

Study and Development of Learning Object Repository (LOR) Service in Rural Area Using the Perspective of Product Service System

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Keywords:

E-Learning
Learning Management System
Learning Object Repository
Product Service System
Rural Networks
Product Service System

ABSTRACT

Digital learning in rural areas have various limitations, such as limitations in access to information and the lack of human resources in rural areas. Availability of learning materials / learning objects (LO) is one of the supporting components of the existing presence of digital learning. Thus it takes existence of Learning Object Repository (LOR) that serves as a storage and information portal for the LO. LOR existence must be supported by a Learning Management System (LMS) that enables interaction between teachers and students in schools within the scope of digital learning. Product development, services and LOR system in rural areas in this study developed using methodologies and perspectives of PSS (Product-Service System).

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1. INTRODUCTION

Various studies have been done to allow learning by using information technology or can be called digital learning or e-learning in rural areas. It's starting from procurement of wireless network connections, provisioning of virtual classrooms for distance learning. The definition of e-learning in general says that e-learning is a set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms and digital collaboration that enable educational content available in a variety of types of electronic media [1]. These educational media used in e-learning can be called with learning objects (LO). Harman and Koohang defined that "a learning object is not merely a chunk of information packaged to be used in instructional settings. A learning object, therefore, can include anything that has pedagogical value - digital or no- digital such as a case study, a film, a simulation, an audio, a video, an animation, a graphic image, a map, a book, or a discussion board so long as the object can be contextualized by individual learners" [2].

Then to allow accessibility, re-use of the LO, we need a storage system called a learning object repository (LOR) [3]. The possible benefits of LORs can be summarized as: collection, presentation, and management of learning objects in a central repository which can globally be accessed on the Web, cost savings by avoiding repetitions in learning resources development, promoting high quality objects production and sharing, enabling learning resources exchange. [4]

Research team in information and communication technology development group or known as PPTIK (*Pusat Penelitian Teknologi Informasi dan Komunikasi*) ITB (Institut Teknologi Bandung) at Bandung, West Java, Indonesia has a test site for developing a digital learning service at Arso, Keerom District, Papua, Indonesia. Learning Management System (LMS), namely Moodle used in the test site provides a way for teachers and students to interact through the same e-learning system.

However, the digital learning service has not yet provided a LOR service that tailored specifically to rural areas needs so that learning material can be stored, organized, and distribute effectively in rural areas. The application of LOR in rural areas is facing numerous problems. Distribution problems and data replication mechanism used in LOR is one of the crucial problems faced. How to keep the LOs in LOR

owned by PPTIK ITB (later will be stated with LOR central) can be accessed efficiently by the users in rural area. This is the problem which is the main topic of this study.

2. RESEARCH METHOD

PSS development process by Nicola Morelli in his research is a design exploration process that consists of an iterative phase of each stage. Each stage produces a solution or an outcome. The process of developing a product or service used in PSS perspective consists of stages as seen on Figure 1.

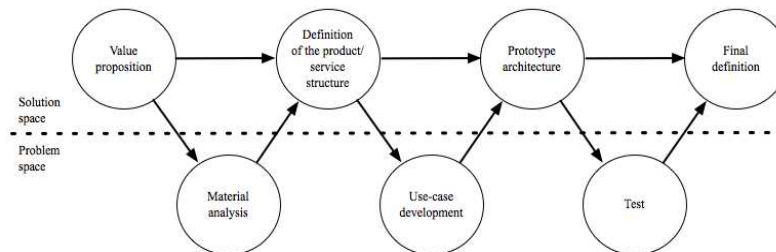


Figure 1. PSS Development Steps [5]

Figure 1 represents the design process followed for the development of a support service for LOR research project. The schematic representation of the sequence emphasizes two dimensions (spaces): a problem space, or behavioral space in which functional requirements are explored, and a design space or structure space in which solutions are proposed. Problem phases lead to new solutions which in turn, refocus the problems and prompt new requirements [5].

3. RESULT AND ANALYSIS

Using the PSS perspective result and analysis chapter presented with methods according to PSS development process and the final definition will be concluded in conclusion chapter.

3.1. Value Proposition

LOR for the education network in rural areas is an activity, methods, procedures and tools which has a function to store (storing), take (retrieving), distribute (distributing) learning objects used in the learning process. LOR is designed with PSS perspective that takes into account socio-cultural aspects (i.e. language) users, aspects of technology and human resources aspects of the user, with a purpose that is LOR can be used by human resources and may involve less experts derived from the city.

3.2. Material Analysis

Material analysis in PSS not only considering physical devices but also considering tangible material such as: users, competitors and other related services.

In developing LOR product and services in rural area different problems must be considered, problems that often occurs in rural area. These problems are: Electricity problems or failure and slow recovery when it occurs, location between nodes are far apart, making it difficult in supporting LOR existence and in socialization process, most rural communities have limited knowledge in using computer [6], level of hardware malfunction higher in rural areas compared with urban areas, internet used to access LOR is often not available or have low levels of availability, low speed internet access, making it hard to distributes LO to LOR rural areas.

To solve or minimize the problems stated above several strategies must be proposed, such as: Providing LOR products and services which can be used without internet connection (later will be stated as local or client LOR), it also designed to use Bahasa Indonesia as a language of instruction, so that it can be easier to use then understood by the community, then providing a detailed documentation that is easy to understand in the form of a written document or video that explains how to use the LOR products and services.

In finding solutions for the problems on providing LOR services at rural areas, there are several researches that describing various methods or architecture of the system synchronization, replication and distribution that have been developed, followed by an technology analysis of researches that described to use in rural areas, among others:

- Edutella [7], LOMster [8] and LionShare [9], Boomerang [10]

The use of JXTA technology on the research cannot solve existing problems in the design of data distribution for LOR in rural areas. JXTA protocol is not fundamentally a structured network and designed to share files among users. Various types of existing applications such as Edutella, LOMster, LionShare and Boomerang also developed by the University to allow users inside or outside the campus shared LO without burdening the main server, either in providing storage space or internet bandwidth for

this activity. Something different is expected in the design of LOR for these rural areas, where the system is designed to have one main LOR server and then the data is distributed to a LOR which is closest to users in rural areas.

- TriblerCampus [11]

The design of LOR in rural areas can use similar architecture used by TriblerCampus in its design, it has the same goal of improving the performance of the network and also increase the level of availability of services provided. However, the main problem that occurs with the architecture design of TriblerCampus is the distribution and data replication problems. The data contained in the LOR central will always increase and this data must be distributed to LOR in rural areas. Update and synchronization problems become major obstacles in the design of LOR service in rural areas that cannot be solved using this architecture.

- EduLearn [12]

Architecture of EduLearn enables users who use the same EduLearn software to run on each machine and share information with other LOR. However, updates and data synchronization problems in the LOR, is not provided in this architecture. While the LOR design in rural areas, is expecting that client LOR in rural areas have the same contents as the one in central LOR. This allows LOR's users obtain the latest information.

- aAQUA offline [13]

Architecture offered by aAQUA offline, can be a solution to existing problems in service system design LOR in rural digital educational network. This architecture allows quick access to information; it can be accessed directly from a user's computer without requiring an internet connection. This architecture can be as reference when designing a LOR products and services for rural areas, although there are differences in applications and data replication mechanisms that are used.

Based on the analysis above, we obtained a data replication mechanism in accordance with the rural area's needs, which is asynchronous mechanism with means that data contained in the LOR rural area is in not always in the same state as to those on the central LOR. This is supported by [14] and also [15]. Then we also got an architecture that is single-master where there is only one server LOR center and more than one client LOR in rural areas. With data replication mechanisms that are using full replication, where all the contents from the central LOR will be replicated by LOR in rural areas. The same was done by [15]. Nevertheless, if later the LOR placed in different areas (not in the same local administration), the ideal type of replication is a partial replication, where replication is only done for data that is suitable for a particular area.

3.3. Product/Service Definition

From the material analysis above we can deduce the definition and the expected product. The resulting product is a central LOR, LOR local integrated with LMS. The services are training, help or support, and configuration updates.

3.4. Use Case Analysis

The use-case diagram in LOR system for rural areas is divided to two use case diagram. First diagram is for the LOR and LMS product integration and the second for the LOR services. Three actors involved in the LOR and LMS product integration use case diagram as seen on the left side of Figure 2 below. Central administrator who is the first actor has duties to start the central LOR server, update the data contained in the LOR and manage users in the central LOR. Then the second actor is the LOR client user, who can start the LOR client and LMS, find information needed in LOR, manage client users, adding LOR data to LMS and manage courses on LMS. The third actor is student who can access LO with enrolling to courses provided in LMS.

The second use case diagram on the right side of Figure 2 describes the task of the system administrator which has tasks to provide training for users of LOR products and services, providing supports and helps to users with difficulties in using the LOR products or services, the system administrator also provides supports in configuring the system used in LOR and also describes the services provided by LOR products in rural areas. The services also allow LOR users in rural areas updating their LOR by replicating the data contained in the central LOR.

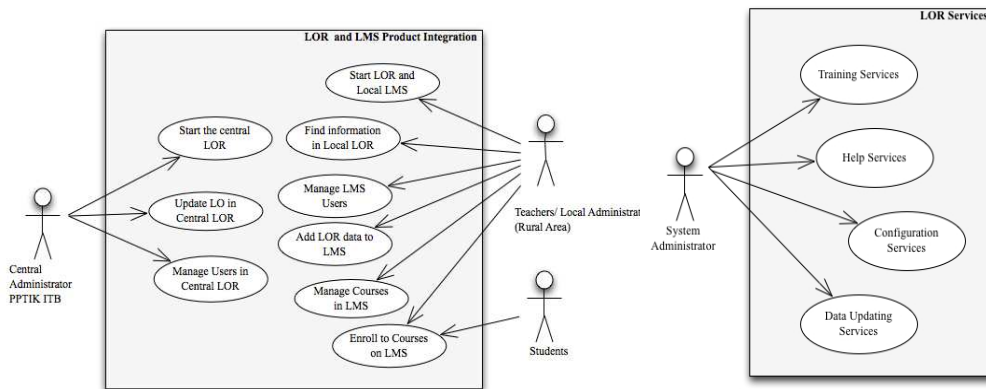


Figure 2. Use Case Diagram for LOR and LMS Product Integration and Use Case Diagram for LOR Services

3.5. Tentative Architecture

Based on material analysis result above, there are two sides of LOR developed the first side is a central LOR which is located in PPTIK ITB, Bandung and the client LOR which is located at rural area or in this case in Papua. LOR client is placed in the local/client computer. Then there is a mechanism which allows both of LORs become in the same state. The data in the local LOR will be updated through certain mechanism so it will have the same data with the central. The update mechanism will be designed in simple steps that is easy to do and is designed to not burdening the user with technical things that quite difficult to understand and also can be performed by a novice user. LOR general description for educational networks in rural areas can be seen in Figure 3.

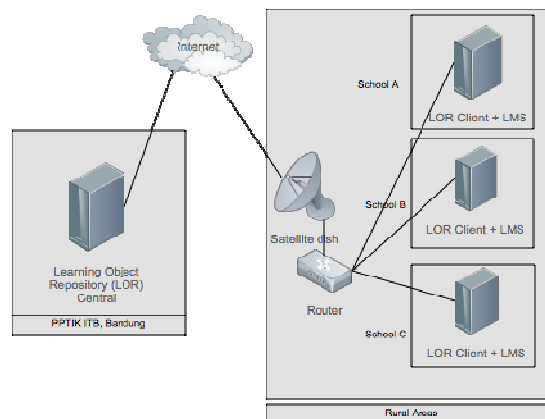


Figure 3. LOR General Architecture

Software development LOR is designed using open source software tailored for rural needs. LOR is designed to be easy to use, without complicated installation procedure and a long installation time. Therefore the LOR designed in this study does not require any installation. LOR products available to download from the PPTIK website or can be distributed via physical media such as USB disks or CD-ROM. LOR files can be copied to a computer and directly ready for use. Thus users in rural areas can run the LOR easily, without worrying the installation and configuration procedures required.

LOR design for rural areas is addressed to users who use Windows OS on their computer, considering that more Windows users than any other OS. Furthermore, distinguishing between central LOR and LOR client in rural areas is the availability and the integration with LMS used in rural areas (Moodle).

There are basically two types of data that must be replicated between the central LOR and client LOR in rural areas. LO data contained in the LOR central consists of two types of data, the first type are file of documents, presentations, images, animations, sounds, videos and the second type of data is in the form of an index or collection of information from the physical document. The information index data is stored in a MySQL database. In the central LOR the MySQL database will be back up every day. The LO data later will be sent from the central LOR to the LOR in rural areas using replication process on the LOR.

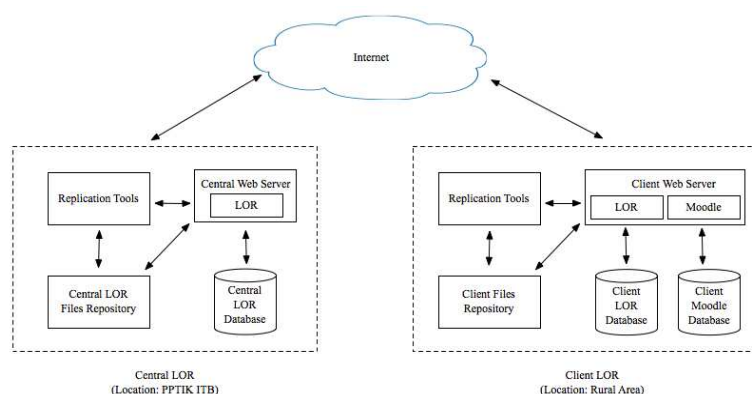


Figure 4. Central LOR and Client LOR detailed architecture

Components that are used in central LOR and client LOR divided by each functions as seen on Figure 4: The need of replication process between central LOR and client LOR created new LOR software that is based on DOOR [16] with additional capabilities in syncing LOR files database and using Rsync and custom PHP scripts. Replication tools used in the design is Rsync. Rsync allows transfer of data between computers occurs in a state that allows data to be sent compressed using a smaller bandwidth. Rsync can detect files that have been there and did not transfer the file again, so it will only download new files or those that have changed in the LOR. MySQL database is used in this design. Web server that is used in the LOR product is Apache with PHP integration. The central server designed is using Ubuntu Linux while the client LOR running on Windows.

3.6. Testing

Testing conducted for each component of the products and services in accordance with the existing use case diagram. In tests performed LOR central and client can run well. The Graphical User Interface (GUI) the LOR central and client are similar (Figure 5) with the difference on the function. The LOR client administrator (teacher) cannot add new LO. While the central LOR has more complete functions where central administrators can add new LO to the LOR central.



Figure 5. LOR Running on Client

LMS in each client can access the LO from LOR is proving that the LOR client can perform its functions properly (Figure 6). LOR client can also synchronize data with LOR centers using facilities at LOR client.



Figure 6. LOR Usage in Learning Management System

4. CONCLUSION


Study and development of LOR products and services platform for digital education networks in rural areas using the perspective of PSS resulted in two major parts, LOR products and services. The products developed are LOR central and LOR client that were developed using on DOOR software with modifications in allowing easy to use data synchronization between LORs. LOR client can be integrated with the LMS used in rural areas. The LOR services provide documentations, supports and LOR updating services. By considering aspects of language as one of the component used in development process using PSS perceptive, LOR developed in this study was using Bahasa Indonesia as instruction language in the products and services, thus making it easier to use for rural communities. Results from this study on developing LOR for rural area can be implemented for education in rural area with further configuration in accordance with specific needs.

Further testing needs to be done, in terms of the ability of the LOR designed to work with a network that is unstable (intermittent network). Due to limited time and resources then further testing is recommended to be future research material. Further research is also needed on the mechanism of training and documentation for the use of LOR products and services in rural areas. This is necessary for the LOR products and services to be implemented optimally.

REFERENCES

- [1] K. Baldwin-Evans, "Employees and e-learning: what do the end-users think?", *Industrial and Commercial Training*, 36, 269-274, 2004.
- [2] A. Koohang and K. Harman, "Open source: A metaphor for e-learning." *Informing Science Journal*, 8, 75-86., 2005. Available from <http://inform.nu/Articles/Vol8/v8p075-086Kooh.pdf>
- [3] G. W. Matkin, "Learning Object Repositories: Problems and Promise", [Updated: March 2008; cited: 6 March 2011]. Available from: <http://learn.creativecommons.org/wp-content/uploads/2008/03/learningobject.pdf>
- [4] Z. Cebeci, et al., "TrAgLor: A Multilingual Learning Objects Repository for Agriculture and Life Sciences", *Int. J. of Metadata, Semantics and Ontologies*, 2009 Vol.4, No.1/2, pp.106 - 117
- [5] N. Morelli, "Designing Product/Service Systems: A Methodological Exploration." *Outcome of Research and Training program of Australian Research Council*; 2002.
- [6] S. H. Susilowati, et.al, "Indikator Pembangunan Pertanian dan Pedesaan: Karakteristik Sosial Ekonomi Petani Padi," *Proposal RTRP Pusat Analisis Sosial Ekonomi dan Kebijakan Pertanian Badan Penelitian dan Pengembangan Pertanian Departemen Pertanian*; 2010.
- [7] W. Nejdl, et al., "Edutella: Searching and Annotating Resources within an RDF-based P2P Network," *Proc. of the 11 th International World Wide Web Conference*, Hawaii, USA, May 2002.
- [8] S. Temier, et al., "LOMster: Peer-to-peer Learning Object Metadata," *Proc. of ED-MEDIA'2002 - World Conference on Educational Multimedia, Hypermedia and Telecommunications*; 2002.
- [9] G. Chinn, et al., "Lionshare Whitepaper." [Updated: 2006; Cited 6 Maret 2011]. Available from http://ets.tlt.psu.edu/whitepapers/LionShare_Whitepaper.pdf.
- [10] R. Lopes, et al., "Bumerang – a peer-to-peer system to share knowledge inside communities at the University". *International Conference on Multimedia and ICT and Education*, 22-24 April 2009, Lisbon, Portugal; 2009.
- [11] M. Meulpolder, "TriblerCampus: An Integrated Peer-to-peer for File Distribution in Course Management System," *Master's Thesis in Computer Science, Faculty of Electrical Engineering, Mathematics, and Computing*, Delft University of Technology; 2006.
- [12] L. S. Prakash, "Integrating EduLearn Learning Content Management System (LCMS) with Cooperating Learning Object Repositories (LORs) in a Peer To Peer (P2P) architectural Framework," *SIGSOFT Software Engineering Notes*, Volume 34 Number 3; 2009
- [13] S. Saurabh, "Information Retrieval in Resource Constrained Environment", *M.Tech Report Master of Technology, Indian Institute of Technology, Bombay, Mumbai*; 2008.
- [14] A. Pentland A, et al., "Daknet : rethinking connectivity in developing nations." *Computer*, Vol. 37, No.1, 78-83; 2004.
- [15] S. K. Lujara, "Learning Objects: A New Paradigm Learning Resource Development for Secondary Schools in Tanzania," *World Academy of Science, Engineering and Technology* 30; 2007.
- [16] DOOR Digital Open Object Repository [Internet]. [Cited March 2011] Available from <http://door.elearninglab.org>

BIBLIOGRAPHY OF AUTHOR

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