Performance-based contracting for PACS implementation in hospitals: A SWOT analysis

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Performance-Based Contracting for PACS Implementation in Hospitals: A SWOT Analysis

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Abstract: This paper aims to examine a contract management process for the Picture Archiving and Communication System (PACS) using a performance-based contract (PBC). In this instance, the customer only pays when a specified outcome is delivered. By conducting SWOT analysis of PBC, the authors seek to offer guidance to practitioners in order to negotiate a robust contract, without surprises or disappointments. During the negotiation of the service offered, the major areas encountered include responsibility of operation, risk sharing, and type of payment. These areas are discussed in detail and their management is assessed based upon the "win-win" principle.

Keywords: PBC; PACS; Performance based contract; Picture archiving; SWOT; Hospital

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INTRODUCTION

The management of large-scale hospitals recognizes the importance of using Picture archiving and communication systems (PACS) as a key technology in cost-effective healthcare delivery at hospital level. The most frequently mentioned reasons for changing from a film-based radiology department to PACS are to increase productivity, efficiency, save money, improve accessibility of images, improve the ability to handle images for interpretation, and to reduce the time and effort it takes to handle film (Honeyman-Buck, 2003).

PACS is a collection of technologies used to carry out digital medical imaging permitting instant reporting from radiologists at a distance. Data is secured and archived on digital media and can be automatically retrieved. Close integration with the hospital information system (HIS) and radiology information system (RIS) is critical for system functionality (Birjandi, 2004). We aim to shed light on the contract management process for PACS using a performance-based contract (PBC), where the customer only pays when a specified outcome is delivered (Abu-Salim and Shehab, 2013). Although PBC is not a new concept, outcome-based models are gaining traction in other parts of the outsourcing industry, driven in part by recent economic conditions, and the desire of customers to derive more value from their outsourcing spend (O’Hare, 2016).

Whilst PACS has been available for over 20 years, it has recently become affordable due to the PBC method of implementation. As the first study to use SWOT analysis to assess PBC implementation of PACS in healthcare, we seek to offer guidance to practitioners in order to identify an understanding of the contract without surprise or disappointment, thereby enabling a better view of negotiating a robust contract.

There is evidence that PBC is increasing to enhance the effectiveness and efficiency of both the service provider and the customer. Despite this, few research studies are available (Abu-Salim and Shehab, 2013, Hypko et al., 2010) which identify the fundamental concepts and issues arising from the implementing PBC in different sectors (such as healthcare) (Ng, Maull and Yip, 2009a). However, Hypko, Tilebein and Gleich’s, (2010) review of PBC literature finds that many scholars focus on different sectors but are not able to capture all the characteristics of PBC, specifically in services provision. Therefore, we seek to clarify the PBC concept, in the context of PACS implementation utilizing SWOT analysis.

The next section of the paper will deliver a review of literature within the scope of the study. This is then followed by the research approach and discussion of PBC in line with PACS, and SWOT analysis. The final section is our conclusion and recommendation.

LITERATURE REVIEW

PBC Definition

Recently, a range of publications have reported examples of solution providers who retained the ownership of the system and sold only the performance of the
machinery or equipment. This emerging business is driven by the tendency of customers to reduce their investment in increasingly capital-intensive machinery or equipment and contract out responsibilities to a performance provider, using PBC (Cowen, Davies, and Kengyelics, 2007; Gebauer, Krempl, Fleischand Friedli, 2008). Hypko et al. (2010) define eight criteria (adapted from Lay, Schroeter and Biege, 2010) which demonstrate different approaches to the PBC. Their conceptual model identifies the roles and responsibilities for each criterion (Table 1).

Table 1: Conceptual model for PBC

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance provider’s background</td>
<td>Independent service provider (PBC in a broader sense)</td>
</tr>
<tr>
<td></td>
<td>Machinery or equipment manufacturer (PBC in a stricter sense)</td>
</tr>
<tr>
<td>Ownership during the contract period</td>
<td>Leasing company</td>
</tr>
<tr>
<td></td>
<td>Special purpose vehicle</td>
</tr>
<tr>
<td>Ownership after the contract period</td>
<td>Leasing company</td>
</tr>
<tr>
<td></td>
<td>Special purpose vehicle</td>
</tr>
<tr>
<td>Responsibility for maintenance personnel</td>
<td>Service provider</td>
</tr>
<tr>
<td>Responsibility for operation personnel</td>
<td>Customer</td>
</tr>
<tr>
<td></td>
<td>Service provider</td>
</tr>
<tr>
<td>Payment model</td>
<td>Pay-on-Availability</td>
</tr>
<tr>
<td></td>
<td>Pay-per-Unit (or Pay-on-Production/Pay-per-Use)</td>
</tr>
<tr>
<td></td>
<td>Pay on Customer’s Economic Results</td>
</tr>
<tr>
<td>Location of Operation</td>
<td>Customer’s in-house</td>
</tr>
<tr>
<td></td>
<td>Fence-to-fence</td>
</tr>
<tr>
<td></td>
<td>Service provider’s in-house</td>
</tr>
<tr>
<td>Exclusiveness of operation</td>
<td>Single customer</td>
</tr>
<tr>
<td></td>
<td>Multiple customers</td>
</tr>
</tbody>
</table>

Note: adapted from Hypko et al., 2010

PBC is different than the conventional contract based on fixed fees for a product or the service provision. Outcome-based contracting, or its narrower equivalent of PBC, is a mechanism that allows the customer to pay only when the firm has delivered outcomes, rather than merely activities and tasks, and provide cost efficiency as both the service provider and the customer have mutually negotiated agreed terms (Ng, Williams and Neely, 2009b). The key concept of PBC emphasis on the outcomes or results rather than the input or the process and from performance delivery instead of simply the physical object and surrounding services (Markeset and Kumar, 2005; Martin, 2007). Yet, Kim, Cohen and Netessine (2007) suggest that aligning risk and incentives between the service provider and the customer is higher in PBC than the traditional contract.
Selviaridis and Wynstra (2015) distinguish between outputs and outcomes by defining the outputs as the result of the service process, while outcomes are defined as the value created by the customer in the process. They pose that this is difficult to quantify in monetary terms. Ng et al., (2009a) confirm the importance of the delivered value; how PBC changed the service delivery process and highlight customer involvement with emphasis on value co-creation rather than the conventional obligation for each party.

This type of contract has been applied in both manufacturing and services, and product-service system (PSS) (Hooper, 2008). For example, Rolls-Royce “Power-by-the-hour” contract concept is “designing a service and the product that supports it” as opposed to “offering a service around an existing product”. Xerox no longer just sells photocopiersons, but rather offers ‘custom-made reproduction services’. Safety-Kleen and Dow Europe have moved their business to selling ‘the services of chemicals’ instead of simply the sale of chemicals. As a result of servitization the boundaries between product and service are blurred and the PBC arise in research and practice (Kindström and Kowalkowski, 2009). Accordingly, the ownership, operation responsibility and payment methods have been changed (Kim et al., 2007; Ng and Yip, 2009).

**PBC in Healthcare Sector**

Selviaridis and Wynstra (2015) completed a systematic literature review of 241 peer-reviewed published about PBC between 1985 and 2014. They found that 90 journals focused on services in the healthcare sector (for example Mehrotra, Damber, Sorbero and Teleki, 2009; Shen, 2003). Brucker and Stewart (2011) emphasize the direct financial benefits to hospitals based on pre-determined levels of performance on specific indicators in PBC.

This trend in the healthcare sector can be explained by the benefits of entering a PBC to improve service delivery; transferring the risk to the service provider and spending accountability especially in the public sector (Ng, Ding, and Yip 2013). Romzek, LeRoux, Johnston, Kempf, and Piatak, (2014) further studied the impact of PBC on developing collaboration and improving accountability. Respondents show positive collaboration and enhanced accountability by emphasizing on outcomes.

PBC has been promoted by the Institute of Medicine (IOM) in the US as a mechanism to manage effectiveness of healthcare services and to monitor hospital performance (Ng et al., 2009a). To attain the best outcome for the patients at the lowest cost, a move from the volume and activity to value agenda that includes bundling payment options and incentive mechanisms. However, there is also emphasis of challenges to overcome following this trend such as: poor visibility of existing costs; existing contractual restrictions; difficulty matching outcomes with costs. A good example of this trend would be the PBC in PACS Project within radiology departments.
PACS

PACS and diagnostics imaging networks have been developed over a long period of time since the 1980s in USA and Europe. Most of the installed systems could be characterized by their focus on a single department, such as radiology or nuclear medicine (Lemke, 2011). Meanwhile implementation of (PACS) in developing countries is a real challenge than in developed countries (Hwang et al., 2016).

Large-scale hospitals have recognized the importance of using PACS in cost-effective, and efficient healthcare delivery. PACS is a medical imaging technology that provides convenient access to images from multiple access points. Data is secured and archived using digital media and can be automatically retrieved when required. Close integration with the hospital information system (HIS) (for example, radiology information systems) is critical for system functionality (De Backer, Mortele and De Keulenaer, 2004). Some of the advantages of PACS include increased productivity, efficiency, less cost, improved accessibility of images, improved ability to handle images for interpretation, and reduced time, and effort for handling films (Honeyman-Buck, 2003).

Currently, the application of PACS has been extended from radiology services to other clinical services (Huang, 2003). In addition, organization-wide PACS integrated with the electronic medical record (EMR) has been conceptualized and implemented in a growing number of selected hospitals across Europe. PACS is now recognized as a basic infrastructure for communication within hospitals. This trend is expected to accelerate further, creating not only new technical challenges of how to accommodate the individual wishes of service providers and receivers in the healthcare system (Lemke, 2011).

For successful implementation of PACS, several elements should be agreed by the hospital so as to avoid unforeseen (or unexpected) issues during the installation of the system (Pilling, 2002). It should be noted that the implementation of PACS is expensive and complicated. To manage the paradigm-shift in radiology services, a clear plan will reduce the risks associated with the project. Many hospitals are currently in a dilemma whether they should apply the best business model or extend the PACS system (Huang, 2014). Traditionally, for a hospital, the budget for a PACS project would contain capital and recurrent elements. The capital is associated with the acquisition of the system in a traditional purchase model, and the recurrent (or operational) cost component is associated with the maintenance and upgrades of the system(s) (Sim, 2008).

Approaches to PBC in PACS Implementation

PACS should be both cost effective and contribute to improved patient care (Romzek et al., 2014). However, the best business model to apply and the best contract to sign are debatable. Hospitals would determine sharing risk when agreeing the PBC in order to experience best available performance form the provider (Mackinnon, Billington, Adam, Dundas and Patel, 2008). Birjandi (2004) suggests accepting milestones as a way to protect the hospital when implementing
PACS by PBC. Three milestones were proposed: technical, functional and hospital acceptance.

Access to capital and financing is a key topic in the current global economy given the instability of worldwide financial institutions in the past several years. The unique challenge presented by medical imaging is the relatively high expense of purchasing the PACS equipment (Mollura et al., 2010).

Some of the financial models available for the medical equipment are “Add-on PACS equipment” where the hospitals attach PACS with existing medical imaging equipment. However, the disadvantage here is that the system will potentially be obsolete in as little as two years (Huang, 2003). A traditional purchase model, whereby the technology is purchased and owned by the institution: normally managed by the PACS administration with the vendor providing technical support under a service contract arrangement (Sim, 2008).

Out-sourcing is another model were the maintenance for the technical components of the PACS after installing the equipment is outsourced. However, no outsourcing provider can aptly understand the intricacy of organization level operations without a long learning period, and process of information collection. The time required would be too long to be beneficial for the hospital (Huang, 2003). The Application Service Provider (ASP) model may also be considered. In this instance, a “service” is purchased from the supplier, who then implements and manages the system, and charges on pay-per-use arrangement. The hospital does not own the hardware or software (but will own the information). This model moves some of the capital acquisition costs into the recurrent budget, spreading the expenditure across the life of the contract. The extent of the ASP model may be limited to archiving, with the facility taking responsibility for and ownership of reporting workstations and interface hardware/software (Sim, 2008). It is important to consider the level of maintenance in PBC-PACS contract, which should include: Software support (PACS complex database structures require specialized software engineering support, which is often delivered remotely through a 24/7 support center included in the service fee); component warranties where some components may have a three-year warranty, whereas some may have a warranty of three months. These arrangements are often included and allow the service provider to increase the service fee in accordance with an agreed formula developed during the negotiation of the various contracts; Hardware support, scheduled maintenance, and hours of coverage (Birjandi, 2004; Bullinger, Spath, Schuster and Meiren, 2004).

A pay-per-use model is attractive in smaller clinics with scarce IT support (Huang, 2003). If an organization should consider software purchase, then they have the choice to design their own image distribution, architecture, hardware, and work station distribution and then purchase its own hardware. It then decides what software can be implemented in-house, and what needs to be purchased. On the other hand, the loosely coupled partnership model is defined in healthcare as the forming of a partnership with a provider and defining responsibility in terms of planning, design, implementation, and operation. This model is being used for many PACS installations. The advantage of this model is the lower price of purchase, but it would be difficult to have full integration at the organization level.
in the case of many hospitals. The opposite of this model is tightly coupled partnership where both the hospital and provider make a long-term commitment in terms of technical, personnel, financial, and ethical support and the software is updated by periodic review. The provider will offer adequate training to assure engineering and operation sufficiency (Alalawi, Eid and Albarrak, 2016). The hospital has the responsibility to guarantee a mutually agreeable annual payment to the provider. Both partners can negotiate a continuing agreement after the contract has expired. Both the parties must abide by the ethical code of a tightly coupled partnership recognized by the IT and the medical community (Huang, 2003). Finally, there are also leasing models. Rather than purchasing the technology outright, a facility may choose to lease the model. This effectively moves the entire capital budget requirement into the recurrent budget and spreads the capital expenditure across the life of the system (Sim, 2008).

This paper discusses PBC where the manufacturer/service provider and the hospital have committed in a long-term contract for a fixed fee on pay-per-use basis. This business model falls between the ASP model and the tightly coupled partnership and is attractive in both technological and financial aspects. The organization will pay per-use without the cost of overheads and can predict the pay-per-use on a daily, monthly, and yearly basis.

To compensate the risk in PBC in PACS project the service providers must persuade a hospital to pay a higher service fee (Hensher and Stanley, 2008). However, hospitals usually avoid paying such a risk premium. The providers, thus, have to search for mitigating strategies that offer more differentiation. For this, they might negotiate minimum service volumes or offer a discount on the service fee if the expected volume is actually achieved. Based on uncovering the hospital’s tendency to operate the PACS intensively or carefully, the service provider might negotiate maximum usage and extra charges if the hospital uses the PACS more than the agreed usage. Despite this broad range of mitigation strategies, thus far, research offers only very little advice on how the service provider may put these strategies into practice and whether they are really suitable to ensure profitability in view of the emerging costs for offering discounts or monitoring (Toffel, 2008).

PACS installation is an expensive and potentially risky venture for any hospital. The larger the organization the greater is the expense and associated risks (Ivanova-Stenzel and Kroger, 2005; Pilling, 2002). PACS is critical in the filmless environment so it is important that adequate redundancy exists to support radiology business continuity in the event of hardware failure (Sim, 2008). The PACS management team must specify the scope of the project; identifying all modalities that will be included, including the volume of studies that will be stored on the archive. In addition, they have to choose the display devices; both diagnostic workstations for the user, and the method for disseminating studies amongst physicians (Honeyman-Buck, 2003). PACS archives typically consist of a number of levels of storage in order to balance cost, reliability, and speed of retrieval. The budget requirement for the archive will depend upon the storage size requirements. While disaster recovery involves mitigation of data loss risks due to fire and natural disasters by having a copy of the archive located in a separate location.
RESEARCH APPROACH AND DISCUSSION

As a conceptual paper, we use SWOT analysis to highlight the key areas of PBC in order to identify how hospitals can implement PACS using PBC (Honeyman-Buck, 2003). We suggest that doing so will have implications for hospital management in creating a robust contract.

SWOT analysis is a relatively simple strategic management conceptual framework (Yuan, 2013) which has been used extensively to investigate internal and external forces from a strategic perspective (Chermack and Kasshanna, 2007). To evaluate PBC and its suitability for PACS implementation, the eight criteria (table 1) suggested by Hypko et al. (2010) were reviewed and a SWOT analysis completed. A SWOT analysis of PACS alongside PBC develops further understanding of the internal and external factors that hospitals may face when agreeing terms of a robust contract for PBC-PACS approach to implementation.

The research method employed followed a simple framework of workflow to identify literature and aspects of both PBC and PACS in order to complete our study. We followed five main points of action, which were supported by two reviews of literature available at the time of writing (PBC and PACS), as demonstrated in Figure 1. The literature reviews were then used to create a separate discussion for both PACS and PBC. The next step was to extract the internal and external aspects of SWOT in order to create a review of the strengths, weaknesses, opportunities and threats for hospitals implementing PACS. The summarized SWOT analysis is shown in Figure 2. We then conclude with a combined discussion which gives further contribution to management within hospital, who may consider PACS implementation by PBC as opposed to fully investing in the product and associated support services directly.

Figure 1: Research method employed
SWOT ANALYSIS

Strengths

Generally, with PBC, the service provider is responsible for “managing the hospital’s PACS”, which will include hardware and software provision, and maintenance activities, meaning that the hospital itself does not need to employ specialist IT staff (Markeset and Kumar 2005; Toffel, 2008). With regard to “staff training”, the responsibility also falls with the service provider. Therefore, the hospital would be prudent to ensure that there is provision for the training of new or additional staff when required and detailed in a robust contract.

With PBC, the hospitals no longer own the capital goods as they purchase the performance, thus “freeing financial capital”. The hospital reduces the need to invest a large sum of capital in the purchase of PACS equipment (Baines et al., 2009; MacDonald and Neville, 2010) thus, making funds available for investment in other areas.

In addition, in PBC the service provider retains the ownership of the machinery or equipment during the entire contract period. In the case of PACS offered as pay-per-use, the service provider keeps the ownership of the system (hard and software) and is responsible for financing the capital and recovering the investment through the service fee (Alonso-Rasgado, Thompson, and Elfström, 2004). The innovative character of pay-per-use PBC is largely based on its “significantly changed payment model”, which is closely related to the change in the ownership. Instead of the ownership of the capital goods, the hospital pays only for performance provided on a measurable basis. Moreover, as the orientation toward performance also affects the payment of support services and replaces conventional fixed-price or cost-plus contracts (Lay et al., 2009; Markeset and Kumar, 2005).

One of the main Strengths of PACS is “enhanced workflow”; the adoption of PACS assures better access to archived images; recognizing important earlier diagnostics that exists only on film, in addition to minimizing physical space requirements for images (Strickland, 2000; Strickland, 2013). Hence, images are permanently accessible, consequently no patient appointment are postponed or repetition of any screening tests. The PACS record guarantees that all images are regularly collected into the accurate investigation, are chronologically well-organized, appropriately positioned and categorized, and can be easily recovered using a range of standards (for example, name, hospital number, date, referring clinician, etc).

Another key strength of PACS is “organizational efficiency”. PACS offers increased organizational efficiency through abolishing the physical management of paperwork. Consequently, no clinical diagnostic decision postponed, which leads to increased productivity of radiology services (Alalawi et al., 2016). “Time saving” is one of the major strength PACS offers: The accessibility of various PACS terminals throughout a hospital permits instantaneous multi-location observing of the same image, significantly dropping the time required to reach a final diagnosis, whereas conventional film can only physically exist in one place at any time. Figure 2 reveals the summarized findings of SWOT analysis.
Weaknesses

In general, there are two options for maintenance provision with PBC (Shapiro, 2002:). On one hand, maintenance provision can be fence-to-fence, where the service provider has property adjacent to the hospital. On the other hand, maintenance can be delivered by on-site staff employed by the service provider (Hypko et al., 2010; Shapiro, 2002). Given the importance of continual operation (Joshi Narra, Joshi, Lee and Melson, 2014), it makes sense only to have maintenance staff located inside the hospital. However, this then means that “adequate space”: (offices, stores, etc.) must be made available to accommodate support staff.

When implementing PACS using a PBC, Petersen et al. (2006) identify that unless there is a combined view of the process of care, there is a risk of “losing sight of what the potential outcomes can be”. They suggest, as an example, consideration of the problem, and outcome of smoking cessation, proposing that the documented advice stored within the PACS is linked closely to the preferred outcome – actual numbers of patients who then go on to stop smoking.

Additionally, as hospitals often “lack the adequate know-how” required for optimal operation of the machinery or equipment. In the case of PACS, the service provider retains the system after the completion of the contract period but the hospital can negotiate “the details of the termination/transition period” (Hypko et al., 2010). The problem here being that at the end of the contracted period, the hospital will either have to renegotiate with the existing provider or embark on a new journey to identify a new contractor.

There is a requirement to guard against a total system failure, as a hospital’s most important function is the imaging service. There is no “restore from back up position” once the hospital has become filmless because the means and infrastructure to generate, distribute, view, and store hard copy film no longer exists (Strickland, 2000). It would therefore be prudent to ensure that a suitable storage and backup feature is detailed within the contract. Joshi et al. (2014) identify the important factors to be considered for continual operability of PACS (e.g. system security, backup features, prevention of downtime). Khamiss and Hussein (2014) go further by considering online backup, access to records, and some security risks.

With the deployment of PACS, it is feared that “medical staff will not have sufficient computer literacy” to be able to use the new technology (Bulgiba and Noran, 2003; Guidry, 2014). For example, the NHS UK National Program for Information Technology (NPfIT) promised outstanding benefits for patients. However, the immediate hurdle was the interruption and transformation that NHS staff experienced during implementation of the NPfIT systems such as PACS (Hendy, Reeves, Fulop, Hutchings and Masseria, 2005).

Opportunities

Ivanova-Stenzel and Kroger (2005) identified that negotiation process between the provider and operator in PBC allows further aversion of risk for both parties.
As opposed to a tender process for procurement/provision, both parties can agree on the best (or most acceptable) price for the PBC, in addition to the level of service and support (Hensher and Stanley, 2008).

In PBC-PACS pay-per-use, the service provider is always responsible for maintenance, which involves proactive checking of the hardware and software to keep the system running, emergency response arrangements, hours of coverage, and upgrades. Other aspects of maintenance include performance availability/reliability, guaranteed uptime, scheduled maintenance, and around-the-clock remote monitoring (Markeset and Kumar, 2005). Thus, the organization may receive a “better maintenance programme” than if they were to directly fund it themselves. The contract with the provider will have been negotiated and costs taken into account. During times of budget cuts, maintenance and service provision will not be affected (Kumar and Kumar, 2004).

Traditionally, PACS service contract may be an annual fee that is somewhere in the region of 10% to 20% of the capital cost of the system. Consequently, it is important to obtain accurate estimates of likely service contract costs for various levels of support in the pay-per-use instance (Bullinger et al., 2004). In this respect, the hospital may be able to “negotiate a better PBC-PACS” before entering the agreement. At this point it is would be prudent to also mention “System Upgrades”. It is not unusual for a PACS to need at least one software upgrade per year. The licensing for upgrades is included within the contracts. System upgrades also require inputs from the PACS support unit in the hospital for planning meetings, training, and for on-site supervision of the various component implementations. Often, upgrades are performed outside normal working hours and on weekends to minimize disruption to the radiology department (Honeyman-Buck, 2003; Sim, 2008). Again, with a robust and well-negotiated contract, this will ensure that the hospital will have continuity of service, maintenance, and availability, of the most up-to-date system.

Additionally, there has been a high level of focus on the socio-technical issues that pertain to the design and deployment of e-Health technologies (Black et al., 2011). Human factors influence the design of an intervention and organizational issues are important in strategizing deployment. The interface between technology and human characteristics are environmental drivers influencing the impact of PACS in delivering eHealth strategies (van Gemert-Pijnen et al., 2011). It is possible that “the more used and integrated the systems become, that further refinement and development will be possible”.

The use of PACS gives way to significant steps towards “creating a comprehensive research database”, as it can contain rich imaging and patient data PACS (Yang, Tan, Loh and Lim, 2007). For example, the use of clinical data from PACS enables the disease registries and databases (NRID) of neurological diseases to be created; keyword searches can produce lists of patients with specific diagnoses.

It would be possible for the hospital to contract with the manufacturer of PACS equipment itself. Alternatively, an independent service provider could also take over the responsibility for the machinery or equipment as a pure service (Kumar and Kumar, 2004). In the case of the PACS being offered on pay-per-use basis,
both the manufacturer of the PACS and service provider are considered as service providers because the hospital does not buy the equipment nor the software but buys the performance of the system (Hypko et al., 2010). Thus, the hospital management has “choice” of how they wish to implement PACS, and the level of PBC they enter.

**Figure 2:** Summarized findings of SWOT analysis

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Service provider responsible for hardware and software costs</td>
<td>• Decision to be made regarding location of maintenance staff: should be internally based within the hospital, hence space and appropriate fit-out of office/storage location required</td>
</tr>
<tr>
<td>• Service provider carries out all maintenance</td>
<td>• Identification of the actual outcome</td>
</tr>
<tr>
<td>• Service provider responsible for staff training</td>
<td>• Termination period: what decision should be made – re-negotiate with existing service provider, or start over with new providers? This can be lengthy</td>
</tr>
<tr>
<td>• No capital investment required by hospital</td>
<td>• Appropriate back-up measures – what storage medium should be used, and where should it be located?</td>
</tr>
<tr>
<td>• Enhanced workflow within the hospital</td>
<td>• Hospital staff computer literacy and further training</td>
</tr>
<tr>
<td>• Increased organizational efficiency within the hospital</td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aversion of risk for both parties</td>
<td>• Cost of PBC pay-per-use may have implications on perceived service quality</td>
</tr>
<tr>
<td>• PACS continuity of service and maintenance agreed in contract: hospital may use this as a factor when negotiating with supplier (service level required v’s cost)</td>
<td>• Confidence that the service provider has the ability to deliver/sustain quality and Operability required</td>
</tr>
<tr>
<td>• Hospital staff involvement can help to design a system which meets their needs</td>
<td>• Cost of available options for implementation not clear</td>
</tr>
<tr>
<td>• Hospital can budget more closely: clear identification of service costs at time of negotiating the contract</td>
<td>• Patient security: personal data</td>
</tr>
<tr>
<td>• Potential to further utilize PACS data for other uses in hospital (databases)</td>
<td>• Cyber-attack and system security</td>
</tr>
<tr>
<td>• Hospital has added choice of how to implement PACS</td>
<td></td>
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</table>
Threats

Ivanova-Stenzeler and Kroger (2005), and Hensher and Stanley (2008) both suggest that, with PBC, “supplier fees” can be either to low (suggested lower level of service) or too high. Where the fee per outcome is too high, there is a risk of PACS not being implemented, which has subsequent effects on patient care and record maintenance. Furthermore, Mirzahosseinian and Piplani (2011) suggest the concept of “readiness risk” whereby the supplier may in fact not offer the appropriate level of operational availability, again affecting the ability to service patients within the PACS.

The responsibility for maintenance personnel is directly related to the service provider’s background and the financing model (Hornschild et al., 2004). Whilst there is a staffing cost benefit to “the hospital, they may have no, or limited, involvement in the provision and availability of the maintenance staff who are managed by the service provider”. This has a potentially critical impact on the availability of patient records and images should the system fail.

There is growing concern within hospitals about availability of “funding” to cover costs associated with IT modernization. In particular, applications such as PACS supplied through local service providers’ (LSP’s) for the NPfIT strategy in England seem more expensive than market alternatives (Hendy et al., 2005).

Web-based PACS allows remote access and also the sharing of medical images within the hospitals’ departments, external consultants and specialists, and with other hospitals across the country, and indeed the world. Challenges with external sharing are technical in nature, for example, “interoperability”, “network availability”, and “reliability of technical infrastructures”. More prevailing issues surrounding “legal implication” of shared images include “patient privacy” and “security” (Ross and Pohjonen, 2011). Whilst Khamiss and Hussein (2014) suggest a number of factors to enhance security of web-based use and file transfer in PACS, we must still consider the risk of “cyber-attack”, such as that against Scotland’s National Health Service (Titcomb and McGoogan, 2017).

CONCLUDING COMMENTS

Although PBC is not a new concept, it has started to receive further attention driven by economic conditions and hospital desire for value in hospitals. PBC in PACS is a very good example of improving available services to patients, and also a good example of business to business service provision.

This study highlights the importance of a meaningful negotiation between the service provider and the hospital management to understand, in detail, the strengths, weaknesses, opportunities and threats when using PBC to implement PACS. The results using SWOT analysis suggest that hospital management should build on its strengths including installing PACS without capital investment and transfer the system management to the service provider that include maintenance, staff training, etc. Meanwhile, the paper demonstrates weaknesses of such contracts, such as management of maintenance staff, identification of the actual
outcome of the system, and what decision should be made when the contract ends? The results also highlight opportunities that the hospital management can attain as well as a few threats that need to be addressed and mitigated. In conclusion, our results support researchers and hospital management to finalize the contract without surprises or disappointment, thereby, building a robust contract.

As conceptual research, this paper has limitations in so far as it is not justified by the analysis of empirical data. However, we have attempted to translate the concepts by demonstrating throughout the literature review and following discussion, ways in which practitioners may view the ideas proposed in a real-world context. A further study may include collecting data from hospitals who have implemented PACS using PBC, to validate the constructs summarized in Figure 2.

REFERENCES


