

Developing a Web-Based Knowledge Product Outsourcing System at a University

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Abstract—The availability of technology and the abundance of experts in universities create an ample opportunity to provide a venue that allows a knowledge seeker to easily connect with and request advice from university experts. On the other hand, outsourcing provides opportunities and remains one of the emerging trends in organizations, and can very clearly observed in the Philippines. This paper describes the development of a reliable web-based approach to Knowledge Product Outsourcing (KPO) services in the Silliman Online University Learning system. The system is called an “e-Knowledge Box.” It integrates Web 2.0 technologies and mechanisms, such as instant messaging, private messaging, document forwarding, video conferencing, online payments, net meetings, and social collaboration together into one system. Among the tools used are WAMP Server 2.0, PHP, BlabIM, Wordpress 3.0, Video Whisper, Red5, Adobe Dreamweaver CS4, and Virtual Box. The proposed system is integrated with the search engine in URLs, Web feeds, email links, social bookmarking, search engine sitemaps, and Web Analytics Direct Visitor Reports. The site demonstrates great web usability and has an excellent rating in functionality, language and content, online help and user guides, system and user feedback, consistency, and architectural and visual clarity. Likewise, the site was was rated as being very good for the following items: navigation navigation, user control, and error prevention and correction.

Keywords—Knowledge Product Outsourcing, Knowledge Management, Web 2.0, IT in Education

1. INTRODUCTION AND MOTIVATION

Outsourcing refers to the contracting out of services or products to external providers and is usually considered for varying purposes, such as to lower costs or to take advantage of external expertise [1]. Outsourcing remains one of the emerging trends in organizations, and can very clearly observed in the Philippines as the number of Business Process Outsourcing (BPO) companies continues to rise. This trend is will continue to grow as organizations shift business strategies and opt to utilize external resources to achieve a business function [2]. One of these external resources includes knowledge products, which is the product or a creation resulting from the expertise, experience, and skills of knowledge provider in a particular knowledge field.

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Knowledge products are often shared and exchanged in explicit form, which is expressed in words or numbers. Examples of knowledge products include research papers, essays, software, and music and lyrics. Knowledge products could be concretely illustrated as “knowledge in a box.” The outsourcing of a knowledge product is known as Knowledge Product Outsourcing (KPO), in which knowledgeable people or experts from a different company provide knowledge products, which may be in the same country or in an offshore location. This allows organizations to take advantage of expertise outside the organization, which may be costly and may take time to acquire and develop within the organization.

KPO is different from the widely known Knowledge Process Outsourcing. The former is a product-centered approach that focuses on knowledge documents, their creation, storage, and reuse in computer-based corporate memories, while the latter is a process-centered approach that mainly focuses on the social communication process of sharing and exchanging knowledge. The difference is very evident in the technologies used, as KPO focuses on technologies that enable file management, retrieval, and storage, while Knowledge Process Outsourcing focuses on using technologies that support socialization like email and instant messaging, as described in the article, “Consolidating the Product Versus Process Approaches in Knowledge Management: The Know-Net Approach.” Although this case, neither are limited in terms of technologies that can be used and they can also use overlapping technologies, as long as the main technologies used remain intact. An example of this is using email in KPO to notify a customer of the status of a requested document.

Traditionally, finding a particular knowledge expert who can provide counsel involves the tasks of locating and going to the employees who work in the knowledge area and inquiring if they can help in providing counsel. All of which are tasks that may cost time and money. An example of this is seeking legal counsel wherein one must physically go to law firms to ask if they can help provide legal counsel. Thus, it ends up costing in terms of fare and time, especially if more than one law firm is visited. Using web technology to provide ready access to the KPO system can ease the experience of organizations and employers in locating and contacting outside experts, and can ease the costs that are inherent to finding experts. Using technology in a KPO system allows a customer facing a specific problem to use mere keystrokes to post their issue, and to get advice on their issue wherever they may be in the world. This minimizes the amount of time customers spend looking for information and finding the right expert by using an integrated approach to people, process, technology, and content.

In the Silliman University Strategic Plan 2008-2016, KPO is one of the phases under the actions on eLearning. eLearning, as defined in the strategic plan, refers to the use of modern information technology to acquire and deliver learning and trade knowledge products remotely, mainly through cyberspace. The first action to build up eLearning is setting up the Silliman Online University Learning (SOUL) system. The SOUL system is designed to serve as an umbrella program to eLearning and to other related online services at the university. This involves undertaking a series of measures in three phases, the third phase focuses on expanding users and subscribers, and also the number of faculty and staff who can deliver eLearning and KPO services [3].

Aside from providing online services to customers, the KPO system also assists experts in career development, as experts are given the opportunity to exercise, utilize, and further develop their knowledge and experience. It also allows them to benefit from the supplemental income from the services rendered to the customer. With the growing trend of outsourcing, the inherent cost and challenges in finding an expert, the availability of web technologies in the university,

and the action directed by the Silliman University Strategic Plan, it was the concern of this study to develop a reliable and secure web-based KPO system, called the *e-Knowledge Box*, to respond to these opportunities, problems, and directives. The uniqueness of the *e-Knowledge Box* in Silliman University lies in the integration of Web 2.0 technologies and mechanisms such as instant messaging, net meetings, social collaboration, and online payments. All of which provide a single platform with a comprehensive set of technologies that could provide online consultancy. Another unique feature of the *e-Knowledge Box* in Silliman University is that the knowledge provider and expert registration is open only to bona fide university professionals. Thus, it ensures that the expert advice that is provided is in accordance with university quality standards. Registered experts have the opportunity to participate in providing knowledge elicitors with solutions and knowledge products, and to receive compensation in the process. Other than financial benefits, experts are able to develop and practice their respective knowledge fields.

The availability of technology and the abundance of experts in the university creates an ample opportunity to provide a venue that allows a knowledge elicitor to easily connect with and request advice from university experts. The development of the project largely focused on the outlining and defining of the set of technologies that are needed to deliver reliable and secure KPO services online. The project was aimed to provide the following features: a) to be user friendly and have a high degree of usability for all knowledge providers and elicitors; b) to have high availability, be efficient, and have a fast turnaround cycle for knowledge requests and the provision of consultations; c) to provide reliable and secured access in performing KPO services and payment systems; d) for the search engine to be optimized in its URLs and architecture; and, e) to have on-site web analytics that will measure a user's activity. It encompassed the evaluation of these technologies in terms of effectiveness and performance in providing a KPO. The project locale is Silliman University, which, as of this writing, has substantial knowledge resources for investigation and has the adequate technological resources to implement the development of the project. The development of the *e-Knowledge Box* mainly comprises the creation of a knowledge repository and its support functions. The function of the *e-Knowledge Box* revolved around enabling customers to have access to Silliman University professionals and in allowing the exchange of knowledge products and payments.

Figure 1 shows the overview of the KPO processes. KPO system development focuses on the interaction and communication of knowledge requests from the elicitors to the knowledge experts using the Internet to connect to the *e-Knowledge Box* as a communication channel. The main flow of the KPO process begins with knowledge elicitors, which include but are not limited to, small and medium enterprises or local government units who post their knowledge request via the *e-Knowledge Box*. The request is received and viewed by various knowledge experts who have experience in the knowledge field where the request belongs. Experts then communicate with the elicitors and post their solutions as knowledge products in the *e-Knowledge Box*. The knowledge elicitors then download these outsourced knowledge products.

This paper discusses the design of a reliable web-based approach to KPO services in Silliman University. It specifically describes the development, implementation, testing, and evaluation of the significant features in the KPO system. The system is called an *e-Knowledge Box*, which represents an electronic and an online repository of knowledge in the university. This paper presents the implementation of Search Engine Optimization and Web analytics in the *e-Knowledge Box* in Silliman University. Furthermore, this paper shows the result of the testing and evaluation of the proposed system.

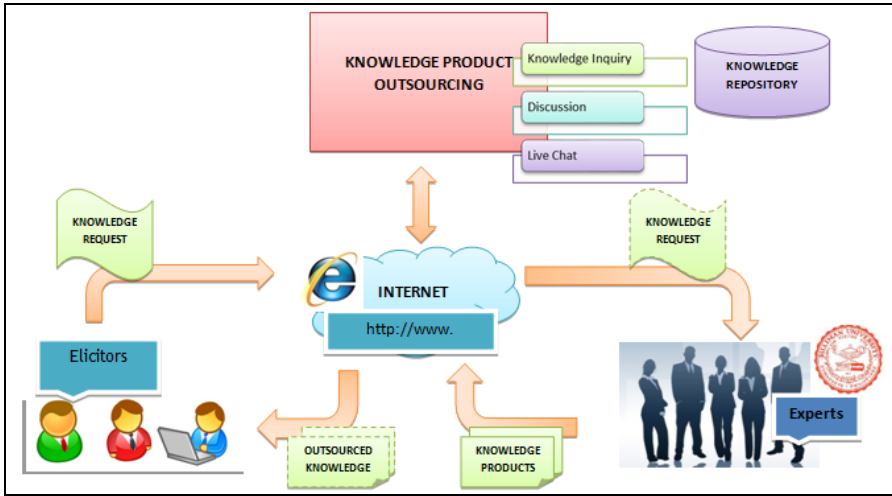


Fig. 1. The KPO Process Model

2. SIGNIFICANCE OF THIS STUDY

The study and development of a web-based Knowledge Product Outsourcing system offers significant value and benefits. It offers a learning paradigm for institutions to provide an accessible source of experts to elicitors of knowledge and to enhance the experts' knowledge and skills using web technologies and sciences. The research about KPO for Silliman University helps to define and promote Knowledge Product Outsourcing as a new approach in acquiring and delivering learning (eLearning). The research promotes the university as the initiator of such an approach. The research and application of KPO also established that existing open-source web technologies and sciences could be organized and utilized to deliver reliable and secure KPO services. Under the SOUL system, the development of a KPO using web technology provides a ready access in delivering knowledge products for society, specifically for small to medium enterprises and local government units that wish to seek professional consultation online. It enabled Silliman University to continue to grow and provide better services for its employees, as well as offer a new service to a new type of clientele – the knowledge elicitors. The development of a Knowledge Product Outsourcing system established KPO as a viable solution that could provide online consultation. The uniqueness of the KPO in Silliman University lay in the integration of Web 2.0 technologies and mechanisms, which provides a single platform with a comprehensive set of technologies that provides online consultancy. Another unique feature of the KPO in Silliman University is that the knowledge provider and expert registration were open only to bona fide university professionals thus, ensuring that the expert advice provided is in accordance with university quality standards.

3. RELATED SYSTEMS

A knowledge base is a centralized repository for information. It is a database of related information about a particular subject that provides the means for the computerized collection, organ-

ization, and retrieval of knowledge. A knowledge base is usually a collection of information regarding related experiences with a certain problem, and the solutions taken to tackle the problem. In a knowledge-base, subjects or knowledge are carefully categorized and organized to allow for the quick and easy collection, organization, retrieval, and searching for information. *Experts Exchange* (www.experts-exchange.com) is a related knowledge-based website with experts from around the globe providing online consultancy through Q&A forums. The system allows people to submit technological problems or queries they might be facing, and waits for posts from experts. Solutions to previously solved problems are readily available for public viewing, which is the same with the *e-Knowledge Box*. Similarly, *Yahoo! Answers* (formerly Yahoo! Q&A) is a community-driven question-and-answer site that was launched by *Yahoo!* on July 5, 2005. It allows users to both submit questions to be answered and to answer questions asked by other users. The system saves all the questions and answers for other users to reference. Likewise, *Ask Me Helpdesk* (www.askmehelpdesk.com) is a similar question-and-answer site that allows users to submit general questions and waits for answers from other users.

On the other hand, the trend towards outsourcing, which is often due to reasons such as to lower costs and employing workers where labor is cheaper, has encouraged the growth of various online outsourcing services that have been designed to create a marketplace in which workers and potential employers can connect. Outsourcing services systems allow employers to post jobs and select the best candidates to perform the job. These systems also allow employers and workers to interact via Web chat and messaging, and they provide the means for files to be shared across the Internet.

Among the popular outsourcing services website that is related to this study is *Odeskisone* (www.odesk.com). It is a global job marketplace that provides a series of tools that are targeted at businesses that intend to hire and manage off-site workers. *Odesk*, like the proposed *e-Knowledge Box* in the university, allows for the posting of job requests. However, the difference is, is that *Odesk* is open to any business posting a job requests that could be answered by job seekers. The proposed *e-Knowledge Box* is open only to bona fide faculty and staff in the university. Another similar and related outsourcing services website is *vWorker* (vworker.org). It allows employers to post various freelance jobs on the site to be bid on by workers. In our proposed KPO, bidding will not take place, because the system will offer the automatic matching of requests from knowledge seekers and the expertise of knowledge providers. *Freelancer.com* is another related system that provides an online job marketplace for freelance workers from around the world. It utilizes the Web to deliver solutions for employers and employees to meet and exchange services and payment. *Elance* (www.elance.com), which is a similar website, allows businesses to post a project and to assess providers who are bidding on the project by reviewing their qualifications, ratings, portfolios, and skill test scores. Once a provider is selected, the employer can then manage people and projects in manner that is similar to the proposed KPO in the university. Moreover, *Guru.com* is another freelance marketplace and expert locator site. It allows companies to find freelance workers for commissioned work. It offers discussion services to allow the generation of solutions from experts in a manner that is similar to the proposed KPO in the university. For financial transactions, it utilizes *Safepay* (www.safepaysolutions.com) and *Escrow* (www.escrow.com) to allow companies to pay workers online.

An essential feature in outsourcing services is the online payment that accesses payment gateways. This allows employers to pay for rendered services and products for workers online. This is usually done through payment gateways like *Paypal* and *PesoPay*. Online payment refers to

the service that manages the transfer of funds from a customer to the merchant of an e-commerce website. The money may come from a digital wallet inside the user's machine, from a credit card stored on a server of the digital wallet service, or from a prepaid account stored in the payment service's server. To ensure security for online payments, the necessary physical infrastructure measures are put in place. These include things such as firewalls and Virtual Private Network technology, which are used to protect the e-commerce website and the payment gateway service. For the security of transactions, online payments use identification and authentication, encryption, and authentication techniques. Payment gateways protect transaction details by encrypting sensitive information, such as credit card numbers, to ensure that information is passed securely between the customer and the merchant and also between the merchant and the payment processor. Encryption is usually provided through the network protocol, Hypertext Transfer Protocol Secure, which handles encrypted communication and secure identification over a network Web server. In the proposed *e-Knowledge Box*, financial transactions from experts to elicitors will be processed by the system through the payment gateway, *PayPal*. Transactions will be securely tracked and recorded by the system.

4. METHODOLOGY, APPROACHES, AND TOOLS

The project was primarily aimed at defining a pragmatic model that could be quickly understood and emulated in similar institutions. Thus, it is imperative that the technologies used in the KPO be readily available and accessible, in addition to being reliable and providing good performance. The selection process and assessment in defining the KPO technologies that should be used involved several factors that were related to determining the appropriateness of different open source technologies. In the project, the Open Source Maturity Model (OSMM) [4] was used to define the set technologies in the development of the *e-Knowledge Box*. OSMM is a framework that has been developed to help in IT assessment and the selection of open source software. This helped to determine the appropriateness of particular software technologies in specific situations (i.e., in this case, the development KPO services). Several criteria areas were considered in the selection of the software. These included the technology's reputation, support, and documentation; and to the skill set of the user in implementing the technology, and the project development model that the technology adheres to.

In the developmental phase of the system, the Rapid Application Development (RAD) model was used to develop the online KPO services. RAD was the most practical approach since the actual research and development occurred almost at the same time, and it allowed for faster development especially for project with a tight target schedule [3] [5]. In designing an online KPO system, many available technologies, as well as combinations of these technologies, could be used. Although such is the case in this proposed system, the tools and technologies used during the development of the system were limited to the technologies that were more available and accessible, as determined by the selection process that used that used OSMM. The accessibility of technologies used in the development and implementation of the system was very much emphasized, as the project aimed to provide a paradigm for others to use and follow. Specifically, the development utilized the following set of technologies:

OS Platform – Windows XP was used as a sample to host the Web application (Linux, Mac OSx could also have been used).

WAMP Server 2.0– this is a Web server package that contains the Web server Apache, which was used to interpret PHP files and the MySQL database.

PHP – these are the dynamic webpages that provide the interface and functions to the user.

BlabIM – this is a Web instant messaging client that allows users on the site to deliver real time text messages.

Wordpress 3.0 – this is a content management system that allows users to post content on a website.

Video Whisper – this is a live video and audio chat client that allows users to interact through Web video.

Red5 – this is a flash media server that hosts flash applications and serves as a hub that connects these flash applications using Real Time Messaging Protocols (RTMPs). The server can send and receive data to and from the connected users with a live Web FLV player installed in the said server.

Adobe Dreamweaver CS4 – this was used as the tool to create and update webpages that contain the core functions used in the KPO.

Virtual Box – this was used as a tool to create and manage virtual servers that host the website and conferencing services.

5. THE E-KNOWLEDGE BOX AND ITS FEATURES

The KPO system in Silliman University integrates Web 2.0 technologies and mechanisms, such as instant messaging, net meetings, and social collaboration. It provides a single platform with a more comprehensive set of technologies that provide online consultations (instant messaging + private messaging + document forwarding + video conferencing + online payment). Having a single platform to perform online consultations without needing to open a separate program for each service provides for a more productive and efficient environment. Another unique feature of the KPO in Silliman University is that the knowledge provider and expert registration is open only to bona fide university professionals. Thus, it ensures that expert advice is in accordance with university standards. Expert registration is simple and effortless. It allows the forwarding of an existing employee profile with the click of a button, which consequently eliminates the need and hassle of re-encoding the same profile. This is done by using the existing MySilliman system, which is Silliman University's enterprise portal (<http://livecomm.su.edu.ph/mysilliman/index2.aspx>), as the platform for employees to opt to forward their employee information to the KPO. The succeeding sub-sections are the features of the *e-Knowledge Box*.

5.1 Net meetings and interaction applications

The *e-Knowledge Box* provides an enhanced and innovative knowledge service to anyone seeking professional counsel and support. Using communication tools to provide real-time online interaction, it supports the exchange of instructions and knowledge products between experts and knowledge elicitors, and facilitates agreements. Screenshots of this feature can be seen in Figures 2 and 3.

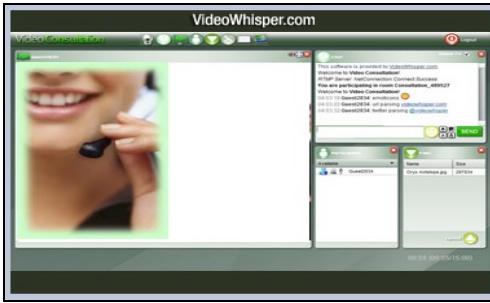


Fig. 2. Net Meeting Feature – Video Conference

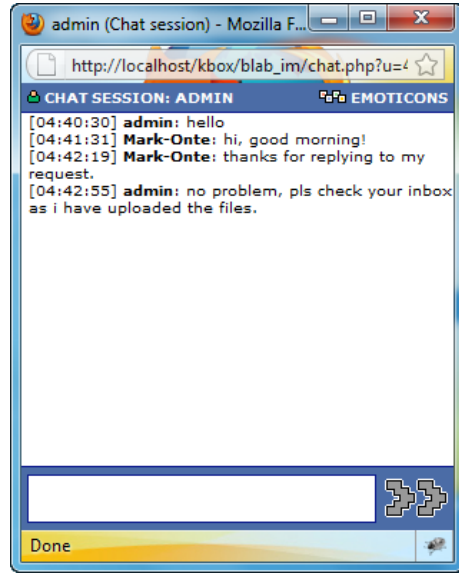


Fig. 3. Net Meeting Feature – Instant Messaging

5.2 Online private messaging

By using the communication tools, the *e-Knowledge Box* allows for experts and knowledge elicitors to interact, even if one of them is offline. This further facilitates and hastens every agreement. Figure 4 is a screenshot of this feature.

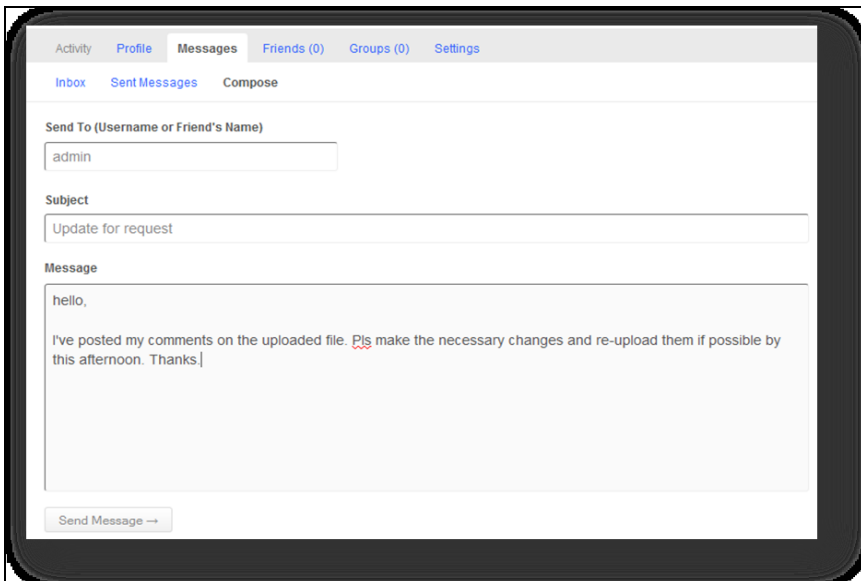


Fig. 4. Online Private Messaging Feature

5.3 Knowledge exchange and sharing

The *e-Knowledge Box* provides professional consultancy services to the community. Experts are able to upload their knowledge products for the respective elicitor to download. The download is to be restricted and to only be made available as a link to the appropriate elicitor. As an alternative, experts and elicitors can use the project thread function of the site to send documents directly in the form of attachments. A screenshot of this feature is shown in Figure 5.



Fig. 5. Knowledge Exchange and Sharing Feature

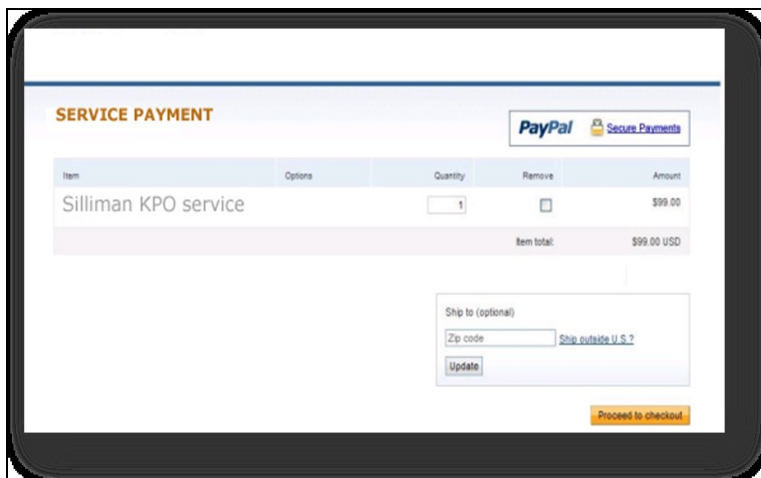


Fig. 6. Payment Gateway Feature

5.4 Payment

The *e-Knowledge Box* allows customers access to a payment gateway, which facilitates the trade of knowledge products and payments (see Figure 6). Financial transactions from experts to elicitors will be processed by the system, and transaction details will be forwarded to the payment gateway, *Paypal*, where the transaction can be completed. Transactions will be tracked and recorded by the system to provide customers with a history of transactions.

6. SEARCH ENGINE OPTIMIZATION IMPLEMENTATION

In the effort to improve the application visibility in the Internet, Search Engine Optimization (SEO) is used. A Search Engine is a system that is designed to search for information on the World Wide Web servers. The search results are generally presented with a list of results and are often called “hits.” SEO is the process of improving the visibility of a website or a webpage in search engines through the optimization of a website’s content and HTML, as well as its associated coding to increase its relevance to specific keywords and to remove barriers to the indexing activities of search engines. This includes the usage of standard tags in coding and avoiding deprecated tags, creating accessible menus, and other elements that have been indexed for the purpose of making it easier for a search engine to find and categorize search results. SEO is one of the widely used techniques that provides websites fast reachable results. [6]. SEO leads to the increase in the website’s online visibility, which allows it to be listed consistently as one of the top sites during related searches in search engines like *Yahoo!* and *Google*. This ability leads to more traffic on the site and increases the number of potential customers. The SEO architecture that is implemented in the system is discussed in the following sub-sections.

6.1 Search Engine URLs

Having Search Engine (SE) friendly URLs increases the likelihood of links on the website or the website itself being visited. Search Engine recommends placing relevant keywords in URLs. The rationale behind this is that search engine can easily search for keywords based on the URL and can rank your site with other relevant websites. The other purpose is that keyword-based URLs, such as URLs with “prod/laptop/cat/technology,” are easier to remember than URLs with ambiguous values such as URLs with “?product=1&cat=78”. In the *e-Knowledge Box*, all URLs are coded to show relevant keywords. Sample URLs include: <http://kbox.su.edu.ph/about>, <http://kbox.su.edu.ph/requests>, <http://kbox.su.edu.ph/category/computing-and-technology/>, and <http://kbox.su.edu.ph/experts>.

All URLs contain hints and offer suggestions about the content of the webpage. SE friendly URLs are achieved using the `mod_rewrite` function of PHP. By using regular expressions, `mod_rewrite` can break the SE friendly URL into separate values and can redirect the user to the correct file in the server. Using the example above, the URL “<http://kbox.su.edu.ph/category/computing-and-technology/>” is broken down, taking the keywords “category and “computing-and-technology” and redirecting the user to the category page with computing and technology as the current category, which exists at “<http://kbox.su.edu.ph/wp-content/themes/kbox/single.php?cat=computing%20and%20technology>”. Figure 7 is the screenshot of the SEO URL of *e-Knowledge Box*.

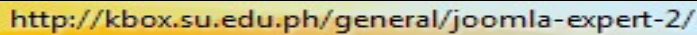




Fig. 7. SEO Features – SEO URLs

6.2 Web Feeds

In the new age of websites, contents could be used and shared using Web feeds. Web feeds are mechanisms that distribute content over the Web, using an XML format. By using Web feeds, visitors to a site can use the content of the site and distribute it to another site (i.e., their blog page). This is entirely different from just copy-and-pasting content over to another site, as Web feeds are dynamic and its content changes as the original content changes, which allows a visitor to have an updated copy of the content all the time. By allowing content to be available on other websites, Web feeds allow a website to be freely marketed on other websites, which thus increases a website’s visibility on the Internet. In the *e-Knowledge Box*, RSS (Really Simple Syndication) is used to provide users with Web feeds. The content available for Web feeds include announcements and requests, which are available by clicking on the RSS icon (“

6.3 Email Links

Email Bookmarking is another way to increase Web visibility. It allows users to directly email a link to friends of the content that they like without having to copy and paste the link from the browser to an email program. Email Bookmarking is used on a site via the email link (Figure 8) icon (“

6.4 Social Bookmarking



Social bookmarking is similar to Web feeds in the way that they both distribute dynamic content from a content website to another website. The main difference is that Social Bookmarking shares content to a social networking site. In the *e-Knowledge Box*, Social Bookmarking is used to allow visitors to distribute and share the content they like to Digg, Facebook, and Twitter by clicking the Social Bookmarking icons (“


Fig. 8. SEO features, Web feeds, email link, and RSS

6.5 Search Engine Sitemaps

Search Engines use Sitemaps to facilitate their scanning of a website and its navigational characteristics and structure. On the site, Google Sitemaps, which is the XML-based standard format specified by Google, is used to map and provide the XML equivalent of the website’s structure.

7. THE IMPLEMENTATION OF WEB ANALYTICS

One of the techniques in measuring and monitoring the performance of a website is Web analytics. It deals with the measurement, collection, analysis, and reporting of Internet data for the purposes of understanding and optimizing Web usage [7]. Web analytics is not just a tool for measuring website traffic. It can be used as a tool for business research and market research. Web analytics provides data on the number of visitors, page views, and the like to gauge the traffic and popularity trends of the searched information. On-site Web analytics tracks a visitor's journey in the website. On-site Web analytics measures the performance of your website in a commercial context. This data is typically compared against key performance indicators for performance and is used to improve a website or audience response to a marketing campaign.

In the *e-Knowledge Box*, On-site Web analytics is used to help monitor visitors and users. By using the Web Analytics Direct Visitor Reports, the length of the visitor's stay, and frequency of the visitor's visit in the website are determined. Using the Web Analytics Direct Visitor Reports, the location of the visitor is also determined. Keyword searches, and how they came to be on the website (referrer pages, search engines, etc.) would also be tracked. This would determine what websites are effective in increasing the visibility of the *e-Knowledge Box* website. It is also used to determine how many visitors visit the website daily. Using Web analytics in the *e-Knowledge Box* helps optimize the website's services. Using the information provided regarding the actions of visitors or users, one is able to act accordingly in order to optimize their website. Pages that have low visits would possibly need some changes, and pages that have high visits would be inspected for the aspects of the website that may appeal more to users, so that it could be emulated in other pages.

8. TESTING AND SYSTEM EVALUATION

8.1 Web Accessibility

WAVE (<http://wave.webaim.org/>) is a free Web accessibility evaluation tool provided by WebAIM (Web Accessibility In Mind). It is used to aid humans in the Web accessibility evaluation process. Rather than providing a complex technical report, WAVE shows the original webpage with embedded icons and indicators that reveal the accessibility of that page. The tool works by scanning the website that has been specified by the user, which in this case is "kbox.su.edu.ph". It examines the syntax and structure of the website and determines if the code follows Web accessibility guidelines. Figure 8 shows the actual result of the Web Accessibility Scan. As shown, the *e-Knowledge Box* has no accessibility errors.

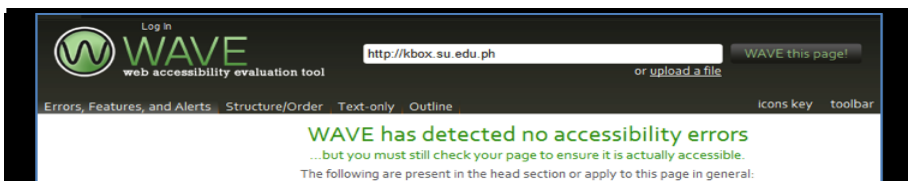


Fig. 9. Web Accessibility Scan Result

8.2 Reliability Testing

The frequency of errors in an application log is the tool that is used in evaluating the reliability of the system. Reliability is the ability of a system or component to perform its required functions under the stated conditions for a specified period of time [8]. It is measured in this case as the failure rate, which is the frequency with which the system or reports fail. It is expressed in failures per hour. Failures include errors and breaks in the application that would prevent the user from proceeding further. Errors in the website are constantly logged in the Apache Web Server error log. A zero failure rate within the system’s operating time during testing would deem the system to be “reliable.” The log is based on records from April 7-11, 2011. The log shows zero errors during this period. Thus, it is deemed to be “reliable.” Figure 10 is the sample of the actual Web Server Apache Error Log for the testing that was done on April 7.

```
[Thu Apr 07 08:05:38 2011] [notice] Parent: Received shutdown signal -- Shutting down the server.
[Thu Apr 07 08:05:38 2011] [notice] Child 3924: Exit event signaled. Child process is ending.
[Thu Apr 07 08:05:39 2011] [notice] Child 3924: Released the start mutex
[Thu Apr 07 08:05:40 2011] [notice] Child 3924: All worker threads have exited.
[Thu Apr 07 08:05:40 2011] [notice] Child 3924: Child process is exiting
[Thu Apr 07 08:05:40 2011] [notice] Parent: Child process exited successfully.
[Thu Apr 07 08:05:42 2011] [notice] Apache/2.2.11 (Win32) PHP/5.3.0 configured -- resuming normal operations
[Thu Apr 07 08:05:42 2011] [notice] Server built: Dec 10 2008 00:10:06
[Thu Apr 07 08:05:42 2011] [notice] Parent: Created child process 3040
[Thu Apr 07 08:05:42 2011] [notice] Child 3040: Child process is running
[Thu Apr 07 08:05:42 2011] [notice] Child 3040: Acquired the start mutex.
[Thu Apr 07 08:05:42 2011] [notice] Child 3040: Starting 64 worker threads.
[Thu Apr 07 08:05:42 2011] [notice] Child 3040: Starting thread to listen on port 80.
[Thu Apr 07 14:24:31 2011] [notice] PHP Notice: Assigning the return value of new by reference is deprecated in wp-settings.php on line 219
[Thu Apr 07 14:25:51 2011] [notice] PHP Notice: Assigning the return value of new by reference is deprecated in wp-settings.php on line 204
```

Fig. 10. Web Server Apache Error Log

8.3 Security Testing

The tool used in evaluating the security of the system is the ZerodayScan Web Security Scanner Tool. ZeroDayScan is an online Web security scanner. Webmasters and security experts use it to validate the security of their websites. The actual scan of the site started on March 14, 2011 at 11 a.m. (Philippines time) and ended at 6 p.m., after which a security assessment report was received via email. In the report, 0 high severity vulnerabilities, 13 medium security vulnerabilities, and 3 low security vulnerabilities were detected. The medium security vulnerabilities were found to be false positives that were related to potential SQL injection attacks. SQL injection is a technique of inserting or injecting malicious SQL statements into a SQL process statement, which would, therefore, make the vulnerability present on the database layer. This usually occurs through the submission of user-inputted data like the ones inputted in login forms. Figure 10 is a screenshot of the actual result.

In the *e-Knowledge Box*, user inputs like, “signup name,” are accepted and concatenated with pre-made statements to form the complete SQL statements that are needed to process several functions in the website. The threat of SQL injection is eliminated using a simple function that the developers of PHP made especially for SQL injections, which is the `mysql_real_escape_string()` function. This function prevents malicious user-injected SQL statements by escaping from or commenting on the injected statements, which prevents the execution of the injected state-

ments. Furthermore, the low security vulnerabilities are due to the display of user emails on the profile pages of users. This has been remedied by hiding the emails on the profile page. Thus, it is no longer an issue. The connection errors can be attributed to the loss of Internet due to maintenance and the reinitializing of the router to re-establish Internet connection.



Summary

Site	kbox.su.edu.ph
Start date	2011-03-13 23:51:10
Scan duration	06:10:19
IP	203.177.186.214
Server	Apache/2.2.11
Powered-By	PHP/5.3.0
No. of Low severity vulnerabilities	3
No. of Medium severity vulnerabilities	13
No. of High severity vulnerabilities	0
No. of Critical severity vulnerabilities	0
No. of URLs scanned	2954
No. of Tests done	6633
Connection errors	1515

Fig. 11. Web Security Scan Result

8.4 Web Usability Testing

In determining the effectiveness of the *e-Knowledge Box* as an application, Usability Testing was used. Usability Testing is a technique that is used to evaluate a product by testing it with representative users. Usability, in general, refers to everything having to do with "ease of use". Several methods exist in determining the application's usability, one of which involves letting users try to complete typical tasks that are related to the system, like posting requests, and filling out a questionnaire that rates aspects of the system. The data gathered on the questionnaire points out the following: usability problems, participants' performance of the task, and participant's satisfaction with the product.

The aspects of Web usability and accessibility were evaluated using a Web Usability Survey and Web Accessibility Tool, respectively. The Web Usability Survey was adopted from the *Usability Guidelines* that were developed by the MIT Information Services and Technology Department. It consists of questions that rate the website's aspects of navigation, functionality, user control, language and content, online help and user guides, system and user feedback, consistency, error prevention and correction, and architectural and visual clarity. The respondents consisted of a mixture of technical and non-technical individuals that visited and used the site. They went through several scenarios such as registering, creating a new request, and applying for a request. After using the site, the individuals were asked to fill out an online survey. Site evaluation ran from March to April 2011, with the bulk of the evaluations being done on April 7, 8, and 11 during a demonstration and training session. All in all there were 67 respondents, 47 experts, and 20 elicitors. The experts were Silliman faculty and staff from the different colleges and served as the experts from various fields. The elicitors consisted of professionals and individuals from other companies. The basis of the interpretation and the scale used in the usability survey is shown Table 1. The specific criteria score was computed as the average of the rating for the specific criteria while the category score (i.e., navigation) was computed as the average of the criteria scores.

Table 1. Usability Metric

Usability Metric	Scale
Excellent	9.00 -10.00
Very good (minor inconsistencies, aesthetic issues)	7.00 – 8.99
Good (non-critical, causes moderate confusion or irritation)	5.00 – 6.99
Fair (serious problem that needs a high priority fix; user can make a significant error)	3.00 – 4.99
Poor (severe problem)	1.00 - 2.99

Based on the results shown in Table 2, the system was rated excellent with an overall score of 9.01. This implies that the system is extremely acceptable among the users. Specifically, the result reveals that the site showed great Web usability with a very good rating in navigation (8.98), an excellent rating in functionality (9.03), a very good rating in user control (8.97), an excellent rating in language and content (9.02), an excellent rating in online help and user guides (9.07), an excellent rating in system and user Feedback (9.01), an excellent rating in consistency (9.06), a very good rating in error prevention and correction (8.97), and an excellent rating in architectural and visual clarity (9.01). The details of each criterion are shown in the appendix section.

Table 2. Summary of the Usability Results

USABILITY METRICS	SCORE	INTERPRETATION
A. Navigation	8.98	Very Good
B. Functionality	9.03	Excellent
C. User Control	8.97	Very Good
D. Language and Content	9.02	Excellent
E. Online Help and User Guides	9.07	Excellent
F. System and User Feedback	9.01	Excellent
G. Consistency	9.06	Excellent
H. Error Prevention and Correction	8.97	Very Good
I. Architectural and Visual Clarity	9.01	Excellent
OVERALL	9.01	Excellent

9. SUMMARY AND CONCLUSION

The aim of this research was to design a reliable web-based approach to Knowledge Product Outsourcing services in Silliman University. The technologies, methodologies, and theories involved in a web-based approach to Knowledge Product Outsourcing were investigated and outlined. The major motivation in the undertaking of the project included the opportunities presented by the growing trend of outsourcing, the addressing of the inherent cost and challenges in finding experts, the availability of Web technologies in the university, and the action to implement as directed by the Silliman University Strategic Plan 2008-2016. The existing theories and ideas, research, and development tools discussed in the project were used to deliver a reliable web-based approach to Knowledge Product Outsourcing services in Silliman University. They

were shown, established, and evaluated. The existing concepts of ICT made it possible to allow the communication protocol and hosting of applications in the Web server. These provided the facilities to allow dynamic websites to be hosted whose contents relied heavily on user content. The theory of Web Usability allowed the system to be evaluated and it provides “ease of use” to the users. The theories of Web analytics, search engine optimization, and online payment were used to deliver the system functions and requirements, as explained in the implementation section.

The Rapid Application Development (RAD) model was the software development model used to develop the online KPO service. RAD was the most practical approach for projects with tight schedule. The KPO system offers a single platform with a more comprehensive set of technologies that offers online consultancy. The system’s major features, which support the processes of Knowledge Product Outsourcing, include net meeting and interaction application, online private messaging, knowledge exchange and sharing, payment, and Search Engine Optimization. A unique feature of the KPO in Silliman University is that it allows only bona fide university professionals to register as knowledge providers and experts.

Several tools were used to evaluate the different aspects of the system, aspects that needed to be present in order to achieve the research objectives. The Web Usability Test was used to evaluate the site’s “ease of use.” A Web accessibility tool (Wave Web Accessibility) was used also to determine if the site was conforming to the accessibility standards in the Web. A reliability test using the Apache Web server logs was used to determine if the site had application errors during the test period. A security test used an online evaluation website (ZerodayScan) to determine and correct any security vulnerabilities of the website.

After a thorough analysis and design, a reliable web-based approach to KPO services in Silliman University was achieved. Based on the Web Accessibility and Web Usability results, the website provided users with a high ease of use and a high degree of usability to all knowledge providers and elicitors. It had 0 Web accessibility errors, an 8.98 score for navigation, a 9.03 score for functionality, a 8.97 score for user control, a 9.02 score for language and content, a 9.07 score for online help, a 9.01 score for user feedback, a 9.06 score for consistency, and a 9.01 score for architectural and visual clarity. The scores translate to excellent ratings (for scores >=9.00), and very good ratings (for scores between 7.00 - 8.99). Having a high ease of use and high degree of usability promote usage and the retention of users in the site.

The site is able to provide high availability, along with efficient and fast turnaround in the process of requesting and exchanging knowledge. It does so by having immediate access and facilities for an elicitor to post a request, and the equally immediate facility to inform experts about the request and provide online consultation. With its fast turnaround cycle, the site also promotes the usage and retention of users in the site.

The Web Security Test showed that the site was able to provide a reliable and secured access to the system in performing KPO services and payment system. It reported 0 security vulnerabilities. Having a secured site is important for establishing trust and confidence in users when they are using the site, and for maintaining the integrity the KPO system.

The presence of Search Engine Optimization (SEO) elements in the site achieves its objective. The site is able to implement SEO in its URLs and architecture using Web feeds, social bookmarking, email links, and search engine sitemaps. Having a SEO-incorporated site promotes the site on other webpages and social networks. It also increases the overall visibility of the site, which, in turn, increases the amount of users visiting the site as well as the opportunities they

may bring.

The presence of on-site Web Analytics was implemented using Web Analytics Direct Visitor Reports. The report measures a user’s activity, such as how long and how often they visit a website, and page referrals. Having on-site Web Analytics helps estimate and evaluate the performance of the website, and helps in the overall improvement of the site. It shows the pages that are the most popular and improves the ones that are not.

With the aspects of a website’s “ease of use,” high availability, and turnaround; Web security and reliability; SEO; and on-site Web Analytics the objectives set by the project have been achieved. All of which have lead to a reliable web-based approach to KPO services.

10. RECOMMENDATIONS

In order to maximize the performance of a website’s services, it is recommended that a separate Web server be used as the host for the website, rather than using the current intended Web server that already hosts several Web applications. This is to ensure that the Web application services installed on the Web server, such as the Content Management System (CMS), will maintain, and not degrade, its performance. To maintain the optimal functioning conditions of the server, a maintenance plan is needed to ensure that the website’s functions are constantly delivering effective results. The primary aspects of the server maintenance plan are conducting scheduled maintenance and the application of updates. Scheduled maintenance includes the regular backup of data, refreshing key programs, and running diagnostic programs. During this scheduled maintenance time, the server must be removed from the production environment to complete its scheduled maintenance. It also must be scheduled to occur outside normal servicing hours to minimize the impact of the server downtime. Data backup typically occurs at midnight, daily. The maintenance plan includes the application of software updates. A software update provided by the manufacturer may be supplied to address known issues. However, not all updates are recommended and they must be selectively installed. Updates that are recommended are updates that are for addressing a security weakness.

Appendix, Usability Results

USABILITY METRICS	SCORE	INTERPRETATION
A. Navigation	8.98	Very Good
Current location within the site is shown clearly.	8.89	Very Good
Link to the site's main page is clearly identified.	9.00	Excellent
Major/important parts of the site are directly accessible from the main page.	8.97	Very Good
An easy to use search function is provided, as needed.	9.00	Excellent
The site accommodates novice to expert users.	9.03	Excellent
B. Functionality	9.03	Excellent
Functions are clearly labeled.	9.14	Excellent
Essential functions are available without leaving the site.	9.08	Excellent
Plug-ins are used only if they add value.	8.86	Very Good
C. User Control	8.97	Very Good
The site reflects the user's workflow.	9.03	Excellent

The user can cancel any operation,	8,86	Very Good
A clear exit point is provided on every page.	9,05	Excellent
Each page loads moderately to accommodate slow connections.	8,95	Very Good
The currently used browser is supported.	8,97	Very Good
D. Language and Content	9,02	Excellent
Important information and tasks are given prominence.	8,86	Very Good
Information of low relevance or rarely used information is not included.	8,92	Very Good
Related information or tasks are grouped on the same page or menu.	9,11	Excellent
The language is simple and without jargon.	8,92	Very Good
The paragraphs are brief.	9,30	Excellent
The links are concise, expressive, and visible- -not buried in text.	9,08	Excellent
The terms are defined.	8,95	Very Good
E. Online Help and User Guides	9,07	Excellent
The site is designed to require minimal help and instructions.	9,05	Excellent
Help and instructions, if needed, are easily accessible.	9,08	Excellent
F. System and User Feedback	9,01	Excellent
It is always clear what is happening on the site - - visual hints, etc.	9,05	Excellent
Users can receive email feedback if necessary.	9,08	Excellent
A confirmation screen is provided for form submittal.	9,00	Excellent
All system feedback is timely.	9,03	Excellent
Users are informed if a plug-in or browser version is required.	8,92	Very Good
Each page includes a "last updated" date.	9,00	Excellent
G. Consistency	9,06	Excellent
The same word or phrase is used consistently to describe an item.	9,08	Excellent
Link reflects the title of the page to which it refers.	9,03	Excellent
Browser page title is meaningful and reflects main page heading.	9,08	Excellent
H. Error Prevention and Correction	8,97	Very Good
Users can rely on recognition, not memory, for a successful use of the site.	8,92	Very Good
The site tolerates a reasonable variety of user actions.	9,00	Excellent
The site provides concise instructions for user actions.	8,97	Very Good
Error messages are visible, not hidden.	8,97	Very Good
Error messages are in plain language.	8,97	Very Good
Error messages describe actions to remedy a problem.	8,97	Very Good
Error messages provide a clear exit point.	8,97	Very Good
I. Architectural and Visual Clarity	9,01	Excellent
The site is organized from the user's perspective.	9,03	Excellent
The site can be easily scanned for organization and meaning.	8,92	Very Good
The site design and layout is straightforward and concise.	9,00	Excellent
The site design and layout are redundant only when required for user productivity.	9,05	Excellent
White space is sufficient; the text on each page is not too dense.	8,95	Very Good
Unnecessary animation is avoided.	9,00	Excellent
Colors used for visited and unvisited links are easily seen and understood.	9,05	Excellent
Bold and italic text is used sparingly.	9,11	Excellent

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