Use of a Wiki as a Radiology Departmental Knowledge Management System

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Information technology teams in health care are tasked with maintaining a variety of information systems with complex support requirements. In radiology, this includes picture archive and communication systems, radiology information systems, speech recognition systems, and other ancillary systems. Hospital information technology (IT) departments are required to provide 24×7 support for these mission-critical systems that directly support patient care in emergency and other critical care departments. The practical know-how to keep these systems operational and diagnose problems promptly is difficult to maintain around the clock. Specific details on infrequent failure modes or advanced troubleshooting strategies may reside with only a few senior staff members. Our goal was to reduce diagnosis and recovery times for issues with our mission-critical systems. We created a knowledge base for building and quickly disseminating technical expertise to our entire support staff. We used an open source, wiki-based, collaborative authoring system internally within our IT department to improve our ability to deliver a high level of service to our customers. In this paper, we describe our evaluation of the wiki and the ways in which we used it to organize our support knowledge. We found the wiki to be an effective tool for knowledge management and for improving our ability to provide mission-critical support for health care IT systems.

KEY WORDS: Wiki, PACS, knowledge management, informatics

BACKGROUND

Two core challenges face modern health care information technology (IT) support teams. The first is the complexity and heterogeneity of the range of technologies purchased within a facility. Each vendor's solution has a unique technology stack, including different hardware platforms, operating systems, Web software, and databases. Support for these may require different systems administration tools and specialized expertise. This

creates a challenge in covering the broad knowledge base needed to support these systems.

The second challenge is the requirement that this diverse expertise be available on a 24×7×365 basis for constant coverage. Providing mission-critical support for these systems is essential, because their continuous and appropriate functioning is viewed as critical to providing patient care in emergency, trauma, and other critical care environments¹. If the picture archiving and communication system (PACS) in radiology experiences a failure, other departments, such as emergency and surgery, are directly affected. Health care IT managers are tasked with providing support delivery organizations with expertise in all the systems that may exist in or be introduced into any given facility and to provide that support with no lapses in coverage, often with limited staffing resources.

Transferring complex, technical knowledge between team members who may have infrequent exposure to a problem or are new to an organization is a constant challenge. More tenured members of the team are often the only individuals who remember how or why an IT system was config-

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ured in a certain way. This “institutional memory” can be lost when a staff member leaves the organization or may be missing after hours, when only a single on-call person is in place to support the entire technical infrastructure. Many organizations struggle with updating and maintaining binders and other technical manuals in an effort to provide their employees with the necessary information, but these are often outdated, are time consuming to use, and fail to provide access for mobile support team members who may be on call at home or away from the hospital.

THE IMPORTANCE OF COMMUNICATION TOOLS FOR RADIOLOGY IT

Regardless of the size of a technical support team, communication is critical to prevention, early diagnosis, and quick recovery of systems problems, whether large or small. For many organizations, communication of best practices has historically been based on word-of-mouth or paper-based methodologies. Providing a strategy to effectively transfer this body of knowledge is key to the success of a technical support team². With the variety and sophistication of online tools now available, the use of a paper-based system for support communication is antiquated. The vast majority of technical support professionals are comfortable with digital communication methods such as email and instant messaging. These forms of electronic communication provide adequate, real-time interaction between individuals but often cannot address the variety of issues that may occur or cannot access a history or record of ways in which similar problems were solved in the past. Modern technical support teams have grown increasingly reliant on collaborative tools to share information³ and archive the technical memory of their projects, support strategies, and technical configurations. At our large, tertiary care teaching hospital and satellite facilities, we chose a novel wiki approach to manage this critical knowledge and deliver information as quickly as possible to the IT team members who need it most in addressing systems failures and other problems.

WHAT IS A WIKI?

A wiki is a Web-based, open source knowledge management tool that allows for a collaborative authoring environment⁴. The word wiki comes from the Hawaiian word for fast⁵. This tool requires no detailed technical knowledge of complex Web programming techniques for users who wish to post information to the Web site. It provides an easy-to-edit site and tracks changes through a history function.

The goal of our wiki is to provide an easy way to view and contribute to the historical technical memory of the team, enabling staff members to build and update their own online documentation in a real-time manner. Our goal in implementing the tool was to improve the efficiency of staffing resources by leveraging social networking and knowledge management technologies to provide round-the-clock expertise to our team members.

METHODS

We installed the freely available MediaWiki⁶ software with the Gentoo Linux operating system⁷ and an open source database, MySQL⁸. The Web server software used was Apache⁹ with Hypertext Preprocessor (PHP)¹⁰ installed. The software package for phpMyAdmin¹¹ was installed as an additional tool to help administer the database. The hardware platform used was an HP DL380 G5 Server (Hewlett Packard; Palo Alto, CA, USA).

Our structure for the wiki is based on the following top level hierarchy (Fig. 1). Additional subcategories are created on an ad hoc basis as needed by support team members to complete the knowledge repository.

- *Mission Statement*: This section contains our team mission statement, providing an overview for new team members and a reminder for existing team members about the purpose of our organization.
- *Team Information*: This section contains information on staffing structure, such as roles, responsibilities, and the team calendar. Additional information, such as meeting schedules and minutes, is also posted in this section.

Fig 1. Opening page of the Radiology IT wiki showing organizational structure.

- *Contact Information:* This section provides detailed contact information for team members, hospital support staff, and vendors. This section also includes home contact information for team members. This information is constantly updated by team members, ensuring that the contact list stays current.

This section also contains detailed information for the team's customers, most importantly radiologists working at home or from remote sites, with specific information related to their technical configurations and home networks. Having ready access to customer information such as details about specific home user firewalls or other relevant

data tied directly to the user provides significant benefits to the support team.

- *Support Information:* This section of the wiki contains the majority of the support documentation for the department. Each system supported by the team is listed with specific decision support information for each vendor and system type. In addition, an overview of the system architecture (if known), departmental workflow descriptions, and troubleshooting information is included for each system.

For some systems, decision support trees were created to help support personnel in the problem

resolution process (see Fig. 2). These support trees have the most benefits for systems with a high degree of complexity but are also beneficial for systems with infrequent support requirements. These decision support trees provide a well-defined troubleshooting path based upon the collective experience of the team. Escalation plans are also included as part of the support trees, so that staff members can quickly identify the point at which they exceed their own levels of expertise and should engage more specialized technical support team members or vendors. Having these support steps clearly spelled out can minimize the amount of time spent with unnecessary troubleshooting, help teams engage the appropriate support resources more quickly, and reduce the

overall time for issue resolution. This section also contains forms, such as confidentiality agreements and user account forms, for easy access to be e-mailed or faxed to end-users.

- *System Administration:* This section contains detailed “cookbooks” on regular maintenance required to keep the systems running on an ongoing basis. Included here is patch management information as well as back-up schedules and tape rotation information. In addition, detailed configuration information for scripts for UNIX and Linux systems are included. In many departments, these scripts are often lost during system upgrades or during total system failures. Having a central,

Fig 2. A view of a decision support tree, providing team members with a troubleshooting flow chart.

online repository of maintenance scripts is essential to providing continuity of service after such events so that performance and maintenance can be maintained at pre-event levels.

This section also contains a repository for our post incident review documentation. These documents were created as part of our root cause analysis policy, providing a history of downtimes and actions taken to improve our processes. Providing a repository of these events is useful as an organizational memory tool. Staff members can review downtimes from past events and understand the risks involved historically in making system changes.

- *New Projects and Development:* This section contains a list by year of new projects that are underway. Included in this section are meeting minutes and configuration information as well as vendor-provided schematics and documentation. As new projects are completed, the documentation is migrated to the "Support information" section of the site.
- *PC Support Information:* This section includes information specifically for supporting the department's microcomputers. Included in this section is information about naming conventions, patch levels, supported software, and hardware platforms. This section also contains detailed how-to guidelines on reloading system images to microcomputers, providing essential details on locations and versions of currently supported configurations.
- *Reports:* This section contains reports for customers as well as administrators on the performance of the team. Reports can be shared with customers on support effort, and the performance of the team over time can be evaluated and compared.
- *Policies and Procedures:* This area contains a listing for all policies and procedures specific to the radiology IT team. Included here are policies ensuring that the team and systems are running according to plan. Specific items include policies for change management, Health Insurance Portability and Accountability Act risk assessments, business continuity, and disaster recovery as well as links to our department-wide standard operating procedures manual.

- *Telephone Support:* This section provides specific troubleshooting information related to telephones and telephone support.
- *General Help:* This generic "how to" section for editing and adding wiki pages was most frequently accessed by new team members who were seeking help in contributing to the site by creating their own wiki pages.

Password-protected user accounts were created for the Radiology IT support team members to protect sensitive configuration and security information. Initially, only Radiology IT team support members had access to the system; however, over time, access was extended to management and other departmental staff. The server is installed in our hospital data center and is accessible to all team members, regardless of location in the medical system network. Remote access to the website was facilitated through the use of a Virtual Private Network system provided by Juniper Networks (Sunnyvale, CA, USA).

RESULTS

The wiki tool met with high adoption rates when used as a knowledge management system for radiology IT support teams. Twelve staff members registered to use the site, creating 248 pages of content. In an 18-month time frame, the site recorded 20,647 page views and 5,138 page edits, with an average of 2.35 edits per page and 4.02 views per edit. In addition, the following benefits were realized:

- Centralized knowledge management for supporting the wide variety of systems in our technical environment. The system allowed team members to edit current information and contribute their own information, thereby facilitating constant and easy updating of all support documentation.
- A method for creating and displaying decision support trees (Fig. 2), combined with vendor and user contact information, that was accessible for team members, whether inside the enterprise or outside and on call after hours.
- A repository for escalation plans based on known system issues to ensure that staff with appropriate training and backgrounds could be engaged in a timely manner based upon any

Fig 3. Basic editing of a wiki page, showing the Mediwiki page editor.

particular downtime scenario. This allows team members to act consistently for either planned or emergent downtime service.

- A central location for policies and procedures with version histories, so that team members can respond in a consistent way based upon a well-codified organizational strategy.

Each member of the Radiology IT support team spent an average of 1 h/week updating, editing, and contributing to the wiki and an average of 5 h/week using the wiki to address issues. In an email-based survey, team members reported their

time of day utilization breakdown as 45% during normal business hours (08:00–16:59) and 55% after normal business hours (17:00–07:59). The breakdown of content by category (based on numbers of Web pages) was: 50% support information, 16% PC support, 16% system administration, 12% contact information, 4% policies/procedures, and 2% related to image management.

DISCUSSION

The wiki provided an acceptable repository for all support technical information and was used

Fig 4. Final version view of basic configuration page after editing is completed.

frequently by the team as a knowledge management system. We found that its flexibility allowed us to use it as both a support tool and a learning tool.

Providing a knowledge management strategy is a core component in building and sustaining an organization's institutional memory, and can be a strategic advantage in industries that rely heavily on knowledge workers¹². The work product of

knowledge workers is often intangible, and can be lost as teams and team members change. Many organizations struggle to remember why decisions were made or how projects were completed in the past, and in the process, often lose the recipe for strategic advantages. Creating a system to both retain this knowledge and effectively mine the institutional memory of an organization can help reduce the loss of strategic information as well as

Fig 5. Historical view of web pages, allowing users to compare versions and track changes.

prevent groups from having to rediscover lost methodologies.

An essential component of a successful knowledge management system is updated content, requiring the team to consistently edit and update the system with the most current information available. Without current, relevant content, a knowledge management system can become stale and outdated, providing little value to team mem-

bers. Our wiki system was easy for all team members to edit using basic built-in tools (Fig. 3) that provided immediately viewable technical information (Fig. 4). By removing the technical requirement for Web development expertise and by providing access to the entire team, our staff was able to easily add content and keep the tool relevant.

The ability to view the history of changes was particularly important, because it gave the team the

ability to track changes over time (Fig. 5). Our wiki was accessed more than 20,000 times in the most recent 18-month period. With a team of 12 individual members, this translates into 90 page views per month per team member or about three views per day. By providing historical page views, the wiki allowed the team to keep track of the history of changes for particular topics over time, allowing them to revert to a previous revision if data was inaccurately entered or needed to be retrieved for troubleshooting.

When assessing use of the wiki over the same 18-month period, we found that the site was accessed more frequently after hours than during normal business hours. This pattern of utilization suggests the value of the tool for those team members working alone or in an on-call capacity. The "Search" functionality built into the website allows users of the site to easily sift through a mountain of information to get instant access to the relevant support documentation. Support staff without direct access to other support team members (normally available during business hours) were more reliant on the wiki to retrieve information in their efforts to support clinical customers.

One barrier faced by many organizations is the cost of implementing a new knowledge management system. In leveraging open source tools for the operating system, database, and knowledge management components of our system, we were able to provide world-class functionality for the price of an off-the-shelf server. Although some initial technical expertise was required to configure the operating system, database, and wiki software, little-to-no Web development expertise was required to edit or add pages. Implemented with minimal hardware costs and using expertise found in most health care organizations, this configuration has been extremely cost effective.

Our future plans for this tool are to extend its deployment throughout the department. Technologists have expressed interest in storing protocol information in an online website for consistency across the department, with the historical features of the website providing discussion points on how protocols have changed over time. While radiologists in our department are not directly using the wiki today, we believe that its success as a tool for technical support team members suggests the benefits to radiologists as well.

CONCLUSION

Effective knowledge management is key to the strategic success of technical organizations¹³ and can often provide the edge in supporting systems in use in mission-critical, clinical environments. A wiki can be an effective tool for technology organizations facing the challenge of supporting the myriad of systems present in most health care environments. Knowledge management systems provide a useful repository for support information, allowing the comprehensive technical memory of support organizations to "live on" through staffing and systems changes.

By providing real-time access to the most current technical information, this knowledge management system provided our team members with an efficient tool to effectively troubleshoot and resolve systems support issues for our clinical customers.

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