CHAPTER

7

FINANCIAL MODELING

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This chapter provides an overview of the financial concepts and tools that are useful in the financial evaluation of picture archiving and communication systems (PACS). The first section discusses various analysis methods and makes a case for using net present value (NPV) methodology. The second section looks at the major cost elements that should be considered and quantified. The third section explores the cost-saving opportunities and nonfinancial benefits of implementing PACS. These three sections should help you on your path to justifying PACS financially.

ANALYSIS METHODS

There are numerous ways to evaluate a capital investment such as PACS. It is worthwhile to understand all of them and to determine which methods are most widely used and respected at your organization, especially by those with decision rights. It is often helpful to use several methods, as each provides a different lens through which you can analyze your investment opportunity. Different methods appeal to different constituencies. The nonfinancial benefits need to be considered as clearly as do the financial benefits if you are to fully evaluate any investment opportunity, especially in a healthcare environment. To add credibility and ensure quality, this financial analysis is best done by an impartial person who has business analysis skills and credentials.

It is important to define the objectives of the financial analyses at the outset. Objectives can be any or all of the following:

- Determining whether investing in PACS makes sense financially
- Obtaining organizational approval
- Negotiating discounts with PACS vendors
- Analyzing different scenarios and performing sensitivity analyses
- Developing budget estimates
- Tracking results

It is possible to incorporate all of the above features in one model. The best financial models are those that clearly lay out assumptions and sensitivities to those assumptions and assign cost-savings responsibilities to parties who control the costs, for example, use of film and the film library. Cost savings produced by eliminating conventional film systems are discussed in detail later in this chapter.

CASH

Most investment analysis methods are based on cash flow. A major difference between accounting income and cash flow is the treatment of capital assets. For accounting income, the cost of a capital asset is allocated via depreciation expense to the periods that benefit from the asset. For cash flow, each year reflects cash spent on the capital asset. To evaluate a capital project, you will want to weigh the capital cash outlays associated with the project against the benefits in terms of cash returned to the enterprise.

Example: A company purchases a $10 million asset that produces $2 million of annual income (cash) and has an expected life of 10 years. Accounting income spreads the cost of an asset over the asset's useful life and matches the cost of the asset to the income it produces. This is the theory behind depreciation. If the asset continues to produce $2 million in revenue in the 11th year (as shown in Tables 7.1 and 7.2), there is no depreciation expense because the asset has been fully depreciated over the prior 10 years.

TABLE 7.1
Cash-Flow Method (in million $)

Year	Cash Outlay	Cash Inflow	Annual Net Cash Flow	Cumulative Cash Flow
0	10		(10)	(10)
1		2	2	(8)
2		2	2	(6)
3		2	2	(4)
4		2	2	(2)
5		2	2	0
6		2	2	2
7		2	2	4
8		2	2	6
9		2	2	8
10		2	2	10
11		2	2	12
Total	10	22	12	

SUNK COSTS

The purpose of all these techniques is to evaluate a possible capital investment. A sunk cost is a cost that has already been incurred and cannot be changed. Sunk costs are irrelevant to the decision of whether to make an investment. Thus, the cost justification effort is less burdensome for those who have already made past investments in digital equipment, information systems, and hardware.

IRRELEVANT COSTS

Costs that would be incurred regardless of the implementation of PACS should be ignored. This is particularly appropriate for organizations that already plan to implement computed radiography. Such costs are not relevant in the financial justification of PACS. Similarly, the decision to invest

TABLE 7.2
Accounting Income Method (in million $)

Year	Depreciation Expense	Revenue	Annual Income	Cumulative Income
0				
1	1	2	1	1
2	1	2	1	2
3	1	2	1	3
4	1	2	1	4
5	1	2	1	5
6	1	2	1	6
7	1	2	1	7
8	1	2	1	8
9	1	2	1	9
10	1	2	1	10
11	—	2	2	12
Total	10	22	12	

in voice recognition technology is separate from the PACS decision and should be analyzed separately.

PAYBACK PERIOD

Payback period represents the number of years it takes for an organization to recover its initial investment via the cash flows generated from the investment, without adding the cost of capital (interest). This is also the point at which the project breaks even on a cumulative cash-flow basis. Some organizations establish required payback periods in addition to other financial hurdles (described later). This method offers ease of use and simplicity of application, but it does not help determine the true value of the investment over its lifetime or its value relative to other investment opportunities (see Table 7.3). The example in Table 7.1 illustrates a payback period of 5 years, the point at which the cumulative cash flow is $0.

NET PRESENT VALUE

The net present value (NPV) method assesses the worth of a project by bringing all cash inflows and outflows associated with the project into one value in today's dollars. With a 10% interest rate, an investor with $1.00 today can generate a future value of $1.10 in 1 year. Alternatively, this investor would value a riskless payment of $1.10 in 1 year at $1.00 today, in "today's dollars." In this example, $1.00 is the present value, $1.10 is the future value, and the discount rate is 10%. Net present value is the current value of the cash inflows less the current value of the cash outflows. For example, suppose this investor were offered an alternative project in which he would get $1.10 at the end of the year if he invested $.98 today. Since the $1.10 in the future is worth $1.00 to him today, and the cost of the investment is only $.98, he gains $.02 by accepting this project versus his first alternative. This $.02 return is the NPV of the project. An investment is worth making if it has a positive NPV; an investment is not worth making if it has a negative NPV. This is the most widely accepted and respected analysis method.

The underlying concept of NPV can best be understood by the following example: Assume that someone promises to pay you $100 1 year from now. What would you be willing to loan that person today? If the loan is to someone you know and trust to pay you back, you would be willing to give that person market rate, or approximately $93 at 8% (= $100.44) for 1 year. On the other hand, if you do not know the person, the risk is substantial,

TABLE 7.3
Payback Analysis: Advantages and Disadvantages

Advantages:

1. Easy to do
2. Quick financial reality check
3. Helps identify capital costs
4. Helps identify sources and magnitudes of savings

Disadvantages:

1. Does not take account of the cost of capital (current market interest rules)
2. Does not account for risk of project
3. Does not quantify the investment value of the project

and you may be willing to give that person only $80, or even $50, based on the higher risk of not being paid back.

Furthermore, if the term of the promise were longer, say 5 years instead of 1, like a savings account in reverse, the interest would have to be compounded over the term of the investment, usually on an annual or monthly basis. The formula for this process, NPV, is similar to the familiar interest compounding formula, but with the compounding portion in the denominator, as shown:

$$NPV = \frac{P}{(1+d)^n}$$

where:

P = future value (being discounted)

d = discount rate per period

n = the number of periods

TABLE 7.4
Risks of PACS Implementation

Technology:
Integration/interoperability
1. Modalities—DICOM compliance
2. RIS-HIS

Software: stability/(robustness)
Scaling
Network infrastructure
1. Institution
2. Community

Disaster Protection
Organization:
Acceptance
- User interface
  - Radiologists
  - Clinicians

Realization of film and personnel savings
Lack of in-house expertise

The discount rate has two components: (1) the underlying (riskless) market rate or cost of capital for the term (including inflation), and (2) an estimate of the risk premium, or interest rate related to the risk of the project. Risk of PACS project implementation is a complex topic that we do not discuss in detail, other than to consider that the risk factor should encompass all the assumptions of the project: costs of implementation, timeliness of implementation, and realized cost savings. Some of the risks that should be considered are listed in Table 7.4.

There are many ways for a PACS project to get off track. Major obstacles or risks with major or even disastrous consequences are often referred to as “showstoppers” by information technology (IT) professionals. Note that because the discount rate includes an inflation factor, the cash flows it is applied to should also include an inflation factor so the analysis compares “apples to apples.”

RISKS OF PACS IMPLEMENTATION

When an organization has more projects than capital, the discount rate should be set at the risk-adjusted return that the funds could generate on a competing project, as a hurdle rate (e.g., build an operating room suite vs. implement PACS). A certificate of deposit bearing 7% offered by a bank insured by the FDIC has a risk-adjusted return of 7% because there is no risk. A PACS implementation expected to generate 20% returns if the implementation is flawless may have a risk-adjusted return of 12% to 15% to reflect the risk that savings might not materialize or additional revenue might not be generated. In this case, enterprises generally set the discount rate or hurdle rate at the corporate level. That rate is usually 15% to 20%, depending on the risk profile of the enterprise. In health care, IT projects are often assigned higher risk rates because they have a reputation of not being able to produce the desired return; PACS falls into this category. For certain IT projects in health care, there are often other enterprise-wide strategic reasons to proceed, even if the expected returns do not overcome the hurdle rate.

If the investment and/or savings occur at different times (years) and/or in differing amounts, the NPV calculation is the sum of each value for the specific length of time from the time of investment into the future:

$$\text{NPV} = \sum \text{P}_\text{i} / (1 + \text{discount rate per period})^\text{i}$$

$$\text{i} = 1 \text{ to n, where n} = \text{number of periods}$$

The simplest way to calculate the NPV is to discount the annual net cash flow, or the sum of capital outlays (termed "investment"), and cost savings (termed "incremental cash flow"), as demonstrated in Tables 7.5 and 7.6. At a discount rate of 15%, cash flows beyond 10 years have a marginal impact, as evidenced in the table examples, in which the $2 million in cash flow in year 10 has a present value of $490,000, or 25% of its future value.

It is useful to project out as many years as it takes to reach steady-state cash flows or to the point at which no further benefits are expected from the investment. The capital outlay occurs in the first year(s). Operating costs will ramp up as the system reaches completion and should be adjusted each year for inflation. Savings ramp up as the enterprise discontinues its use of film. So, if the organization plans to implement PACS over 2 years and to take 5 years from implementation before achieving its film elimination targets, the analysis should be carried over for 7 years (2 years to implement plus 5 years to achieve full cost savings). The PACS life expectancy would serve as a time-cap on this exercise.

TABLE 7.5
Net Present Value Example with Initial Investment of $10 (in millions)

Year	Investment	Incremental Cash Flow	Net Cash Flow	Discounted Cash Flow
0	$10.00		($10.00)	($10.00)
1		$2.00	$2.00	$1.74
2		$2.00	$2.00	$1.51
3		$2.00	$2.00	$1.32
4		$2.00	$2.00	$1.14
5		$2.00	$2.00	$0.99
6		$2.00	$2.00	$0.86
7		$2.00	$2.00	$0.75
8		$2.00	$2.00	$0.65
9		$2.00	$2.00	$0.57
10		$2.00	$2.00	$0.49
			NPV	$0.02

TABLE 7.6
Net Present Value Example with Initial Staggered Investments of $6.00, $2.00, and $2.00 (in millions)

Year	Investment	Incremental Cash Flow	Net Cash Flow	Discounted Cash Flow
0	$6.00		($6.00)	($6.00)
1	$2.00	$2.00	$0.00	$0.00
2	$2.00	$2.00	$0.00	$0.00
3		$2.00	$2.00	$1.32
4		$2.00	$2.00	$1.14
5		$2.00	$2.00	$0.99
6		$2.00	$2.00	$0.86
7		$2.00	$2.00	$0.75
8		$2.00	$2.00	$0.65
9		$2.00	$2.00	$0.57
10		$2.00	$2.00	$0.49
			NPV	$0.77

In reality, an organization's capital projects with positive NPVs may exceed the capital available. As a result, projects with the highest return win in the battle for capital. Sometimes political and other nonfinancial considerations increase or decrease the financial value of a project. Those who prepare on all fronts increase the likelihood that the capital project will be approved.

INTERNAL RATE OF RETURN

The internal rate of return (IRR) is the discount rate at which the NPV of a project is 0. Instead of solving for a project's worth in dollars after applying a predetermined hurdle rate, the formula is solved for the discount rate itself, specifically the rate at which the NPV equals 0. This method offers one of the most common ways enterprises evaluate portfolios of opportunities, particularly if the decision is made on a financial basis only. This approach is somewhat shortsighted, since some of the costs (savings) are difficult to measure, particularly those that accrue outside the radiology department, and there are enterprise-wide strategic reasons to invest in PACS.

Tables 7.7 and 7.8 demonstrate the IRR method for the preceding example of a phased investment in PACS in years 0 through 2. The IRR calculation in a spreadsheet function, such as the one in Excel, solves for the unknown rate of return by using iterative or repeated calculations of the NPV formula. One actually has to make a guess or initial estimate of the rate, but usually any starting point between 0 and 10% will work. The NPV is calculated and driven to 0 by repeated adjustments to the rate, until the NPV is close to 0. This then yields the calculated IRR for the project or the rate at which future discounted cash savings balance the initial and future discounted investments in the project.

TABLE 7.7
Internal Rate of Return at 7 Years (in million $)

Year	Investment	Savings	Net Cash Flow	Discounted Cash Flow
0	$6.00	$0.00	($6.00)	($6.00)
1	$2.00	$2.00	$0.00	$0.00
2	$2.00	$2.00	$0.00	$0.00
3		$2.00	$2.00	$1.46
4		$2.00	$2.00	$1.32
5		$2.00	$2.00	$1.19
6		$2.00	$2.00	$1.07
7		$2.00	$2.00	$0.96
			NPV	($1.32)
			IRR: 11.0%	

TABLE 7.8
Internal Rate of Return at 10 Years (in million $)

Year	Investment	Savings	Net Cash Flow	Discounted Cash Flow
0	$6.00	$0.00	($6.00)	($6.00)
1	$2.00	$2.00	$0.00	$0.00
2	$2.00	$2.00	$0.00	$0.00
3		$2.00	$2.00	$1.23
4		$2.00	$2.00	$1.05
5		$2.00	$2.00	$0.89
6		$2.00	$2.00	$0.76
7		$2.00	$2.00	$0.65
8		$2.00	$2.00	$0.55
9		$2.00	$2.00	$0.47
10		$2.00	$2.00	$0.40
			NPV	($0.00)
			IRR: 17.5%	

Same data as Table 7.7, but with return extended out 10 years.

BREAKEVEN ANALYSIS AND FIXED AND VARIABLE COSTS

It is useful to compare the fixed and variable costs of the organization's film-based system to those of PACS to determine the volume level at which PACS produces lower total costs than do conventional methods. Fixed costs are costs that do not change as volume changes. Variable costs vary directly with volume and are 0 if nothing is produced. Because the objective is to solve for the volume, it is best to do this as a 1-year snapshot. To arrive at an annual cost, spread the capital costs over the useful life of the asset. Most of the capital costs are fixed, although one could argue that the cost of storage varies with volume. The personnel required to manage the PACS is also somewhat fixed. Variable costs are minimal. A conventional system's fixed costs are lower, since there is less capital equipment. The conventional system's variable costs consist mainly of film (and other disposables) and film library support activities (personnel). Although these are the major ingredients, you could try to capture numerous other costs that are more difficult to quantify. (We discuss those more fully later in this chapter.) These economic relationships are depicted in Figure 7.1.

In Figure 7.1, the dashed line (traditional fee-for-service income) no longer exists as such but is replaced by an underlying linear demand line for imaging services, to which a value can be assigned or ascribed. For example, in a managed care or capitated healthcare enterprise, a demand for imaging services is some function of the number of insured lives (linear), demographics (nonlinear), utilization profile of the referring physicians (complex), and possibly other factors. Some generalizations can be made, however. If the horizontal axis is labeled "Insured Lives," then the slope of the demand line is proportional to the diagnostic imaging utilization profile and determines the volume of examinations. An institution still has to provide this volume of services. However, the important differential is not between the demand line and the cost line (digital or conventional), but between the conventional and the digital, where the crossover occurs at some volume level.

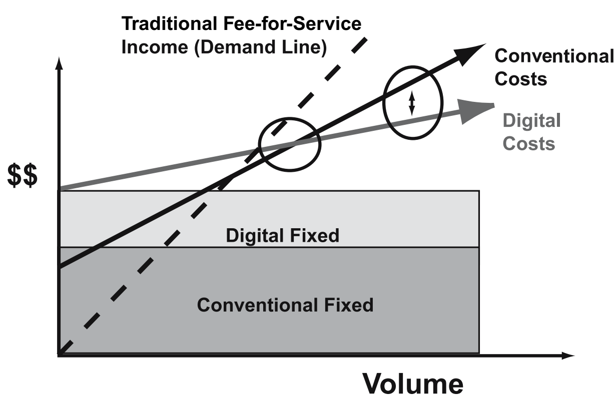

FIGURE 7.1

Breakeven analysis.

That is because the incremental or variable costs of a digital study are lower, particularly for the digital modalities.

COSTS

FACTORS DETERMINING COSTS

There is no boilerplate solution for how to determine the costs of implementing PACS. The costs depend on the sophistication of the enterprise's existing information system network and its imaging equipment inventory and needs. These capital costs, together with ongoing costs for operating the system, determine what levels of savings are required to justify PACS. Investing in PACS represents a trade-off: decreased operating costs (film and film personnel) versus increased capital costs together with PACS maintenance and personnel costs. To produce a credible financial analysis, it is best to err on the side of overstating costs and understating savings to the extent that the results allow.

Determining the cost to acquire, move, and store images is critical. An equipment inventory assessment must be done by a technician who understands how each radiology practice operates, what equipment exists, and what PACS equipment is needed. As the cost of software and maintenance is often in question and the discounts are flexible, the price to pay for the system could be calculated by using the number that generates a positive NPV. The required discount could be calculated by comparing this number to the list price offering. Equipment vendors can easily supply list prices and customary discounts. This discount, which can be substantial, is influenced by negotiation, size of purchase, and reputation value of the enterprise to the vendor. In addition, list prices are in a deflationary mode as technological advances and competition drive down prices.

CAPITAL EXPENDITURES

The initial capital outlay consists of the categories of expenditure listed in Table 7.9, the technical nature of which are discussed more fully in the following chapters. Archive capital costs will continue to decrease, and in spite of early skepticism, creative methods for management of hierarchical storage promise to decrease storage costs even further in the near future.

TABLE 7.9
Categories of Expenditures

Imaging equipment: Captures image in digital form	
Workflow managers/servers: Store, retrieve, and distribute images	
Archive: Longer-term storage of images	
Display stations: Display images to radiologists and clinicians throughout the enterprise	
Facility upgrades: temperature-, humidity-, and security-controlled environment for equipment; furniture and lighting changes for reading areas	
Clinical distribution and viewing	

COST REDUCTION AND REVENUE ENHANCEMENT

Once the capital and operating costs are defined, determine the cost savings and revenue enhancements that will result from implementating PACS. There is a credibility continuum, with hard costs such as film and associated costs being the most credible, and soft ones such as improved patient outcomes being the least credible. An analysis that financially justifies PACS without including savings, which are more difficult to quantify and demonstrate, will be better received than one that shows an impressive financial impact but is built on extensive, unproven assumptions. In other words, proceed along the credibility continuum only until the cost is justified. Doing so also eases the follow-up analysis that may or may not be required to demonstrate postimplementation outcomes.

Partners HealthCare System, Inc. (Partners), in Boston provides an example of how one organization proceeded along the credibility continuum, using the financial techniques outlined earlier in this chapter, until PACS was justified. At Partners, founded in 1993, by the Massachusetts General Hospital and Brigham and Women's Hospital, PACS was financially justified based on savings from decreased film and film library costs alone, and no further analysis of cost savings or revenue opportunities was necessary. The Partners system is armed with a world-class information system infrastructure, consisting of the largest integrated Intel/Microsoft platform in the world connected to more than 30,000 desktop computers for almost the same number of employees. The two hospitals were also well on their way to converting to computed radiography when this analysis was conducted.

Partners arrived at an implementation cost of approximately $12.6 million, along with operating costs of approximately $1.5 million per year, together composing the cost to be justified. The analysis was based on an annual volume of 775,000 radiology examinations per year. This represented 2.7 million films, at a film cost of $3.5 million and a film library cost of $1.7 million. An 8-year analysis was performed to cover 3 years of investment and implementation, 3 years to break even, and 2 years to reach steady-state savings. All these factors resulted in an NPV of 0 dollars, or breakeven (using a discount rate of 10%, required by the Partners treasury department). Likely but difficult-to-quantify cost savings and revenue enhancement opportunities would clearly produce a positive financial return, not to mention all the nonfinancial benefits such as improved clinical outcomes.

On a per-unit (per-exam) basis, Partners estimated that it would save $8 per exam for film and film library expenses on an annualized basis, for an additional PACS operating cost of $2 per exam, resulting in a net savings of $6 per exam. This, however, required a one-time capital investment in PACS infrastructure of $16 per annualized exam but only $3.20 per exam, assuming a useful life of PACS investment of 5 years.

Mayo authors divided personnel costs associated with film into those occurring inside the radiology department and those occurring outside. These costs are incurred by nursing and clerical staff when engaged in both the "film search game" and traditional methods of requesting and managing exams needed in the clinic or operating rooms. Mayo arrived at $15.82 per exam, as shown in Table 7.10. The Mayo authors also made the comment that "[o]ur estimated cost of film per exam per year is most likely an underestimation of real costs when compared to other institutions."

TABLE 7.10
Mayo Study: Estimated Film Cost per Exam

Film	$6.25
Supplies	$1.46
Personnel	$5.91 (direct) $2.20 (indirect)
Total	$15.82 per exam

FILM COST

To capture film costs it is necessary to develop assumptions about the number of annual exams, films per exam, and cost per film over the life of the capital investment in PACS. Annual savings is the product of annual exams multiplied by number of films per exam multiplied by the expected film cost per sheet. For example, an enterprise that generally conducts 10,000 annual MRI exams using 8 films per MRI at a cost of $1.50 per film would save $120,000 if it eliminated 100% of its film use. It is easiest to combine all associated film costs, including chemicals, processing, folder jackets, and so forth, with the film commodity cost for simplicity.

For most enterprises, it is necessary to ramp up film elimination from 0% to 90% or so over some number of years. It is difficult to eliminate film entirely (thus the 90%) because of the need to produce films for clinicians outside of the enterprise, for legal proceedings, and so on. Nevertheless, it is necessary to reach a fairly aggressive target quickly in order to justify PACS currently. The rapidity with which film use is eliminated is the key factor in cost savings. A long implementation perpetuates dual systems and processes, delays savings, and destroys value. A commitment must be made by the clinical enterprise that film use will be eliminated as soon as PACS is implemented. To make these assumptions real, keep in mind that a replacement for image distribution must be in place as well as a PACS prior to successful film elimination.

FILM LIBRARY COST

The film library cost consists mainly of personnel managing the contents of the film library. As with film costs, the savings here would ramp up and shadow film reduction. The analysis could also include costs saved by reducing the space required for film storage. For many institutions, the space saved depends on legal requirements for film storage, which may take several years to develop, as the law generally follows practice, and these, from a legal perspective, are uncharted waters. For the analysis to capture space savings, the organization must have an alternate need for the space, and by gaining the film storage space, be able to avoid leasing additional space. It may be easier to treat such space savings as a wash when anticipating the increased space required for the PACS equipment and its staff, but this needs to be determined on a case-by-case basis.

The analysis can also phase in a reduction in warehouse costs for film storage that shadows the implementation phases. This reduction would also have to respect the film storage time required by law.

LOST EXAMS

The financial impact study could also include the elimination of incremental costs and lost revenue associated with misplaced films. Savings may materialize from a decrease in staffing required of practitioners and administrative personnel to serve existing volumes, or as increased throughput (revenue less incremental costs). This impact is difficult to quantify, and the inclusion of these costs depends on whether the institution tracks this information.

It is also difficult to quantify the cost to the enterprise of not producing a film for a legal proceeding, or the cost of the department's and institution's reputations in not being able to produce a film for a patient or physician who needs it. The nonquantifiable cost to the patient might be staggering if a previous study is needed for comparison with a present study before a clinician can make an informed diagnosis. These situations can be enumerated in the analysis as nonquantifiable benefits.

REDOS

PACS virtually eliminates the need for redos for two reasons. First, computed radiography imaging modality has a very wide range of latitude for exposure error, compared to film. Second, the rate of lost exams in a well-engineered PACS is very low compared to the estimated 10% to 15% temporary or permanent loss rate in a conventional film library. To calculate this savings, estimate the cost of redos to the organization in terms of time and materials. The savings in time depends on whether the clinician would be serving other patients instead of repeating the process; the savings in cost depends on whether a reduction in staffing would result. Such savings apply not only to radiologists but also to clinicians who are detained by redos. Savings on materials are calculated by the number of redone exams multiplied by films per exam multiplied by the cost per film.

Again, it is difficult to quantify the cost to patients associated with the delay caused by a redo. At the risk of being overly dramatic, we can say that a savings in time can make the difference between life and death for patients whose critical condition may depend on a rapid diagnosis.

SAVED TIME FOR PRACTITIONERS AND ADMINISTRATIVE STAFF

PACS makes image distribution faster, easier, and more reliable. This feature translates into a cost reduction if staff are eliminated or into an additional financial contribution (incremental revenue less incremental costs) if an unmet demand for services (additional volume) exists. This impact will not be felt until the PACS is fully implemented and all radiologists and clinicians are proficient in its use. This time saved is difficult to measure without comparing the task time today versus the task time in a carefully projected environment, but few data are available for such comparison.

Faster turnaround time will likely translate into shorter stays which, in turn, can reduce costs of care or produce additional income if additional patients can be served. The potential impact on length-of-stay and increased admissions would be difficult to substantiate. It is difficult to know or measure how PACS contributes to shortening length of stay because there are so many complex factors that contribute to length of stay; it is difficult to segregate PACS as a single component.

SITE OPPORTUNITIES

Just as the electronic revolution makes it possible for millions of people to spend more time working from home, electronic imaging makes the locus of work far less important for radiology services. PACS enables diagnostic images to be available anytime, anywhere they are needed, with little or no human intervention. This eliminates the necessity and cost of having radiologist coverage in multiple sites within an entity and in many entities within a system. The mobility of images created by PACS facilitates peer or expert review of images inter- and intra-network. This mobility reduces the potential number of radiologists required to serve a given population and also the time in which those services can be provided. Enterprises that take advantage of these site opportunities will be able to serve existing patients with fewer resources (reduce costs) or serve additional patients with existing resources (increase revenue).

MULTISITE IMAGE READING

The peaks and valleys of demand can be better managed by diverting image reading to alternate sites. Diversion allows for more effective use of resources, faster turnaround times, and improved patient outcomes. It also lets any appropriate radiologist read images for a clinician anywhere within the defined network, thereby allowing patients to receive care in their own locales and in some instances, allowing clinicians to receive radiology services with only a technician, rather than a radiologist, on-site.

IMPROVED PATIENT OUTCOMES

Perhaps the most difficult benefit to quantify is improved patient outcomes, yet such benefits represent perhaps the most compelling argument for PACS implementation. Improved outcomes are the product of many factors: image clarity, fewer lost exams and redos, multi-availability of digital images, and, most important, turnaround time. The latter is especially true where distance is involved. No simple quantitative value can be placed on improved detection of disease or image availability, nor is there a simple way to assess the value of a secure and fast repository of images. These factors will have a huge impact on the way medicine is practiced and the quality of care patients receive.

COMPETITIVE IMPACT

A financial analysis could attempt to capture whether implementing PACS would have an impact on the organization's overall revenue and admissions. Many enterprises, especially integrated delivery networks, will see the decision to implement PACS simply as a necessary step in maintaining their market position. If PACS is financially justified and greatly improves patient outcomes, the entity or system that adopts it first will have a competitive advantage.

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