, and both benefits and costs decrease.

Benefit–Cost and Cost-Effectiveness Analyses

A number of studies have documented the use of conventional benefit–cost, cost-effectiveness, or cost–utility analysis in healthcare (e.g., Gold et al. 1996). The discussions that follow are not significantly concerned with dif- ferentiating these techniques, as a full history of the concepts is beyond the scope of this book. In simple terms, ***benefit–cost analyses*** are applied when all aspects of the costs related to a technology and benefits of that technology

EXHIBIT 13.2
Technology Cost and Outcome Effect Decision Matrix

	Outcome Effect		
Cost Effect	**Improve**	**No Change**	**Worsen**
Increase	1 ?????	2 Never	3 Never
No change	4 Always	5 ?????	6 Never
Decrease	7 Always	8 Always	9 ?????

are measured in monetary terms. The outcome from these analyses might be presented as \$3 in benefits for every \$1 in cost (\$3/\$1). The decision calculus then enables leadership to select among alternatives that have the highest ratio.

For many healthcare applications, some of the outcomes or benefits may be difficult or objectionable to put into financial terms. Loss of life, for example, can be quantified in financial terms (Viscusi 2004), but not every- one is comfortable with making those assessments. ***Cost-effectiveness analyses*** were developed for technologies and resulted in outcomes that could not be quantified (Weinstein and Stason 1977). For example, one might estimate the costs associated with extending life for an additional year. The outcome from these analyses might be presented as \$10,000 cost per life year saved (\$10,000/life year). In this case, considering alternative technologies, lead- ership would adopt the technology with the *lowest* cost per life year saved.

Cost–utility analysis extends this measurement challenge even further by recognizing that the quality of life year extended might not always be the same. That realization led to a host of attempts to adjust the life years saved by some notion of the utility, value, or quality of that life (see, for example, the findings on the Centers for Disease Control and Prevention's Health- Related Quality of Life website at www.cdc.gov/hrqol/index.htm). For example, if the outcome is an additional year of life, but the patient spends that year in pain or confined to a nursing home bed, the value of that life year might not be as great as nine months of pain-free or fully functional extended life.

The key to using any of these formal methods of cost evaluation is to follow a series of eight steps (see Glandon and Shapiro 1988; Gold et al. 1996; Warner and Luce 1982).

Steps in Using Cost-Evaluation Methods

Step 1: Identify Study Objectives

While this step may be obvious to many, clearly identifying study objectives may be the most important step in the analysis. Without knowing precisely what the organization desires or what the proposed HIT application or tech- nology is designed to do, the outcomes of the evaluation are meaningless. Essentially, the decision comes down to whether the organization is looking narrowly at the financial benefits and costs associated with the decision or considering broader organizational or social benefits and costs. From the perspective of information technology, social costs include those incurred by physicians or others who are not employees of the organization but whose opinions matter to decision makers. An otherwise strong HIT system may fail if the burden on the users is not fully measured.

Step 2: Specify the Alternatives

The relevant alternatives to the proposed technology must be clearly articulated, otherwise, a valid decision cannot be attained. Make the decision relative to the best alternative to ensure that the optimal choice is made. Not using credible alternatives in judging the proposed technology invites the risk of participants losing faith in the outcomes. A common error is to compare a proposed HIT solution with the status quo; the status quo is often not relevant when adopting an EHR, for example. Comparisons should be required among alternative vendors rather than with the current state of health record management.

Step 3: Develop a Framework for Analysis

The analysis framework is often called the *theoretical framework* or theoretical model, and one might have a tendency to ignore this step. Developing the framework is important, however, because it puts the technology into the broader systems context and defines how the inputs to the technology are related and how the outcomes are used by the system. It also forces an understanding of how the technology affects the total healthcare delivery system so that the direct and indirect (unintended consequences) costs and benefits to the system can be clearly identified and measured (Han et al. 2005). Returning to the EHR example, the theoretical framework forces a full understanding of how the information flows from the bedside or the physician's office to the electronic record; how that information is stored, catalogued, and retrieved from the record; and what the information's end uses are designed to be. Without that full understanding, crucial components of costs and benefits might be ignored or shortchanged.

Step 4: Measure Costs

Cost assessment is essential to the benefit–cost analysis. The identification and measurement of costs is relatively straightforward for big-ticket items such as direct labor, equipment, and supplies, but fully identifying indirect or opportunity costs associated with the intervention takes more time. The concept of *total cost of ownership* is an operational device designed to aid in defining and collecting relevant startup (one time) and recurring costs (Hickman and Kusche 2006; Smaltz and Berner 2007). The EHR might shift some of the burden of data collection, analysis, and reporting. Unless that added burden results in easily measurable increases in time or supply use, it can often be overlooked. Management, in particular, can easily be affected by added data availability. The electronic record facilitates more analysis in an attempt to make better evidence based decisions. While this may result in added benefits associated with better decision making, it may also result in added time spent understanding the data that are generated. Managers may find they spend more time preparing and poring over reports at the expense of other tasks.

Step 5: Measure Benefits

As with cost identification, good evaluation requires clear identification of all benefits associated with the technology. Ignoring key benefits can clearly lead to underestimating the net effect of technology. Johnston, Pan, and Middleton (2002) argue that many researchers take a narrow view of benefits, or, in their term, *HIT value*. They argue that one should consider organizational, financial, and clinical benefits. Identifying these benefits is facilitated if the framework for analysis is done correctly. A related issue with regard to benefits is that they must be realized and not necessarily speculative, assumed, or hypothetical.

Step 6: Factor-In Lifecycle and Discounting

Most HIT projects have a pattern of costs and benefits that varies over the product's lifecycle. Typically, costs are incurred early in a project cycle as resources are expended to purchase equipment, hire staff, and train staff. Conversely, the benefits or value to the organization accrue over time. Understanding that cycle with respect to the organization's technology is important for making valid comparisons. Although the CIO or HIT decision maker may not be as concerned with the timing issue as others in the healthcare organization, the timing of incurred benefits and costs cannot be ignored. In fact, considering alternatives with the same net costs and benefits, one should select that project with the distribution of costs skewed toward the future rather than that project with the distribution of benefits skewed toward the present.

Step 7: Deal with Uncertainty

By the nature of HIT investments, uncertainty exists regarding the estimates of both their costs and their value or benefits. Despite leadership's best efforts, they may find that these estimates are inaccurate. For example, with the EHR, physicians may not readily adopt the new technologies and systems as planned. In these cases, the costs of developing and implementing the system are the same, but the measured benefits are much lower. One never assumes exceedingly high levels of avoidance by the medical staff. If physicians do not adopt, the evaluation of the EHR most likely appears unsatisfactory. To deal with uncertainty, most look at the estimates being used and develop a best-case scenario and a worst-case scenario. For example, in the EHR example, assume benefits with 80 percent of the medical staff fully participating. To test the best case, estimate benefits with 90 percent medical staff participation (base estimate + 10 percent). To test the worst case, estimate benefits with 70 percent medical staff participation (base estimate −10 percent). This process is often called *sensitivity analysis*. If performing a sensitivity analysis yields estimates that do not change the overall evaluation of the technology, then confidence has been added to the decision. If at extreme values the overall evaluation of the technology changes, return to the framework and assumptions to be certain they are accurate.

Step 8: Consider Equity

This step has its origins in the federal government's use of benefit–cost analysis for evaluating alternative government interventions. However, it has application to individual healthcare organizations as well. Equity considerations require examination of not just what the costs and benefits are for the organization but also who receives those benefits and costs. Again from the perspective of the EHR, if the benefits accrue to the institution, its employees, and its patients, but the costs are largely borne by those involved in using the technology (physicians), the EHR strategy is likely to fail (Landro 2003). For social investment decisions, consider compensating those who bear the costs from the gains made in the use of the technology. Healthcare organizations have no way to compensate cost bearers, and legal restrictions may limit their compensation.

Challenges to Evaluation

Despite the prevalence of HIT mechanisms in place in healthcare organizations, much evidence exists that HIT value is not easy to attain or ensure. Early assessments of the "state of the art" (Glandon and Shapiro 1988) suggested that more work was needed in this area. High-profile failures occurred, such as at Cedars Sinai Medical Center in Los Angeles, which ended its effort to convert to a computerized physician order entry (CPOE) system in January 2003 (Chin 2003). The cause of this extreme failure is uncertain. Failure most probably occurs at the implementation stage, although failure of that magnitude may have had many causes.

In the late 1980s, some key findings on reasons for poor evaluations of technology suggested why HIT value did not always ensue from these significant investments. First, much of the technology was selected for the wrong reasons, such as keeping up with the competition. While there might be good reasons to adopt the technology that the competition is using, that alone is not sufficient reason to implement a HIT system or application. Second, knowledge, time, and money prohibited adequate evaluation. The CIO and his or her managers just might have been too busy to spend the time conducting evaluations to determine value from the investment. Third, in many cases, the technology in place was determined to be a poor decision, which might help in future decisions but has no impact on the original decision going forward. This "water under the bridge" argument might keep leaders who are living in the past from investigating prior failures seriously (Glandon and Shapiro 1988).

Related to these items are the following two fundamental impediments to maximizing HIT value:

1. *Documentation*. The comprehensive, reliable data on the clinical or business outcomes related to the technology and the true, full costs

associated with selecting, purchasing, implementing, hiring staff, training staff, training users, and so forth are difficult to obtain, synthesize, and report. It takes time and money to determine if the value from HIT investments actually exists. More on this issue, called the *total cost of ownership*, is presented in the next section.
2. *Interdependence*. Even if data have been defined and collected, the pervasive nature of the influence of many HIT investments across functional areas in the organization makes determination of value difficult at best. Many systems have both direct and indirect cost and outcome effects across a wide portion of the organization; thus, assigning value to a particular investment is a major undertaking.

Glandon and Buck (1994) identified these fundamental challenges to effectively maximize value from HIT investments. They developed a model of information systems that separates application and function (see Exhibit 13.3) and suggests where more rigorous evaluation might exist.

Assessing and ensuring value at the operational systems level has the greatest chance of success. Investments to improve admissions, discharge, and transfer (ADT) or general ledger applications have a greater chance of clearly linking the technology change to a measurable outcome. The well defined and limited scope of such application reduces the severity of the measurement challenges. Outcomes at the operational level are generally characterized as intermediate compared with outcomes of the healthcare organization as a whole. For example, ADT outcomes might include time to admit a patient to a bed from the emergency department as an intermediate outcome. This

EXHIBIT 13.3 Information Systems by Function and Information Requirement

Information Requirement	Function	
	Clinical	Business
External systems	Physician recruitment and retention Contracting	Legal actions Cost containment
Administrative systems	Case mix Incomplete chart reporting Care planning Patient scheduling	Absence and turnover control Revenue statistics Wage and salary planning Capital spending
Operational systems	Admission, discharge, and transfer Census reporting	Inventory control General ledger Accounts payable

SOURCE: Glandon and Buck (1994). Adapted with permission from Sage Publications, Thousand Oaks, California.

outcome may depend on the ADT system, but ultimate outcome of patient mortality, morbidity, or satisfaction is less likely to be influenced by the ADT system.

Investments applied to administrative systems are less clear in terms of value assessment. These systems influence the efficiency and effectiveness of institutional operations and often contain some of the quantifiable elements inherent in operational systems. However, they often apply to cross-functional areas within the organization, making their impact more difficult to quantify. In administrative systems, then, it is less clear than in operational systems that outcomes, benefits, and costs are attributable to the new technology. Outcomes for administrative systems are generally intermediate, as are the outcomes for operational applications, but should apply more broadly than operational systems. For example, systems designed to improve incomplete chart reporting can have somewhat measurable outcomes, such as delinquent report rates. This outcome has broader impact because medical staff, nursing, ancillary systems, and quality assurance and accreditation preparation all bear costs or benefit from changes in this outcome.

Finally, investments applied to strategic planning have the greatest difficulty with respect to value determination. All of the inputs used in these systems are cross functional, which implies that data must be gathered from diverse units across the institution and often from outside of the institution. Outcomes are generally final from the perspective of the healthcare organization as a whole; thus, they are very difficult to measure, and attribution is always a challenge. For example, systems to support physician recruitment might be expected to lead to greater market share and improved physician retention. However, many external factors influence these outcomes, leading to greater uncertainty with respect to the value of this type of HIT investment. For example, you might have improved physician recruitment by operating a well functioning system. However, your market share and physician retention may suffer because a specialty hospital moved into your market and siphoned off key physicians and associated patients. The outcomes are poor from the organization's perspective.

Probably the best example of this type of challenge is with the introduction of the EHR strategy. Smaltz and Berner (2007) outline the interrelated nature of benefits and challenges the EHR system faces. Because EHR is not a thing but a comprehensive strategy, it is difficult to value. It is an "organizational, cultural transformation project that just happens to have a technology component" (Smaltz and Berner 2007, 16). Examination of just the benefits section of an EHR strategy described by these authors reveals how investment in this process spans the organization and creates difficulties in financial documentation. The descriptions in Exhibit 13.4 by major benefit

EXHIBIT 13.4 Descriptions of EHR Benefits by Category: Demonstration of System Nature of EHR

Category	Subcategory	Description Example of Impact
Improve efficiency		Improve efficiency of the clinical patient care–related processes
	Access to information	Getting information when and where it is needed
	Organization of the data	Patient data entered one time
	Claims processing	By allowing the clinical data to drive billing processes
Improve monitoring		Enables individual provider profiles of performance as well as aggregate profiles
Improve clinical processes		Real-time clinical decision support
	Quality improvement	Clinical and financial outcomes can be more easily monitored and linked
	Disease management	Aggregate data across patients

SOURCE: Smaltz and Berner (2007). Reprinted with permission from Health Administration Press, Chicago.

category and subcategory demonstrate that benefits are not confined to a single operational unit.

Value Realization

The IT Governance Institute (2006, 5) developed a multipart initiative to support HIT value realization in response to a perceived need for "organizations to optimize the realisation of value" from investments (see Chapter 5 for more background on HIT governance). The comprehensive framework assists users in measuring, monitoring, and maximizing realized value from HIT investments. Rather than a simple "cookbook" approach, this framework employs a holistic approach to value realization. While not fundamentally different from the benefit–cost analysis and cost-effectiveness analysis methodologies described earlier, this framework is more attuned to practicing HIT leadership's decision making.

The IT Governance Institute approach starts by asking the following four questions, posed originally by Thorp (2003):

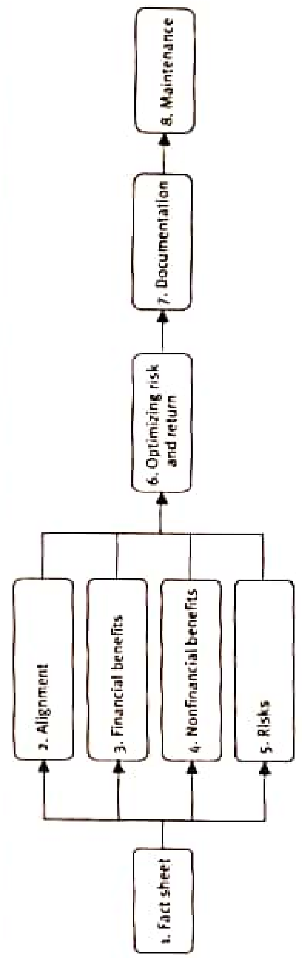
1. *Strategic question: Are we doing the right thing?* Is the investment aligned with a broader business vision, is it consistent with established principles, and does it contribute to the strategic objectives?
2. *Architecture question: Are we doing it the right way?* Is the investment aligned with existing information technology architecture and consistent with ongoing architecture principles?
3. *Value question: Are we getting the benefits?* Do you have a clear understanding of the expected benefits, and do you have a process for realizing the benefits?
4. *Delivery question: Are we getting it done the right way?* Do you have effective and disciplined management, delivery, and change management processes with technical and business resources to deliver the promise of the technology investment?

In the context of these four questions, the Governance Institute uses a three-part strategy to maximize return on HIT investment (the first two elements are developed in chapters 5 and 11, and the third is discussed below):

1. *Value governance.* Optimizes the value of an organization's information technology-enabled investments by establishing the governance, monitoring, and control framework; providing strategic direction for the investments; and defining the investment portfolio characteristics (see Chapter 5)
2. *Portfolio management.* Ensures that an organization's overall portfolio of information technology–enabled investments is aligned with and contributing optimal value to its strategic objectives by establishing and managing resource profiles, defining investment thresholds, evaluating and prioritizing new investments, managing the overall portfolio, and monitoring and reporting on portfolio performance (see Chapter 11)
3. *Investment management.* Ensures that HIT investments deliver outcomes at reasonable costs while also managing associated risk

To accomplish the investment management aspect of obtaining a return on HIT investment, the IT Governance Institute proposes that the organization engage in an eight step process. In this framework, implementing the investment management process requires detailed information gathering; assessment of benefits, costs, and risks; selecting the investment vehicle; and monitoring outcomes. This process is geared to the corporate environment, as opposed to the government or social perspective. These eight steps by the IT Governance Institute (2006) are outlined in Exhibit 13.5 and detailed in the following sections.

EXHIBIT 13.5
Steps in Information Technology Business Case Development



SOURCE: *Enterprise Value: Governance of IT Investments, the Business Case*, IT Governance Institute, © 2006. All rights reserved. Used by permission.

Step 1: Building the Fact Sheet

The first step in the process is to gather all of the information relevant for making the appropriate HIT business decision. The IT Governance Institute provides a model form for collecting the necessary data, but our experience suggests that each organization should implement a collection form that works in its environment. The key point is that no category of information can be ignored. At a minimum, the following categories need to be assembled (IT Governance Institute's equivalent terms are given in parentheses):

- *Congruence (Alignment)*. The investment must be consistent with documented business strategy (see Chapter 5), current HIT management practices, and government regulatory constraints (current and anticipated).
- *Business outcomes*. The investment must deliver an organizational need to achieve intermediate and final outcomes. These outcomes need to be documented and measurable.
- *Financial benefits*. Input for financial benefits should document cost savings, revenue enhancements, capacity/volume growth, and risk mitigation from the investment decision. These include the tangible revenue enhancements or cost reductions in capital, operations, or risk.
- *Indirect benefits (Nonfinancial benefits)*. As in the benefit–cost assessment, some benefits are not easily quantified in financial terms but must be seriously considered nonetheless.
- *Costs (Resources and expenditures)*. All categories of equipment, human resources, supplies, consultants, and other resources necessary for the HIT investment must be documented.
- *Sensitivity (Risk)*. Alternatives that quantify the risk in the investment must be identified. Understanding the best case and worst-case scenarios for the investment helps the organization select an investment that meets its tolerance for risk.

4. *Model (Assumptions and constraints)*. Understanding how the HIT investment accomplishes the desired outcomes, with associated benefits and costs, helps to determine the reasonableness of the subsequent analyses. The logic of the empirical claims for outcomes, benefits, and costs depends crucially on the assumptions employed. These must be articulated clearly.

Step 2: Alignment Analysis

Investment alternatives abound, necessitating decision making. The selected option needs to optimize net benefits from the scarce resources available. Alignment helps to ensure that the HIT-related investments support the organization's strategic business objectives. This might include direct contribution to the objectives of the current organization or to the broader system or contribution to a future vision for the organization. The investment must also be consistent with existing enterprise architecture. Assuming that this architecture has been selected as a guideline to achieve the current vision, each investment must be chosen carefully so as not to move away from that guideline.

Step 3: Financial Benefits Analysis

To gain acceptance in the healthcare corporate environment, HIT investments must pass conventional financial analysis constraints. Discounting of financial benefits and costs is an essential technique. The final decision requires the project to have a positive discounted net value (positive net present value or NPV) and perhaps have better NPV than alternative investments so that the organization selects the best investment.

Step 4: Nonfinancial Benefits Analysis

The nonfinancial aspects of business processes must also be considered, especially in not-for-profit healthcare organizations. Building positive relations with constituencies external to the HIT function may create value for the organization. Alternatively, negative relations can destroy value. Consideration of the external or indirect effects of the investment may not fully offset poor financial considerations but may influence a decision that is otherwise close.

Step 5: Risk Analysis

Not every organization tolerates risk in the same way, and not all investment opportunities carry the same risks. Assessing and documenting these risks in outcomes, financial benefits, and resource use or costs are integral steps in the value-assessment process. Both delivery risk and benefits risk are inherent in any HIT investment. One must ask if the investment delivers on the anticipated business processes, human resources, technology, and organizational changes being proposed. Likewise, the outcomes and financial benefits promised may not, in fact, occur. In simple terms, the HIT investment may not perform as promised. The IT Governance Institute (2006) provides many examples of both delivery and benefits risks.

Step 6: Optimizing Risk and Return

As stated in Chapter 11, the program planning office (portfolio management office) must assess and review the HIT investment proposal in the context of other applications and broad business needs. The key is that all proposals have the same sets of information collected and reported and that assessment is done in a comparable manner. The best decision emerges if valid comparisons are made by those with the incentive to maximize value to the organization.

Step 7: Documenting Business Case

Nothing can be more important than transparency in decision making. Documentation of data and information, assessment techniques, and findings all add to the open framework for decisions. This "open architecture" helps to create a culture of critical assessment that is so important to good decision making. The tendency to not reveal information as a mechanism to protect those making the decision may lead to poorer outcomes and to greater consequences should those outcomes fail to meet standards.

Step 8: Feedback Mechanism

The single view of HIT investment value as presented by the value realization effort is a necessary first step for healthcare organizations, but HIT investment needs, organizational priorities, staffing constraints, and other environmental changes occur continuously. The information collected, assumptions made, benefits observed, and costs incurred should be reviewed periodically throughout the lifecycle of the investment. While many decisions cannot be undone, mid-course adjustments in investment scale and scope are often possible. If the organization veers off course as a result of an investment, having a feedback mechanism enables the organization to adjust to minimize loss. CPOE provides a good example of the potential value of feedback. Faced with resistance to the widespread adoption of this technology, an organization could apply a temporary solution of implementing it in only some parts of the organization; that is, identify clinical areas or key supportive medical staff leaders and implement only in select areas. This prevents some of the resistance and presents the areas more likely to be successful. Full implementation might occur later, but the costly failure of the entire project could be avoided.

To close this discussion, a number of investigators and thought leaders have found that the methods for realizing HIT value are often difficult to implement. As Johnston, Pan, and Middleton (2002) suggest, HIT investment decisions continue to rely on "anecdote, inference, and opinion" rather than evidence. They argue that HIT leadership must support a comprehensive assessment of value using existing data. Toward that end, Bates and colleagues (2003) propose the "ten commandments" to follow for effective clinical decision support. While specifically interested in making evidence-based medicine a reality, these commandments also enhance HIT value realization. Four of the ten commandments are particularly important for HIT value and are as follows (Bates et al. 2003):

1. *Be aware that speed is everything.* Providers will not accept a system that does not respond quickly to their inquiries. System design for rapid access appears to be essential for information technology effectiveness.
2. *Fit into the user's workflow.* The HIT investment must support the providers' and other users' current practice processes to be readily accepted. They will not use a system that does not fit seamlessly.
3. *Keep in mind that simple interventions work best.* The HIT investment with grand plans to alter the practice of medicine may not be as effective as a simple solution.
4. *Monitor impact, get feedback, and respond.* The feedback mechanism appears to be essential for success. Even the best systems may not integrate in the manner anticipated; thus, being flexible and adaptable may be keys to success.

HIT Value Findings

Impact of Specific HIT Investments on Patients

Many studies have been conducted on specific HIT investment value recognition, and in this section we feature three studies that illustrate this process. A common characteristic of these studies is that they tend to report only narrow analyses of the effects of HIT investments. The desire for academic rigor results in such narrow scope. HIT managers need broader evaluations to make decisions for the organization; therefore, two additional studies report organizational value of HIT investments.

The first study, by Hillestad and colleagues (2005), presented a national simulation of the potential cost savings from HIT investments—specifically, adoption of an electronic medical record (EMR). Exhibit 13.6, from the Hillestad and colleagues study, suggested that in the near term, savings may total as much as \$21.3 billion per year (year 5), more of which was derived from inpatient care than from outpatient care. Once adoption reached the anticipated 90 percent, savings could amount to more than \$77 billion per year (again, more of this savings was derived from inpatient care). The savings in inpatient care came from reductions in length of stay followed by reductions in nursing time. On the outpatient side, most of the savings came from reduced/appropriate drug use.

In addition to these cost savings, benefits or value from HIT investments were derived from improved patient safety and health outcomes. Hillestad and colleagues (2005) estimated that the safety benefits of CPOE were seen at the national level for both inpatient and outpatient care. Inpatient care savings resulting from an estimated 200,000 adverse drug events (ADEs) eliminated amounted to \$1 billion per year once fully implemented.

EXHIBIT 13.6 Short Term and Long-Term Annual Cost Savings from HIT, by Selected Major Categories

	Short Term Year 5 (in billions)	Percent of Total	Long Term Year 15 (in billions)	Percent of Total
Outpatient				
Transcription	$ 0.4	1.9	$ 1.7	2.2
Chart pulls	$ 0.4	1.9	$ 1.5	1.9
Laboratory tests	$ 0.5	2.3	$ 2.0	2.6
Drug usage	$ 3.0	14.1	$ 11.0	14.2
Radiology	$ 0.8	3.8	$ 3.3	4.3
Total output savings	$ 5.2	24.4	$20.4	26.3
Inpatient				
Nursing time	$ 3.4	16.0	$13.7	17.7
Laboratory tests	$ 0.8	3.8	$ 2.6	3.4
Drug usage	$ 1.0	4.7	$ 3.5	4.5
Length of stay	$10.1	47.4	$34.7	44.8
Medical records	$ 0.7	3.3	$ 2.4	3.1
Total input savings	$16.1	75.6	$57.1	73.7
Total HIT savings	$21.3	100.0	$77.4	100.0

NOTE: Numbers and percentages do not sum to totals because of rounding.
SOURCE: Hillestad et al. (2005). Used with permission from Project HOPE, Millwood, Virginia.

Outpatient care savings resulting from an estimated two million ADEs avoided amounted to $3.5 billion per year. In both settings, the bulk of the study participants were older than age 65, thus the findings might not be generalizable to other participants. Featherly and colleagues (2007) also found that EMR benefits were largely indirect and came from workflow improvements and reductions in medical mishaps.

Near term preventive care can benefit from HIT intervention as well. This study generated estimates for two vaccination programs (influenza and pneumococcal vaccinations) and three screening programs (breast cancer, cervical cancer, and colorectal cancer screenings). The findings were highly positive from a health outcome perspective and depended heavily on assumptions regarding current compliance rates in the defined population, compliance rates for the specific vaccination and screening programs, and costs. Taking the midpoints of the estimated effects, pneumococcal vaccination resulted in a median reduction of 21,000 deaths per year (15,000 to 27,000), 2.25 million median bed days eliminated (1.5 million to 3.0 million), and

150,000 median workdays restored (100,000 to 200,000). These effects came at a program cost of about $90 million per year. At the same time, however, the program generated median financial benefits estimated at $750 million per year ($500 million to $1 billion).

The second study, by Pizziferri and colleagues (2005), examined the issue of an EHR and physician clinic time with patients. The study broke time down into a number of key components so that the total time and contributing factors to any time change could be examined. Overall, Pizziferri and colleagues found no difference in time spent in direct care, indirect care (reading, writing, or other activities), administrative activities, or miscellaneous activities. From a value perspective, this is only one small consideration but an important element with regard to physician acceptance of the EMR. Pizziferri and colleagues recommended that future investigations examine the impact of the EMR on nonclinic time spent.

The third study, by Poissant and colleagues (2005), involved a comprehensive review of research examining physician and nurse documentation time as a result of implementation of an EHR. Generally, Poissant and colleagues reported that neither bedside nor central nursing station use of EHR reduced nursing documentation time by more than 20 percent. Physician documentation time increased by 17 percent for bedside technology and by more than 200 percent for central nursing station terminals. This analysis of time impact raised some significant questions regarding system impact. This study did not examine the cost of the EHR or the direct cost impact.

Consistent with the assertion that HIT leadership must reach out to the entire organization in its efforts to invest in HIT, studies are now being published that assess the value of HIT investments in terms of their impact on the organization as a whole.

Impact of HIT Investments on Organizations

Iansiti and colleagues (2005) demonstrate that HIT matters at least in midsize firms. Their research does not measure the impact of any specific technology intervention or even overall dollars spent. It uses an index of what "IT actually does for a business" to measure impact. Iansiti and colleagues created an IT scorecard to assess HIT capability in the functional areas of sales/marketing, finance, operations, empowered professionals, and information technology infrastructure. They found that greater capability generates business process scalability, which enables firms to do the following:

- Improve process knowledge and standardization
- Streamline operations, allowing the firm to grow without expanding the labor force

- Become flexible enough to take advantage of or respond to new opportunities
- Enhance management's access to critical business indicators used in decision making

Similarly, Menachemi and colleagues (2006) demonstrate a robust relationship between HIT adoption and hospital financial performance, at least for hospitals in Florida. Their findings suggest that overall and operational improvement followed from information technology adoption. This outcome was observed for their categories of clinical, administrative, and strategic information technology.

Summary

HIT should adhere to core business processes. In that context, the decisions regarding how much and what types of HIT resources an organization uses should fall under a valuation paradigm. Finding value in any healthcare investment has proven to be a challenge, however, because data collection, methodology, and application make the use of evidence-based management difficult. Because of the complexity of the problem and the lack of comprehensive data, healthcare executives have largely been forced to make decisions about HIT investments on the basis of cursory evidence at best and occasionally on the basis of instinct or hope at worst. As a result, HIT may fall short in helping to address the problems plaguing healthcare.

The median hospital spent at least $6,300 per bed on HIT in 2011. From a HIT leadership perspective, however, HIT is essential for the provision of high quality care in today's environment, so they must face the decision to invest in HIT. Many factors make such decisions difficult, including the scaling of information technology and the systems nature of information technology. For example, technology acquisition is not an all-or-nothing proposition; questions of scale, scope, application, integration, and timing are involved. The interdependence of providers in a healthcare "system" complicates the decision further. Healthcare delivery organizations implement interoperable EHRs to enable the exchange of information across venues while still focusing on value creation.

Early evidence from HIT investment studies indicates that EHRs, HIEs, clinical decision support systems, and a host of other technologies have the potential to improve care and contain or lower costs. However, value has not been identified and the potential benefits may be less than estimated. Furthermore, not all HIT leaders are yet fully behind HIT implementation. Providers will come to expect electronic information exchange as they increasingly work in teams that require a real-time exchange of information. The incentives offered by the HITECH Act are intended to encourage widespread adoption of HIE and other HIT technologies, but impediments still exist. The 2012 HIMSS survey data suggested that many HIT leaders face barriers and remain reluctant to facilitating or implementing an HIE.

Business decisions faced by the CIO—and indirectly by the CEO and board—come down to a challenge of deciding among competing alternatives, leading to the evaluation challenge. The questions that must be asked are whether the HIT investment increases or decreases organizational outcomes, and whether it increases or decreases costs to the organization. Economists have frameworks for assisting in making these decisions, called benefit-cost analyses, cost-effectiveness analyses, and cost-utility analyses. Further, business models suggest a similar evaluation process for value realization that consists of conceptualizing, capturing, analyzing, and reporting detailed financial and nonfinancial information. In addition, the IT Governance Institute (2006) has developed a detailed value-realization process that can direct HIT leadership to achieve their goals.

A number of challenges hinder the efforts to maximize the value of HIT investments, including lack of proper, detailed documentation of key information and conceptual problems of assigning benefits and costs to a particular investment. These investments garner benefits from and impose costs throughout the organization, thus posing problems of assignment to uniquely evaluate the net effect of any single investment. These effects are now extending even outside of the confines of the traditional organizational entity. Obtaining that data and generating reliable estimates of net value are problematic at best.

Web Resources

A number of organizations (through their websites) provide more information on the topics discussed in this chapter:

- Blue Cross and Blue Shield's Technology Evaluation Center (www.bcbs.com/betterknowledge/tec/) and University HealthSystem Consortium (www.uhc.edu). These websites provide information on cost analyses for healthcare technologies.
- Center for Information Technology Leadership (www.citl.org). This website provides specific HIT intervention evaluations.
- Centers for Disease Control and Prevention's Health Related Quality of Life (www.cdc.gov/hrqol/index.htm). This website provides quality of life measurements.

Discussion Questions

1. Explain why obtaining value from HIT investments is so important in today's healthcare environment.
2. How valid and reliable do you think HIT investment decisions are currently? Why?
3. What is the system nature of healthcare, and why does it affect value estimation?
4. What do you think will drive adoption of interoperable EHRs—cost savings or consumer preferences? Why?
5. What is the evaluation problem faced by HIT investment decision makers? Why does the matrix in Exhibit 13.2 help in understanding that problem?
6. Why do we not observe examples of all of the cells in Exhibit 13.2?
7. Compare and contrast benefit-cost, cost-effectiveness, and cost-utility analyses. Which do you prefer, and why?
8. List and assess the eight steps in conducting benefit-cost analysis, cost-effectiveness analysis, or cost-utility analysis.
9. What is value realization? In what ways is it similar to and different from economic evaluation techniques?
10. Explain the four questions proposed by the IT Governance Institute, and explain why they are important.
11. Describe how the nature of the HIT investment application affects the quality and nature of the value determination.

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